BULLETINS

OF

ALABAMA

Agricultural Experiment Station

INDEX

VOL. IV

BULLETINS 59—75

JANUARY, 1895—DECEMBER, 1896

BIRMINGHAM:
ROBERTS & SON.
1898

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BULLETIN No. 59. JANUARY, 1895.

Agricultural and Mechanical College,

EXPERIMENT STATION,

AUBURN, ALABAMA.

Co-operative Soil Tests of Corn

—BY—

A. J. BONDURANT.

MONTGOMERY, ALA.:
THE BROWN PRINTING CO., STATE PRINTERS AND BINDERS.
1894.

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CO-OPERATIVE SOIL TEST EXPERIMENTS FOR 1894.

Fertilizers, mixed at the Experiment Station, were sent to twenty-seven farmers living in different sections of the State, for Co-operative Soil Test Experiment on Corn.

The ferilizers sent out consisted of 250 pounds of cotton seed meal, and 250 pounds of acid phosphate.

The land to be used for this experiment was two plots of one-half acre each.

Plot No. 1 was to receive all of the fertilizer. Plot No. 2, no manure.

The object of this experiment was to ascertain the greatest quantity of corn that could be produced on a half acre of land, with a given quantity of fertilizer, as compared with a half acre unmanured.

The following instructions were sent to each one of the Co-operative Soil Test Experimenters:

Break the land broad-cast. When ready to plant, lay-off rows with a shovel plow. Each sack of fertilizer sent contains 125 pounds. Scatter two sacks in the furrow and follow with a scooter plow in order to mix thoroughly with the soil. Drop the corn in the furrow and cover with a scooter. When the corn is up, thin to one stalk in the hill. If the land is not already in excellent condition, plow *deep* at first plowing. All subsequent plowing should be done shallow and with a heel scrape if possible.

Some time in May scatter the other two sacks of fertilizers broad-cast, and at this time plant a row of peas in each *corn middle*. The planting of the peas and plowing in the fertilizer will be done at the same plowing.

Keep a record of the time of planting, of the method of cultivation and of the difference between the manured and unmanured plots or half-acres, and note whether the fodder ripens at the same time, or not, on both plots.

Weigh corn in the *shuck*, and report as soon as convenient after gathering.

The following tabulated reports show the results of the experiments :

CORN EXPERIMENT BY MR. E. J. BEASLEY,

Red Level, Covington County, Alabama.

Soil—Red, with Red Clay sub-soil.

Rows 70 yards long—5 feet wide.

Plot Number.	Size of Plot.	Fertilizers, use Per Plot.	Pounds yield of corn weighed in shuck.		Estimated yield per acre in bush., allowing 80 lbs. per bush., weighed in shuck.
			Per Plot.	Rate Per Acre.	
1	½ Acre........	250 lbs. C. S. Meal. 250 lbs. Acid Phos.	1243......	2486......	31⅓
2	½ "	Nothing..........	755......	1510......	18⅞

Mr. Beasley says that he prepared his land according to instructions from the Station.

Corn was planted March 10th, on the 25th killed by freeze. On the 14th of April planted the second time, securing a good stand. First plowing was done with a scooter, and succeeding culture with scrape and scooter. Just as corn was bunching for tassel, a drought began, which lasted three weeks. A good rain fell at the close of this drought, and another three weeks drought came on which cut off the fertilized half acre, fully one half. The unfertilized plot did not seem to suffer much for rain. Mr. Beasley thinks that the first application of fertilizer was lost on account of the heavy rains in April and May.

Corn Experiment by Mr. M. A. Bishop,

Madison, Madison County, Alabama.

Soil—Dark Loam with Red Clay sub-soil.
Rows 70 yards long—5 feet wide.

Plot Number.	Size of Plot.	Fertilizers used Per Plot.	Pounds yield of corn weighed in shuck. Per Plot.	Pounds yield of corn weighed in shuck. Rate Per Acre.	Estimated yield per acre in bush., allowing 80 lbs. in shuck to the bushel.
1	½ Acre........	250 lbs. C. S. Meal. 250 lbs. Acid Phos.	1262......	2524......	31½
2	½ "	No Manure.......	878......	1756......	21 9-10

The land on which this experiment was made, Mr. Bishop writes, was planted in cotton for four years in succession previous to the corn, was high upland, and well adapted for corn with favorable seasons. Planted corn March 22d, in the face of inauspicious seasons, varying from cold to dry. From April 6th to June 27th, three months lacking one week, no rain fell; and although the crop was much injured from this drought, the fertilized plot started off in advance and maintained a difference, and a good color, although the growth was slow for want of rain. After the rains set in, the fertilized plot developed a large, vigorous growth, but the ears were not in proportion to size of stalk. Plot 2, or the unmanured half acre, was the reverse as to results, the stalks being medium in size and the ears well developed. The quality of corn good from both plots.

The variety of corn used was a cross of Hickory King and Tennessee Gourd-seed.

The crop of peas on No. 1 was very fine, and will pay the rent of land, while No. 2 scarcely made the seed planted.

The variety of peas planted was the "Unknown," and was furnished by the Agricultural Department at Washington, at the suggestion of your Station.

Peas were late in ripening, which prevented the gathering of the corn until September 25th.

Corn Experiment by Mr. F. W. Bradley.

Walker Springs, Clarke Co., Ala.

Soil—Sandy with red clay sub-soil.
Rows 70 yards long—5 feet wide.

Plot Number.	Size of Plot.	Fertilizers used Per Acre.	Pounds yield of corn weighed in shuck.		Estimated yield per acre in bushels, allowing 80 lbs. in the shuck to the bushel.
			Per Plot.	Rate Per Acre.	
1	½ Acre........	250 lbs. C. S. Meal. 250 lbs. Acid Phos.	896.......	1792......	22 2-5
2	½ "	No Manure.......	435.......	870......	10⅞

Mr. Bradley says that the land on which the experiment was made was old sandy soil never before fertilized. Broke the land deep broad cast, laid off rows as directed and applied 250 lbs. fertilizers at time of planting which was Mar. 27th. Failed to get a stand and planted again April 14th, and failing again, replanted the second time April 26th, when a good stand was secured. Thinned to one stalk to the hill. First plowing was done with shovel and sweep. Used the other 250 lbs. fertilizer at second plowing. Plowed corn every two weeks. Injured very much from drought.

Corn Experiment by Mr. G. W. Compton.

Wayne, Marengo Co., Ala.

Soil—Dark sandy with clay subsoil.
Rows 70 yards long—5 feet wide.

Plot Number.	Size of Plot.	Fertilizers used Per Plot.	Pounds yield of corn weighed in shuck.		Estimated yield per acre in bush., allowing 80 lbs. in shuck to the bushel.
			Per Plot.	Rate Per Acre.	
1	½ Acre........	250 lbs. C. S. Meal. 250 lbs. Acid Phos.	538.......	1076......	13 3-7
2	½ "	No Manure.......	196.......	392......	4 9-10

Mr. Compton writes: "I planted corn Mar. 16th, at which time I put in one-half the fertilizers. Corn came up and looked well until the last of April. Rains were plentiful until the 19th of April. On May the 12th a light shower fell, at which time I applied the other half of fertilizers, and there was no more rain until the 19th of July, which made 67 days without rain. The fertilized corn burned up to the ear. The crop is about one-half what it would have been with seasons.

Corn Experiment by Mr. R. H. Cross.

Letohatchie, Lowndes Co. Ala.

Soil—Dark sandy with clay sub-soil.
Rows 70 yards long—5 feet wide.

Plot Number.	Size of Plot.	Fertilizers, use Per Plot.	Pounds yield of corn weighed in shuck.		Estimated yield per acre in bush., allowing 80 pounds in the shuck to the bushel.
			Per Plot.	Rate per Acre.	
1	½ Acre........	250 lbs. C. S. Meal 250 lbs. Acid Phos.	1820...	3640...	45½
2	½ Acre..........	No Manure.......	980...	1960 ..	24½

The results of Mr. Cross's experiment are more satisfactory than some others, which may be attributed to the favorable seasons. He says this acre was in cotton last year (1893) from which he gathered a good crop. In February, the land was broken with a Double Avery plow, turning under the cotton stalks. On March 1st laid off rows 5½ feet wide with a long scooter, distributed fertilizer and bedded on it, with a Pony Avery plow. Next day opened furrows and planted the usual way, and in a few days had a perfect stand.

Cultivated the crop very shallow after the first plowing.

The seasons were all that could be desired for a perfect development of stalk and ears.

A magnificent crop of peas is made which were planted at the last plowing of corn.

Corn Experiment by Prof. H. Benton.

Uniontown, Perry Co., Ala.

Soil—

Rows 70 yards long—5 feet wide.

Plot Number.	Size of Plot.	Fertilizers used Per Plot.	Pounds yield of corn weighed in shuck. Per Plot.	Pounds yield of corn weighed in shuck. Rate per Acre.	Estimated yield per acre in bush., allowing 80 pounds in the shuck to the bushel.
1	½ Acre........	250 lbs. C. S. Meal. 250 lbs. Acid Phos.	626....	1252....	15 6-10
2	½ Acre..........	No Manure.	468....	936....	11 7-10

Mr. Benton accompanies his report with the following remarks: "The land used for this experiment was a rich bottom. The small yield was due to the long drought from April 11th to July 16th. All corn in this immediate vicinity suffered likewise.

One noteworthy fact is that the experiment shows that fertilizers will increase the yield on canebrake lands, a fact which is denied by most farmers of this section."

CORN EXPERIMENT BY MR. JOHN F. DEER.

Monroeville, Monroe Co., Ala.

Gray sandy soil with clay sub-soil.
Rows 70 yards long—5 feet wide.

Plot Number.	Size of Plot.	Fertilizers used Per Plot.	Pounds yield of corn weighed in shuck.		Estimated yield per acre in bush., allowing 80 pounds in the shuck to the bushel.
			Per Plot.	Rate per Acre.	
1	½ Acre........	250 lbs. C. S. Meal. 250 lbs. Acid Phos.	800....	1600....	20
2	½ Acre..........	No Manure.......	483....	966....	12 1-16

This experiment was planted March 13th, instructions being followed as to preparation, putting in fertilizer, &c. Corn was killed and replanted March 30th, resulting in a good stand. Mr. Deer says on the 14th of April, run around corn with a "half-twister" barring it off, in which condition it remained until the 26th, when the dirt was thrown back to it. Hoed it May 1st and on the 3d plowed out middles. Run around corn May 15th with Dixon sweep, planted the "Unknown" pea in this furrow three days afterwards and covered with the same sweep. On the 31st plowed out the middles.

Second application of fertilizes made at time of planting peas, May 18th.

Good rains, in fact there was too much rain up to the 24th, and none from that time to the 17th of June. For four days previous to this rain corn failed rapidly and a fair estimate is, that it was cut off one-third.

Fertilized plat grew rapidly from the beginning and appeared to be about 10 days earlier than the unmanured.

Much of plot 2 was destroyed by worms. While plot 1 averaged 90 hills to the row, plot 2 averaged 60 hills.

Corn Experiment by Mr. R. M. Dick.

Albertville, Etowah Co., Ala.

Red loam soil—red clay sub-soil.
Rows 70 yards long—5 feet wide.

Plot Number.	Size of Plot.	Fertilizers used per Plot.	Pounds yield of corn weighed in shuck.		Estimated yield in bush. per acre, allowing 80 lbs. in shuck to the bushel.
			Per Plot.	Rate per Acre.	
1	½ Acre........	250 lbs. C. S. Meal 250 lbs. Acid Phos.	978...	1956...	24½
2	½ Acre..........	No Manure.......	485...	970...	12⅛

Mr. Dick says that on the 19th and 20th of May a cold spell injured the corn very much, at which time plot 1 was twelve inches high, vigorous and green, and plot 2 was four inches high, yellow and not vigorous. Plot 2 was not damaged so much as the other plot, it being less forward. Mr. Dick remarks that one thing developed, "that Sand Mountain soil will stand as heavy fertilizing as river or creek bottoms, so far as moisture is concerned."

Corn Experiment by Maj. E. M. Davis.

Prattville, Autauga County, Alabama.

Plot Number.	Size of Plot.	Fertilizers used per plot.	Pounds yield of corn weighed in shuck.		Estimated yield per acre in bush., allowing 80 pounds in the shuck to the bushel.
			Per Plot.	Rate per Acre.	
1	½ Acre.........	250 lbs. C. S. Meal 250 lbs. Acid Phos.	593	1186	14 4-5
2	½ Acre	No manure.......	389	778	9 7-10

Mr. Davis says: "This has been a bad year for fertilizers in this country, the extremely dry spring and early summer seem to have caused the plant to lose the benefit of the 250 lbs. applied at planting time."

Corn Experiment by Mr. R. T. Ewing.

Round Mountain, Cherokee County, Alabama.

Soil—Gray sandy (piney woods) yellow clay sub-soil.
Rows 70 yards long—5 feet wide.

Plot Number.	Size of Plot.	Fertilizers used per Plot.	Pounds yield of corn weighed in shuck. Per Plot.	Pounds yield of corn weighed in shuck. Rate per Acre.	Estimated yield per acre in bush., allowing 80 lbs. in the shuck to the bushel.
1	½ Acre	250 lbs. C. S. Meal. 250 lbs. Acid Phos.	1165	2330	29⅛
2	½ Acre	No Manure........	793	1586	19 4-5

Mr. Ewing reports that he planted corn on April 7th, and owing to the late cold Spring, had to replant three times before securing a stand. Preparation of land, putting in fertilizers, &c., were according to instructions. On 2nd of May run around corn with scooter and scrape, and on the 5th plowed out middles. On the 12th run around with scooter and scrape and followed with hoe. Did the same on the 22d. On May 31st run a furrow in the middle of each row, dropped peas in this furrow, scattered the other 250 lbs. fertilizer broadcast and plowed out with scooter and 20 inch scrape.

All of May and the early part of June was dry and the fertilized portion of experiment stood drought better than the other.

CORN EXPERIMENT BY PROF. J. B. ESPY.

Southeast Alabama Agricultural School, Abbeville, Henry County, Alabama.

Soil—Sandy. Sub-soil, sand and clay mixed.

Plot Number.	Size of Plot.	Fertilizers used Per Plot.	Pounds yield of corn in the ear. Per Plot.	Pounds yield of corn in the ear. Rate per Acre.	Estimated yield per acre in bush., allowing 70 lbs. in the ear to the bushel.
1	½ Acre........	250 lbs. C. S. Meal. 250 lbs. Acid Phos.	726.......	1452......	20 5-7
2	½ Acre..........	No Manure..	403.......	806......	11½

The report of this experiment, as will be seen from the above table, was made in the *ear* instead of in the shuck. The estimate is made at the rate of 70 lbs. of ear corn to a bushel of shelled, that being the custom. Prof. Espy says that the corn was planted Mar. 12th, but owing to a freeze killing it, was replanted April 14th.

Fertilizer on plot 1 was put on at time of planting, that is the first application and the other 250 lbs at last plowing. First plowing May 8th, second May 23d, and third and last plowing, June 9th. Seasons very unfavorable, no rain for two months after the first plowing.

Prof. Espy thinks the last application of fertilizer did very little good.

Plot 1 yielded 165 lbs. fodder and plot No. 2, 98 lbs.

CORN EXPERIMENT BY DR. JOHN GORDON.

Healing Springs, Washington County, Alabama.

Soil—Sandy loam. Sub-soil about the same.
Rows 70 yards long—5 feet wide.

Plot Number.	Size of Plot.	Fertilizers used per Plot.	Pounds yield of corn weighed in shuck. Per Plot.	Pounds yield of corn weighed in shuck. Rate per Acre.	Estimated yield per acre in bush., allowing 80 pounds in the shuck to the bushel.
1	½ Acre........	250 lbs C. S. Meal. 250 lbs. Acid Phos.	750....	1500....	18¾
2	½ Acre..........	No Manure.......	288 ...	576....	7 1-5

Dr. Gordon makes the following statement about his experiment: "The experiment was almost a complete failure in consequence of the dry weather in May and June, and the excessive rains in July and August. I followed instructions in preparing land and cultivating crop. Planted corn Apr 6th in 5 feet rows. Plowed May the 7th, thinned to a stand and sided up on the 17th. Plowed with heel scrape June 12th, planted peas and put down the other 250 lbs fertilizer at this time."

CORN EXPERIMENT BY MR. J. A. LOGAN.

Clanton, Chilton County, Alabama.

Soil—Mulatto and sandy. Sub-soil, red clay.

Plot Number.	Size of Plot.	Fertilizers used per Plot	Pounds yield of corn weighed in shuck. Per Plot.	Pounds yield of corn weighed in shuck. Rate per Acre.	Estimated yield per acre in bush., allowing 80 pounds corn in shuck to bushel.
1	½ Acre........	250 lbs. C. S. Meal. 250 lbs. Acid Phos.	1103....	2206....	27 3-5
2	½ Acre..........	No Manure.......	570....	1140....	14¼

Mr. Logan, in selecting his ground for experiment, says that he got an acre as level as possible, plowed it broad-cast from 4 to 6 inches deep on Mar. 1st, and on the 24th run off rows 5 feet apart, using mold board, put in 250 lbs. of fertilizer and run a small plow through it in order to mix it with the soil. In this furrow he dropped the corn and covered with one furrow. On April the 2nd put another furrow on opposite side.

The experiment was cultivated according to directions and did not lack for work. On May 22nd the other 250 lbs. fertilizer was scattered broad-cast, corn plowed, hoed and put to a stand. Bud worms were very injurious and with difficulty succeeded in getting a stand. From the 14th to the 22nd of May, light showers and some little rain in June, but the corn was in a wilted condition half the time. Mr. Logan thinks on account of the dry weather, that the last 250 lbs. of fertilizer did but little good.

Corn Experiment by Mr. J. P. Oliver.

Dadeville, Tallapoosa Co., Ala.

Soil—Gray sandy—sub-soil, clay.
Rows 70 yards long—5 feet wide.

Plot Number.	Size of Plot.	Fertilizers used per Plot.	Pounds yield of corn weighed in shuck.		Estimated yield per acre in bush., allowing 80 lbs corn in the shuck to the bushel.
			Per Plot.	Rate per Acre.	
1	½ Acre........	250 lbs. C. S. Meal. 250 lbs. Acid Phos.	1110....	2220....	27¾
2	½ Acre..........	No Manure.......	960....	1920 ..	24

Corn was planted April 1st. Preparation of land, applying fertilizers and culture of crop according to instructions. Mr. Oliver says that the long and very severe drought at the time the corn was tasseling and silking, reduced the yield considerably. No fodder was saved—all burnt up and peas failed to come up, the ground being so hot and dry.

Corn Experiment by Mr. J. C. Ott.

Florence, Lauderdale Co., Ala.

Soil—Gray and gravelly—sub-soil, clay.
Rows 70 yards long—5 feet wide.

Plot Number.	Size of Plot.	Fertilizers used Per Plot.	Pounds yield of corn weighed in shuck.		Estimated yield per acre in bushels, allowing 80 lbs. in the shuck to the bushel.
			Per Plot.	Rate Per Acre.	
1	½ Acre........	250 lbs. C. S. Meal. 250 lbs. Acid Phos.	1622......	3644......	40½
2	½ Acre..........	No Manure.......	1390......	2780......	34¾

While this experiment was considerably damaged by cold in the spring according to Mr. Ott's opinion, yet the yield is quite satisfactory. He says it was planted on clover land which was broken flush last fall, and this in connection with favorable seasons after the crop started off, is the reason why there is so little difference between the manured and unmanured plots.

Corn Experiment by Mr. T. M. J. Porter.

Georgiana, Butler Co., Ala.

Soil—Light sandy—sub-soil, red and yellow sand.
Rows 70 yards long—5 feet wide.

Plot Number.	Size of Plot.	Fertilizers used per Plot.	Pounds yield of corn weighed in shuck.		Estimated yield per acre in bush., allowing 80 lbs. in shuck to the bushel.
			Per Plot.	Rate per Acre.	
1	½ Acre........	250 lbs. C. S. Meal. 250 lbs. Acid Phos.	1617	3234	40 3-7
2	½ Acre..........	No Manure.......	945	1890	23⅝

Mr. Porter says he carried out instructions according to the letter. The plot was selected in a field planted in oats last year (1893), but a portion of the plot had peas on it the year before, and the difference in the corn where the peas had been grown was so marked as to attract the attention of every visitor who saw it.

May 16th plowed corn the last time, and at this time put down the last fertilizer and planted peas. From the 2nd of May until the 17th of June, had no rain. Mr. Porter says he thinks the crop would have doubled in yield, had the seasons been favorable. His opinion is that the "*intensive system*" is the best, as better crops are insured and the land vastly improved by it.

Corn Experiment by Mr. M. H. Sellers.

Geneva, Geneva Co., Ala.

Soil—Sandy, with sub-soil of clay and sand mixed.
Rows 70 yards long—5 feet wide.

Plot Number.	Size of Plot.	Fertilizers used per Plot.	Pounds yield of corn weighed in shuck. Per Plot.	Pounds yield of corn weighed in shuck. Rate Per Acre.	Estimated yield per acre in bush., allowing 80 lbs. in shuck to the bushel.
1	½ Acre	250 lbs. C. S. Meal. 250 lbs. Acid Phos.	550	1100	13¾
2	½ Acre	No Manure	200	400	5

Mr. Sellers reports that he planted corn on March 15th, was killed by freeze on the 28th, and replanted April 10th. Thinned to a stand April 18th, and cultivated with scrape and sweep.

Corn Experiment by Mr. Wm. Martin.

Greensboro, Hale Co., Ala.

Soil—Sandy loam—sub-soil, clay.
Rows 70 yards long—5 feet wide.

Plot Number.	Size of Plot.	Fertilizers used Per Plot.	Pounds yield of corn weighed in shuck.		Estimated yield per acre in bushels, allowing 80 lbs. to the bushel in the shuck.
			Per Plot.	Rate Per Acre.	
1	½ Acre........	250 lbs. C. S. Meal. 250 lbs. Acid Phos.	1400......	2800......	35
2	½ Acre..........	No Manure.	940......	1880......	23½

Mr. Martin in rendering his report simply says that the experiment suffered some for want of rain. The inference is that preparation of land, planting, culture, &c., were all according to instructions.

Corn Experiment by Mr. T. A. Snuggs.

Holly Pond, Cullman Co., Ala.

Soil—Sandy and gravelly—sub-soil, yellow sand.
Rows 70 yards long—5 feet wide.

Plot Number.	Size of Plot.	Fertilizers used Per Plot.	Pounds yield of corn weighed in shuck.		Estimated yield per acre in bushels, allowing 80 lbs. in the shuck to the bushel.
			Per Plot.	Rate Per Acre.	
1	½ Acre........	250 lbs. C. S. Meal. 250 lbs. Acid Phos.	1195......	2390......	29⅞
2	½ Acre..........	No Manure.......	715......	1430......	17⅞

Mr. Snuggs says he planted corn April 21th. Secured a good stand. No rain from date of planting until June 21st, being two months without rain. On June 21st, a severe wind and rain storm came which damaged the experiment, particularly the fertilized portion.

CORN EXPERIMENT BY MR. J. H. RADNEY.

Roanoke, Randolph County, Alabama.

Soil—Light sandy, clay sub-soil.
Rows 70 yards long, 5 feet wide.

Plot Number.	Size of Plot.	Fertilizers used per Plot.	Pounds yield of corn weighed in shuck.		Estimated yield per acre in bush., allowing 80 lbs. in shuck to the bushel.
			Per Plot.	Rate Per Acre.	
1	½ Acre	250 lbs. C. S. Meal. 250 lbs. Acid Phos.	1960	3920	49
2	½ Acre	No Manure.......	1312	2634	32¾

Mr. Radney reports that the corn was closely slip-shucked and that the weight of shucks from 75 lbs. were 4¾ lbs. In this instance, as well as several others, 80 lbs. in the shuck are *too much to allow* to the bushel but an *average* was necessary to all alike. Supposing that 76 lbs. were allowed in this instance, which would be about correct, the yield from plot No. 1 would show nearly 51½ bushels per acre, and plot No. 2, in proportion.

Corn Experiment by Mr. A. C. Walker.

Wheelers Station, Lawrence County, Alabama.

Soil—Sandy, yellow clay foundation.
Rows 70 yards long, 5 feet wide.

Plot Number.	Size of Plot.	Fertilizers used per Plot	Pounds yield of corn weighed in shuck.		Estimated yield per acre in bush., allowing 80 pounds corn in shuck to bushel.
			Per Plot.	Rate per Acre.	
1	½ Acre........	250 lbs. C. S. Meal. 250 lbs. Acid Phos.	1176....	2352....	29¼
2	½ Acre..........	No Manure.......	630....	1260....	15¾

Mr. Walker makes the following statement concerning preparation, planting, culture, &c.: March 12th, broke land with single Oliver chilled plow, the soil being too thin to use the double plow as it would have turned up too much clay. Then harrowed over and planted in 5 feet rows. Before planting, drilled the fertilizer in the rows, run a scooter in it to mix it thoroughly with the soil, dropped the corn and covered with a scooter, using two lists. The seasons were all that could be desired up to May 15th. Plowed over with Iron Age 5 tooth Cultivator and planted peas in middles, at the same time sowing the other two sacks of fertilizers. Corn grew off well, was laid-by June 1st, seasons still very favorable. July 13th, manured plot began to tassel and silk, and fully 12 feet high. The unmanured plot still very small and just shooting and beginning to tassel in spots.

The manured half acre ripened fully two weeks before the other. A severe storm blew it down, and the yield was lessened, but the test shows that the acid phosphate and cotton seed meal are a perfect fertilizer for this light soil.

Corn Experiment by Mr. Jno. C. Killebrew.

Newton, Dale County, Alabama.

Soil—Sandy loam, red clay sub-soil.
Rows 70 yards long, 5 feet wide.

Plot Number.	Size of Plot.	Fertilizers used per Plot.	Pounds yield of corn weighed in shuck. Per Plot.	Pounds yield of corn weighed in shuck. Rate per Acre.	Estimated yield per acre in bush., allowing 80 pounds in the shuck to the bushel.
1	½ Acre........	250 lbs C. S. Meal. 250 lbs. Acid Phos.	753....	1506....	18 4-5
2	½ Acre........	No Manure.......	280....	560....	7

Mr. Killebrew reports the following: Planted corn March 1st, killed by freeze and planted over. But for spring drought, and with 10 per cent. less of stalks, would have made 20 per cent. more of corn. As it was, crop fired badly. Seasons were extreme, first cold, then dry, and then rain for forty days in succession, and August 2d, a heavy rain and wind storm, levelling much of the corn to the ground and rendering the fodder worthless.

Corn Experiment by Alabama Experiment Station.

Auburn, Lee County, Alabama.

Soil—Light sandy, clay sub-soil.
Rows 70 yards long—5 feet wide.

Plot Number.	Size of Plot.	Fertilizers used Per Plot.	Pounds yield of corn weighed in shuck. Per Plot.	Pounds yield of corn weighed in shuck. Rate Per Acre.	Estimated yield per acre in bush., allowing 80 lbs. in shuck to the bushel.
1	½ Acre........	250 lbs. C. S. Meal. 250 lbs. Acid Phos.	690......	1380......	17¼
2	½ "	No Manure.......	510......	1020......	12¾

SUMMARY.

Reports were received from twenty-three co-operative Soil Test men, including this Station, to whom fertilizers were sent. Five failed to report.

(1) The *rate per acre* cost of fertilizers sent to each experimenter, was $9.62 laid down at Auburn, and we estimate the cost to each one at that price, which would have been the figures if purchased for cash.

(2) To determine whether high fertilization has been a gain or loss the past season, which in many respects has been an unfavorable one, as can be seen from the reports, the following facts are submitted for comparison; and in this connection the *average* yield of the 23 experiments is given, both for the manured and unmanured plots.

Average yield per acre for the *manured* plots is as follows:

26 4-5 bus. corn valued at 55c in farmer's crib		$14 74
330 lbs. fodder, valued 75c per cwt.		2 47
276 lbs. shucks valued at 50c per cwt		1 38
Total		$18 59
Cost of fertilizers per acre	$9 62	
Labor expense	5 44	
Total	$15 06	
Deducting the total expenses $15.06 from the proceeds $18.59, we have a *profit* of		$3 53

Average yield per acre for unmanured plots, as follows:

16 1-3 bus. corn at 55c. in farmer's crib	$8 98
196 lbs. fodder at 75c. per cwt	1 47
163 lbs. shucks at 50c. per cwt	81
Total	$11 26
Deduct labor expense per acre	5 44
We have profit	$5 82

(3) From the foregoing it would appear that the value of the product from the unmanured acre is............$5 82
and from the manured........................... 3 53

Leaving balance in favor of the unmanured........$2 29

In making this report, several things however are to be considered, and as peas were planted in this experiment, one prominent consideration is, that a large crop of peas is reported in some instances by some, justifying the following yield; and taking the same proportion, for both manured and unmanured plots, as for corn, we have—

For the manured, 10 bus. peas per acre, at 75c......$7 50
For the unmanured, 6 " " " 75c..... 4 50

Leaving in favor of the manured, profit..........$3 00

Now by deducting the $2.29 from $3.00, we have a net gain of 71 cts. in favor of the fertilized plots.

(4) As to the character of the soils on which these experiments were conducted, many of them were among the poorest in the State. In addition to the net gain of 71c per acre in favor of fertilizers, other benefits were secured. The heavy fertilization, owing to the adverse seasons in many cases as can be seen from these reports, was not all available to the growing crop, and much remains in reserve for succeeding crops. Besides there is an improved condition in the soil due to the large amount of organic matter in the pea vines, which we reasonably conclude is much greater in the manured, than in the unmanured plot.

(5) While the profits from these experiments have not proven large in dollars and cents, yet the indirect benefits are considerable. And the writer is persuaded to believe that the results might have been better, and more economically attained, had the fertilizers contained a higher per cent. of potash and a smaller of nitrogen.

Since writing the foregoing, I have been informed that 76 lbs. of corn in the shuck are allowed to the bushel of shelled corn, instead of 80 lbs.

This being the case, the *average* yield of corn from the use of fertilizers would be 28 1-5 bushels, instead of 26 4-5, and without fertilizers 17 1-5, instead of 16 1-3.

This correction is made in justice to the Experimenters, who deserve to have a correct report of their work.

BULLETIN No. 60. JANUARY, 1895.

ALABAMA

Agricultural Experiment Station

OF THE

AGRICULTURAL AND MECHANICAL COLLEGE,

AUBURN.

Experiments on Foreign Seeds.

P. H. MELL.

MONTGOMERY, ALA.:
THE BROWN PRINTING CO., STATE PRINTERS AND BINDERS.
1895.

STATION COUNCIL.

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A. J. Bondurant.......................................Agriculturist.
B. B. Ross..Chemist.
P. H. Mell..Botanist.
J. M. Stedman...Biologist.
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C. G. Greene..................Assistant Botanist and Biologist.
T. U. Culver...........................Superintendent of Farm.

☛The Bulletins of this Station will be sent free to any citizen of the State on application to the Agricultural Experiment Station, Auburn, Alabama.

BULLETINS OF 1895.

59. Co-operative Soil Test Experiment on Corn.
60. Experiments on Foreign Seeds.

EXPERIMENTS ON FOREIGN SEEDS.

During the season of 1894 the foreign plants described in this bulletin were tested on the grounds of the Botanical Garden, and have been found sufficiently valuable to warrant their introduction into Alabama.

There has been much published in recent years in regard to certain field crops and vegetables highly prized by the inhabitants of India, Japan, China, Egypt and the South American countries. In some of the Northern States experiments have been conducted on a somewhat elaborate scale to determine which ones of these foreign plants are best adapted to that climate and will repay cultivation. Comparatively little, however, has been done on this subject in the Southern States. This is to be regretted, since some of these plants are of great value as food for stock and man and can be successfully grown only in a southern climate. The season in the South is so mild and the cool weather is of such short duration, many of the field crops, vegetables and fruits which are so valuable abroad can be as successfully grown here as in their native countries; and we have a means here of greatly increasing the lists of our food producing plants. It is the intention of the Botanical Department to continue the experiments on these foreign plants from year to year until much that is valuable to the Alabama farmer is secured and published for his benefit.

Ragi Millet. (*Eleusine corocana.*)

This grass was imported from the Madras Presidency, India, and a small area was planted in 1894. The growth was quite rapid and luxuriant; and within a few weeks after the seeds were sown the fine growth of culms and leaves were admired by every passer-by. The stalks reached a height of three or four feet and then threw up thick flower heads, and soon began ripening their seeds; other flower stalks came forth in succession until three crops of seeds were gathered. During the first two periods in which the seeds were being matured, the stems and leaves remained green and succulent and in excellent condition for green feeding. The grass matures remarkably well for hay and supplies a great abundance of forage. It will stand several mowings before the time of blooming and will, no doubt, make excellent pasturage for cows and other stock.

The following is a chemical analysis of this grass, made under the direction of Professor B. B. Ross, in charge of the Chemical Department:

Water	16.09
Ash	6.02
Ether extract	3.00
Crude fiber	20.65
Crude protein	2.40
Nitrogen free extract	51.84

KODO MILLET. (*Paspalum scrobiculatum.*)

This plant was imported at the same time and from the same country as the last. It also yielded good results and produced foliage almost as tall and luxuriant as was secured from the Ragi. Its valuable properties are unmistakable, and I recommend it to the farmers of Alabama for a good hay producing plant. The growth was not quite as rapid as the last, but it is vigorous and makes ample foliage before the season closes.

The following analysis was made by the Chemical Department:

Water	14.75
Ash	3.95
Ether extract	2.10
Crude fiber	30.57
Crude protein	1.92
Nitrogen free extract	46.71

New Japanese Buckwheat.

The grains of this buckwheat are nearly twice the size of those produced by the ordinary American varieties. The yield is very large—one quart produced two bushels of seeds on the poor sandy soils of Auburn. The plant throws out numerous branches on all of which flowers are developed, and the stem is stout and tall. Planted early in the season the crop will mature rapidly, and may be harvested in time to permit the use of the land in the same season for another crop of a different nature. The flour from the kernels is fine flavored and is equal in all respects to that obtained from the best grades of American buckwheats.

Buckwheats are not often seen as far South as Alabama, and I have many times thought experiments should be made to determine whether the crop could be profitably cultivated in the lower belt of the Southern States. The results of the past season's trials are so remarkable and satisfactory it is deemed best to call attention to them and advise the farmers of the State to add this grain to the important crops of Alabama.

Flat-pea, (*Lathyrus Sylvestris.*)

This plant may be truly termed a sub-soiler. The tap roots penetrate deep into the soil, and the droughts, unless very long continued, fail to produce any material effect on the plants. This pea is a perennial, and, on ordinary land will grow to a height of eight to ten inches the first year. Light frosts do not kill the tops and the roots remain alive in the soil throughout the winter months ready to throw forth a strong, vigorous growth in early spring, thus yielding a valuable forage and good grazing for cattle. Cows and horses greatly relish the cropping at any time but especially so before the other plants have put forth their foliage. Grown from the seed it requires some care to secure a stand, but after it takes good hold of the soil the growth becomes vigorous and rank. Experiments conducted on the Botanical grounds of the College indicate that the flat-pea is a good soil renovater and is fully equal to the field pea in this respect. Its slow growth at first. however, is rather discouraging, and great care is required to prevent weeds from choking the young plants, but proper attention the first year will enable the roots to take good hold of the soil and thereafter it will far more than repay the farmer for all his painstaking. An excellent way to grow this plant is to sow the seeds in a small bed in the garden, properly enriched with phosphate fertilizer and calcareous matter, and then transplant to the field in the same manner adopted for growing potato slips. As soon as the weather becomes mild in early spring the seeds may be sown.

Sugar Beets.

Duing the season of 1894 some experiments were made on sugar beets to determine if the climate of Alabama would permit the development of sugar in sufficient quantities to warrant the culture of this plant in the State for the manufacture of sugar.

Three varieties of seeds were planted viz: Wohawk, Wanzleben and Vilmorin's Improved. The experiments, however, were greatly damaged by the attacks of Nematodes causing a rapid decay early in the season. The results secured before this decay was too far advanced are of such encouraging nature as to warrant the repeating of experiments another year under more favorable circumstances. The chemical analyses made under the direction of Prof. Ross give the following results:

Wohawk	8.5	per cent.	of	sugar.
Wanzleben	11.4	"	"	"
Vilmorin's Improved	10.4	"	"	"

These results are much more encouraging than we would be led to hope for judging from the reports sent out from the Chemical Bureau of the United States Depatment of Agriculture in which it is stated that beets will not mature the standard per cent. of sugar when grown as far south as

Alabama and Georgia. Now when it is well known that beets producing 12 per cent. of sugar can be worked with profit the above results are at least encouraging in view of the extremely unfavorable conditions under which the plants were raised at Auburn.

BENGAL GRAM OR CHICK-PEA. (*Cicer Arietinum.*)

The name arietinum is given to this plant because of a fanciful resemblance of its seed to a ram's head. In India and Egypt the peas are parched and sold in the markets to the natives for the best food to carry on long journeys. An excellent use in this country for the seeds would be for stock food, although not quite so valuable as the ordinary cow-peas. It will also serve as good food for fowls.

GREEN GRAM OR SMALL FRUITED KIDNEY BEAN. (*Phaseolus Mungo.*)

The peas are deep green in color, quite small and are delicate in flavor. The plants come to maturity very early before the ordinary green peas of our gardens are ready to gather.

SESAME, GINGELLY, TIL SEED OR OILY-GRAIN. (*Sesamum orientale.*)

The seeds of this plant are used by the natives in India and Africa for expressing an oil not unlike or inferior to the oil of almonds. An attempt has also been made to manufacture salad oil ("olive") from the seeds but without much success. The Jews of Jamaica also use the seeds for making a cake much relished by them. The chief value of the plant, however, is in the oil extracted which has fine keeping qualities. Two varieties were grown in the Botanical Gardens at Auburn the past season, viz: White and Yellow Sesame.

SOJA OR SOYA OR SOY BEAN. (*Glycine hispida.*)

"The soja bean is much cultivated in tropical Asia on account of the seed, which are used for preparing a well known brown and slightly salt sauce called "Soy," and is used both in Asia and Europe for flaboring certain dishes, especially beef, and supposed to favor digestion. Of late it has been cultivated as an oil plant. It is an erect hairy herb with trifoliate leaves and axillary racemose flowers. The pod contains from two to five compressed seeds. The Japanese call this plant "Sooja," and the seed-like kidney beans in form though smaller are called "Miso." The manner of making the sauce called Sooja or Soy is said to be by boiling the beans with an equal quantity of barley or wheat, and leaving the mixture for three months to ferment, after which salt and water are added and the liquid strained. This sauce is used in many of the dishes and the beans are also used in soups."—(The Treasury of Botany.)

This plant is valuable for man and stock and the results of the experiments conducted at Auburn show that it can be easily grown in Alabama. The forage cured from it is excellent, and stock eat it with relish. Two varieties of the seeds have been tested and both have yielded favorable results.

The soja bean is not a new plant in the United States since it has been grown with marked success in some of the Middle and Western states for several years; it is however new to the South.

The Experiment Station has a small quantity of the following seeds of the plants mentioned in this bulletin for distribution among the farmers of Alabama. Efforts will be made to give the seeds as wide a distribution as possible:

Ragi millet. (*Eleusine corocano.*)

Kodo millet. (*Paspalum scrobiculatum.*)

New Japanese buckwheat.

Soja bean. (*Glycine hispida.*)

P. H. MELL, Botanist.

BULLETIN No. 61. JANUARY, 1895.

ALABAMA

Agricultural Experiment Station

OF THE

AGRICULTURAL AND MECHANICAL COLLEGE,

AUBURN.

Insects Injurious to Stored Grain.

J. M. STEDMAN.

MONTGOMERY, ALA.:
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INSECTS INJURIOUS TO STORED GRAIN.

J. M. STEDMAN.

INTRODUCTION.

In the Southern States more particularly, the stored grain and seeds are usually greatly damaged, if not entirely destroyed in one season, by the attack of insects, principally weevils. The amount of damage needs no comment. It has been stated that grain affected with insects is injurious to stock; but whether this be true or not, it is of little consequence compared with the injury done to grain used for seed. When injured grain is planted, there will be a poor "stand," since the essential part of the seed is usually eaten away and germination rendered impossible; or else if the seed germinates, it has been robbed of much of the nourishment placed there by nature to enable it to attain a healthy and vigorous start, and such seeds will yield a small crop. Instances have come under my observation where whole graineries of corn have been entirely ruined; and it is almost impossible to purchase peas that are not badly effected.

Fortunately we have methods by which we can destroy these pests in our graineries, and there is no excuse now for suffering any considerable loss from insects in stored grain. I find, however, that few understand these methods, and how easily and cheaply they may be applied. There are nine different species of insects that may attack stored grain in Alabama, and in all cases the method of combatting them is the same.

In order that one may determine the kind of insects found in stored grain, I have given a figure of all but one, and a short description.

Figures 12, 13, 14 and 15, were kindly loaned by the Mississippi Experiment Station.

The discussion of the life history of the insect is given only in so far as it is important that the farmer should know it.

In view of the fact that the edition of bulletin number 45 on Injurious and Beneficial Insects has long since been exhausted, and that the demand for it still continues, on account of the general remarks, insecticides and machines for applying the same that it contained, I have here repeated, with some additions and omissions, that portion of Bulletin 45.

GENERAL REMARKS.

In order to arrive at the best results in combatting insects, it is important that we should understand at least the general life history of the insects in question, that we may thus know at what stage in its development means can best be taken to destroy it. Some insects can best be fought in the egg stage, others in the larva or worm stage, a few in the pupa stage, and still others in the adult stage; while many can be controlled in two or more stages. To arrive at this in a scientific way forms one of the great problems of the economic entomologist.

The larger number of our insects have four well defined stages of growth. The first is known as the *egg* state and of course in itself can do no harm. In a few cases these eggs are deposited in clusters or groups and in such a way that we can gather and destroy them, or when this is not practicable, they can be killed by spraying them with kerosene emulsion or soda and caustic soap.

Many insects winter in this egg stage as well as in the pupa or in the adult state, and since they frequent sheltered places, as leaves, rubbish and brush along fences and ditches, etc., it becomes important that all such useless material be gathered and burned every fall, thereby destroying many insects that otherwise would appear the following spring. Hence clean farming is one sure road to success.

The second, or *larva* or worm state is the one in which most insects do their greatest amount of injury, since it is here that most of the growth and feeding takes place. Many insects are injurious only in this larva stage, as our cotton-worm, cabbage-worm, cut-worm, etc., and all other moths and butterflies. Some exceptions to this rule are to be found, as in our grasshoppers and most beetles, that do as much damage in the adult as in the larva stage in many instances. While again, the Rosechafer that does little or no damage in the larva stage, as an adult, does much injury to our vineyards. The larva or worm does not resemble in the least the adult insect in most cases, and hence unless one be familiar with the subject, he can not tell the adult insect by the larva. The caterpillar or worm changes to a butterfly or moth, the maggot to a fly, and the grub to a beetle. It is in this second stage that most insects are to be controlled.

The third, or *pupa* state is usually a quiet, inactive and perfectly harmless stage. Since many insects winter in this condition we can take advantage of it, and resort in the fall to a general cleaning up and burning of all rubbish, leaves, etc., and to the burning over of stubble and to late plowing.

The fourth, or *adult* or imago stage is the perfect insect, such as a butterfly, moth, beetle, fly, etc., and it is in this state only that the eggs are deposited from which a new brood developes. As stated under the second or larva state, most adult insects except grasshoppers and beetles are in themselves harmless to the farm and garden crops; they deposit the eggs, however, on the respective plants on which the larvæ feed, and in view of this we can take means to prevent such a deposit and hence protect the plant. This is especially true and important in those cases where the larva is a borer and hence can not readily be gotten at in that stage. Hence the necessity of covering up the base of peach trees with straw, cotton seed, ash, etc., to keep the adult from getting at the proper place to deposit her eggs, or of spraying apple trees with Paris green or London purple to prevent the coddling moth. from getting into the apple, or of covering the trunks of trees with a sticky or poisonous wash to prevent the borer from entering. All preventive applications must be made just before the adult insect appears, and must be kept up at frequent intervals as long as the adult is in a condition to lay eggs.

So far as the farmer is concerned vegetable feeding insects can be divided into three groups. I. Those insects that live, either in the young or adult stages or both, within the tissues of the plant. These are called borers. They feed upon the juices and tissues inside the plant. II. Those that suck the juices of plants, in which case one finds no parts of the plants eaten away, but the leaves shrivel up and dry or turn another color. These are called sucking insects. They pierce the plant with their mouth-parts and simply suck the juices. III. Those that eat the parts of plants, in which case we find places eaten away, or parts eaten or cut off, as we say. These are called biting insects. They feed upon at least the outer parts of plants and in most cases the inner tissues at the same time.

REMEDIES.—From the nature of the case, it is evident that each of the three groups of insects as above described will require a different mode of treatment.

In general (special and exceptional cases will be noted under their respective heads) the best if not the only way to get rid of the borers is either to dig them out or, as has lately been successfully done in the case of the peach tree borer, pour hot water on that part of the tree that is infected. The application of chemicals after the insect is once inside the plant is of little or no use, since the plant would be killed before the insect could be reached. The application of chemicals to prevent their entering has succeeded in some cases. Paris green or London purple mixed with water (see formula under insecticides) and thrown in the form of a spray (apparatus for spraying will be explained later) on to the plant or parts of the plant liable to be infected, has resulted in lessening the attack in a number of cases where the insect or its young eat their way in through the outer tissue, but where the adult deposits its eggs inside the tissue beneath the outer layer, this method is of little value. The application of certain substances like coal tar, tobacco, etc., is sometimes used as a repellant. Methods and contrivances to keep the insect away will be noted under the special insect.

The sucking insects cannot be destroyed by putting poison like Paris green on the plant, since these insects do not eat the outside of the plant and hence not the poison. They can insert their mouth-parts through the surface of a leaf covered with Paris green, for instance, and not eat it, but suck the pure juice from the part beneath. They must be killed by simple contact with some chemicals, and a substance like Paris green, which is very poisonous to insects if it be eaten, may not affect the insect in the least to have it covered with the poison. Perhaps the most effectual substance with which to kill sucking insects is what is known as Kerosene Emulsion. (See formula under Insecticides.) This must be thrown on the plant in the form of a spray by means of some kind of a force pump. (See spraying apparatus.) Pyrethrum is an active substance in killing by contact nearly all kinds of insects, but unfortunately it is of late years so adulterated that it is almost useless for the farmer. It comes in the form of a powder and can be dusted on the plants by means of a bellows or mixed with water and thrown on in the form of a spray. (See Insecticides.)

The biting insects can be destroyed by poisoning the parts of the plants effected. To accomplish this we can resort to a large number of chemicals, compounds and patent insecticides. Some of the most useful being Paris green, London purple, White Hellebore, etc. A number of the patent insecticides (so called) that are advertised to kill *all kinds* of insect enemies are of no value to the practical farmer.

The mode of applying the different poisons to kill biting insects varies with the kind of plant infested and also with the insect. Some are simply dusted on to the plant as a powder, others sprayed on with a force pump. The methods of applying each substance will be given under their respective heads. (See Insecticides.)

INSECTICIDES.

The various substances, compounds and mixtures used to destroy or drive away insects can be divided into three groups. First, internal poisons, that kill by being eaten with the natural food of the insect. Second, external remedies, that kill the insect by contact, either by irritating the skin, or by stopping up the breathing pores. Third, repellants, including substances that keep the insects away by offensive odors or by mechanical barriers.

INTERNAL POISONS.

Paris green is the most important insecticide of its class. It kills by virtue of the arsenic that is here in chemical combination with copper. It comes in the form of a fine powder and can be purchased at about thirty cents per pound. It can be used either as a powder to be dusted, or as a liquid to be sprayed on the plants. As a powder it is to be well mixed with from twenty to forty, and even eighty, times its bulk of flour, Plaster of Paris or air slacked lime; and can then be evenly and thoroughly dusted on to all parts of the plant by means of some kind of bellows or other powder dusting machine. (See machines for applying Insecticides.) One pound of Paris green to the acre is usually sufficient provided the dusting be done evenly and thoroughly. Paris green is sometimes used undiluted, or very slightly so (one part of Paris green to three parts of flour) as is the usual case with cotton, when the poison is placed in two heavy sacks made of some strong cloth, as 8 oz. osnaburg, and fastened to each end of a five foot pole. It is the thoroughness with which this poison is applied and not the strength that secures success. As a liquid Paris green is to be mixed with water in the proportion of one pound poison to from 150 to 200 gallons water. Paris green does not dissolve in water, and since it is very heavy and tends to settle quickly, it is very essential that the liquid be often and thoroughly stirred. It is to be sprayed on the fruit trees and other plants by means of some kind of force-pump and hose with a spraying nozzle. (See machines for applying Insecticides.) One should be exceedingly careful in spraying peach trees not to get the mixture too strong, since the leaves of this plant are very tender and easily "burned" by Paris green or London purple. A mixture of one pound Paris green to 250 gallons of water should be used on peach trees, and that only when the leaves are young. Apple trees should be sprayed just after the flowers have fallen. Small fruits and vegetables are not easily injured, if at all, by Paris green. Since Paris green is frequently adulterated, it is advisable to test it before making any extensive application. One sample of Paris green analyzed by the chemical department here last year was found to contain not a trace of Paris green, nor even of arsenic or any other poison. Some failures in the application of insecticides are due to poor or adulterated material.

Paris green or London purple may be mixed with Kerosene Emulsion in some cases, and thus an insecticide for both biting and sucking insects is made. The great advantage to be gained by this mixing is the time saved in making one application instead of two. For details see under Kerosene Emulsion.

London Purple is about as good as Paris green as an insecticide in many cases, and has this advantage, that it is much cheaper, costing about fifteen cents per pound, and is also a much finer powder and hence remains suspended in water much longer. It is to be used in the same way and in the same proportions as Paris green.

Hellebore (white) is a powder poison made from a plant. It kills both by being eaten and by contact. It can be used as a powder to be dusted on to the plant either full strength or diluted with flower, or as a liquid, one pound Hellebore to 40 gallons of water, to be sprayed on the plant. It costs about twenty-five cents per pound. It is used less extensively than Paris green or London Purple, but is especially excellent in destroying the currant worm.

White Arsenic is not to be used when Paris green or London purple can be had, since it is dangerous to have about and is apt to burn the leaves.

EXTERNAL POISONS.

Pyrethrum is a powder made from the flowers of a plant and is very poisonous to insects, but is perfectly harmless to man and domestic animals. It kills insects by contact, and can be most successfully used as a powder to be dusted by means of a bellows or other powder dusting machine. Pyrethrum is hard to obtain pure or at least in a fresh condition. It loses its strength by standing, and should be kept well corked. It may be used as a spray in the proportion of one pound of Pyrethrum to 40 gallons of water. Pyrethrum is very useful for killing the cabbage worm, or insects destroying parts of plants that are ready to be eaten by man. It is also of great use in clearing rooms of flies, musquitoes, &c., and fleas and lice on domestic animals.

Kerosene Emulsion is perhaps the best substance to be used for sucking insects. It is made as follows: "Dissolve one-half pound of hard soap in one gallon of boiling water, and while the liquid is still hot, but not near a fire, add two gallons of kerosene. The whole is then violently churned until it forms a creamy mass, which will thicken into a uniform jelly-like mass on cooling, and the oil remains incorporated in the mass, and will not separate or rise to the top. The churning can best be done by means of a force pump with a small nozzle, pump the liquid back into the vessel containing the liquid. The emulsion thus obtained will keep indefinitely." When ready to use, thoroughly mix one part of the emulsion with nine parts cold water. This is to be thrown in the form of a spray on the plants, by means of some kind of a force pump and spraying nozzle. (See machines.)

The kerosene emulsion will injure no foliage, and since it kills insects by contact, it is the most effectual remedy against the chinch bug, plant lice, bark lice, melon bug and other sucking insects, and also for the cabbage worm, and white grub, and will even kill eggs in some cases. It is of the greatest importance that the emulsion be forcibly, thoroughly, and evenly applied, as can be done only by the use of some force pump arrangement.

Kerosene may be used without the trouble of making an emulsion with soap and water, and, so far as my experience goes and from what I can learn of others, with equal results to the soap emulsion. This is rendered possible by using a force pump that will mechanically mix the kerosene with the water at the instant of spraying. One can readily see what an immense saving of time and trouble this will effect. The best machine to use in this connection is the Perfected Galloway Knapsack Spray Pump with kerosene attachment, made by the Deming Company, Salem, O. or the one made by the W. & B. Douglass Company, Middletown, Conn. (See figure under machines for applying poisons.) The water is placed in the usual reservoir and the kerosene in an additional reservoir attached to it. The proportion of kerosene to the water can be regulated by a stop-cock. The kerosene is thoroughly mixed in the pump and spray nozzle only when the pump is in action, otherwise the two fluids remain separate. This attachment does not interfere with the use of the pump for other purposes, since a stop-cock completely shuts off all communication with the attachment, which may also be removed.

Kerosene emulsion may have added to it a small amount of Paris green or preferable London purple and thus be converted into an insecticide for both biting and sucking insects. This method does away with the necessity of making two applications of insecticides. I find it better to first dilute the stock emulsion to the usual extent, and then to add the Paris green or London purple in the proportion of one-fourth pound to the barrel. To use the Paris green or London purple with the kerosene and water spray from the knapsack sprayer, I thoroughly mix one-fourth pound of the poison in a barrel of water, and fill the knapsack sprayer with this mixture, and the attachment with kerosene.

Carbolic Acid Emulsion is made by adding Carbolic Acid (the crude material, dry to get a good strength) one part to 5 or 7 parts of the soap solution similar to that used in making the Kerosene Emulsion. The liquid is to be churned in the same manner as the Kerosene Emulsion, to form an Emulsion. This Carbolic Acid Emulsion is one of the best preparations to protect plants against lice and fruit trees against borers. It can be sprayed upon the trunks of fruit trees or rubbed on by means of a cloth. Every fruit tree should be treated in this way, especially the young trees, about two weeks after the trees blossom.

Tobacco Decoction is made by adding refuse tobacco, which can be obtained at small cost from tobacco factories, to boiling water, in the proportion of one pound of tobacco to two or three gallons of boiling water. As soon as the water has cooled, strain out the tobacco, and the decoction is then ready to use. It is to be sprayed upon the leaves, and is an effectual remedy against the striped flea beetle, and the cucumber, watermelon and squash flea beetles. It will also drive away some bugs from similar plants. It is also valuable as an insecticide against lice and ticks upon domestic animals, and has the advantage over Kerosene Emulsion in that it leaves the hair in better condition.

Bisulphide of Carbon is a liquid that is of great use in destroying the Phylloxera of grape, ants, insects in stored grain, and other insects which can be reached by means of a vapor. For Phylloxera and ants it is to be poured upon the top of the ground above them.

For grain insects and insects affecting clothing, it is placed in shallow dishes and kept in the closed room. The vapor from this liquid is extremely explosive, and must not be used in a room near the least trace of fire, even a lighted cigarette may cause a great explosion. Bisulphide of Carbon can be had from the manufacturer for from 10 to 12 cents per pound in 50 pound cans.

E. R. Taylor, Cleveland, Ohio, advertises Bisulphide of Carbon for ten cents per pound in fifty-pound cans.

MECHANICAL ARRANGEMENTS.

These are intended to act as barriers to keep away insects, or as traps to capture them. They will be described under the special insect which can thus be best treated.

MACHINES FOR APPLYING POISONS.

There are a great many kinds of machines and devices manufactured and sold by dealers for applying insecticides and fungicides, some of which are very good, and every farmer, fruit grower and gardener should have at least one. In order to save the purchaser time and trouble in making a selection, a few of the more important machines are here figured, together with the price and manufacturers address.

It is of course important, whenever possible, that one provide himself with two machines, one for using a powder, the other for syraying a liquid; but in case only one can be purchased, a force pump and spraying nozzle should be selected, since one can often mix the powder with the water and apply it in this way.

One of the best machines for dusting a powder on plants is Leggett's Powder-gun. It works by turning a crank, and throws the powder in a fine dust constantly and evenly, and the supply can be easily regulated so that one or one-half pound of Paris green or London purple can be evenly distributed over an acre. This instrument has been highly recommended by all who have tried it. The price of this gun delivered complete with four extra tubes, shoulder strap, oil can and all necessary attachments for distributing the powder is $7.50. This machine can be purchased from the makers, Leggett & Bros., 301 Pearl St., New York. See fig. 1, 2, 3.

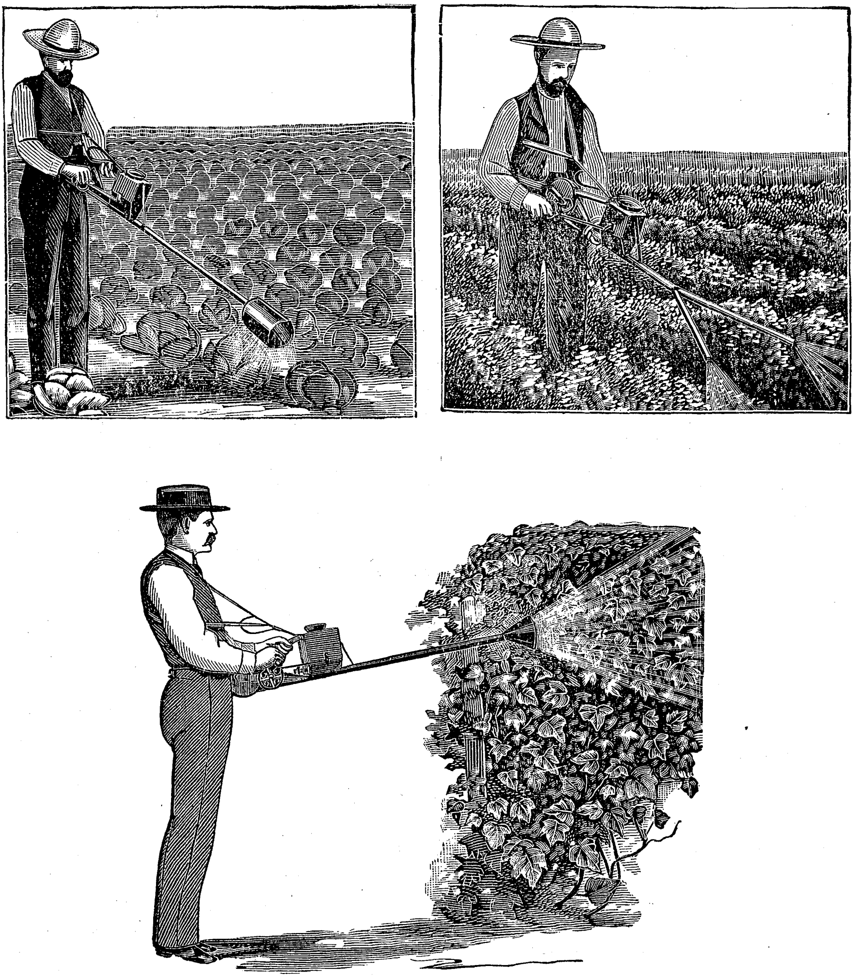

Fig. 1, 2, 3. Leggett Bros. Powder-Gun.

Another very simple and effective machine is Woodason's Liquid and Powder Spraying Bellows, of which four styles are made. The Double Cone Bellows for dusting Paris green, London purple or Pyrethrum, can be purchased for $3.00, and will be found a very simple and economic machine. The liquid spraying bellows can be had for $2.00. These machines will be found very useful, and are highly recommended. They are manufactured by Thomas Woodason, 2900 D. St., Philadelphia, Penn., or they can be purchased of H. A. Kuhus, Atlanta, Ga.

In the purchasing of machines for spraying liquids, three things should be taken into account. The pump should be made of such materials as will not be easily affected by the chemicals used, there should be some automatic device for keeping the liquid constantly stirred, and the spraying nozzle should be one that is not easily clogged and one that will throw a fine and uniform spray. There are many nozzles manufactured for this purpose, almost any of which can be purchased from a dealer in force pumps.

The names of some of the different spraying nozzles are "Masson," "Cyclone," "Vermorel," "Boss," "Graduating" and "Climax." Some of these nozzles, such as the "Boss" and the "Graduating," can be made to throw a fine or coarse spray, or a solid stream. They are all of value and range in price from a dollar to a dollar and a quarter.

There are many force pumps with spray nozzles manufactured for spraying liquids on plants; but my experience leads me to believe that for cheapness, durability, simplicity and effectiveness the pumps of The Deming Company, Salem, Ohio, are superior to all others. The "Success" brass spray pump for bucket is shown in fig. 4. I regard this as the best pump made for ordinary use, and it is extremely cheap. The regular catalogue price is $6.00, but it can be had for $4.00. In ordering, one should state that they wish a hole drilled in the suction casting for an agitator.

Where it is necessary to do a large amount of spraying, the "Ideal" double-acting brass spray pump manufactured by the same company, and shown in fig. 5, should be used. The price of this pump varies according to the attachments from $12.00 to $18.00, exclusive of the barrel. This pump can be placed on any barrel and carried about the field in a wagon.

This company, and also the W. & B. Douglas Co., Middletown, Conn., manufacture a "Knapsack" spray pump with an attachment for kerosene. By means of this attachment one can save much time and trouble in not having to make a regular kerosene emulsion, since the water and kerosene are mixed in the act of spraying. These pumps are a great convenience, but they are rather costly for most farmers. Fig. 6 shows one of these pumps made by The Deming Co. The price with the kerosene attachment is $18.00 in the catalogue, but they can be had for $15.00,

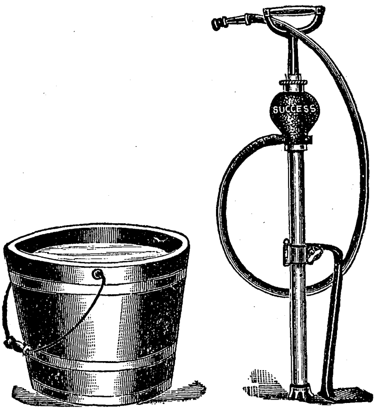

FIG. 4. "Success" brass spray Pump for Bucket.

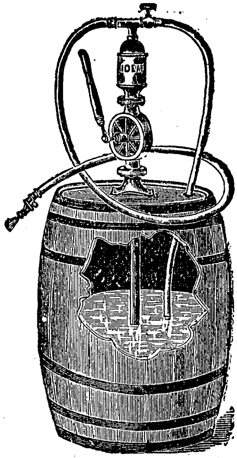

FIG. 5. "Ideal" double-acting brass spray pump mounted on barrel.

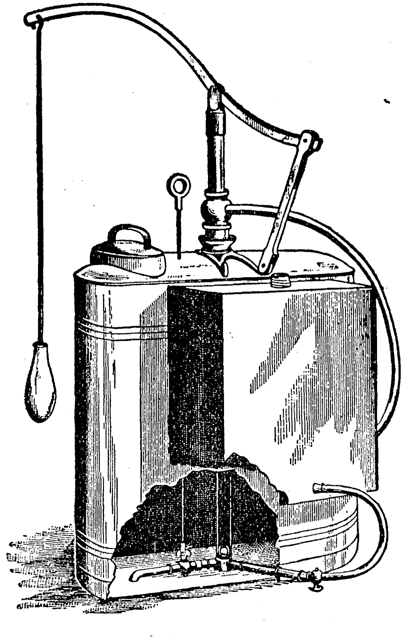

FIG. 6. The Perfected Galloway Knapsack sprayer with kerosene attachment.

INSECTS INJURIOUS TO STORED GRAIN.

THE PEA WEEVIL.

(*Bruchus pisi*, Linn.)

The pea weevil is a small beetle about three-sixteenths of an inch in length. It is of a dull gray color, with a few markings on the back and occasionally a white spot on the thorax. Figure 7 shows this beetle in its different stages enlarged, and with the natural size figures near them. The adult beetle lays her yellow colored eggs singly on the outside of the young pea pod. As soon as the eggs hatch, the small larvæ bore through the pod and enter the peas. Here they feed, avoiding as a rule the germ, until full grown, when they cut a hole nearly through the seed coat, leaving a thin membrane over the burrow. The larvæ then turn to the pupa stage. But one insect can, or at least usually does, develop in a single pea. The adult beetle issues either in the fall or more commonly in the spring.

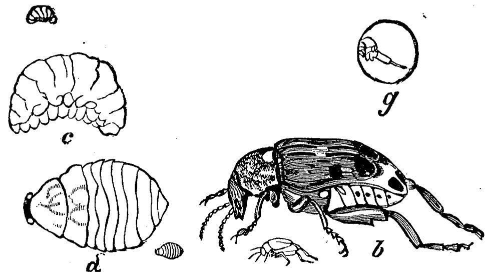

FIG. 7. Pea weevil; b, adult; c, full grown larva; d, pupa; g, pea showing exit hole. Natural size indicated by smaller figures.

THE BEAN WEEVIL.

(*Bruchus obtectus*, Say.)

The bean weevil is a small brownish beetle a little over one-eighth of an inch in length. It resembles very much the pea weevil, and has much the same life history and habits. Figure 8 shows this beetle enlarged at *a* with a natural size figure near it, and an effected bean at *b*. The female beetle deposits her eggs in clusters, either in a slit or hole made with her jaws in the pod, or else in the split caused by the partial drying of the pod. The eggs are most abundantly found in fully developed or partially dried pods, where the seeds are fully matured. The young larvæ

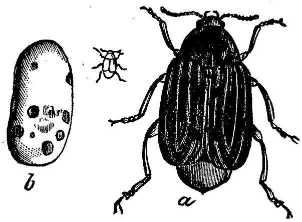

FIG. 8. Bean weevil; a, adult; b, damaged bean. Natural size shown by smaller figure.

enter the beans, and make circular mines in them while feeding upon their substance. Unlike the pea weevil, only one of which is found in a single pea, the bean weevil may occur in considerable numbers in a single bean. When the larvæ are fully grown, they bore a hole to the outer skin of the bean, and then turn to the pupa stage. When the adult beetles emerge, they will deposit their eggs in the stored grain, and thus multiply and damage the beans continually. Hence when these insects once infest stored beans, it is necessary to kill at once all the insects, or they will completely ruin them. The number of generations varies, and thus one finds these insects in all stages in the stored beans. The bean weevil is very troublesome in cow peas also.

THE FOUR-SPOTTED BEAN WEEVIL.

(*Bruchus 4—Maculata.*)

The four-spotted bean weevil is a little larger than the pea weevil, and can be distinguished from it by the presence of four black spots on the wing covers. The habits and life histories of this insect are similar to the bean weevil, and therefore will not need describing here. The four-spotted bean weevil is extremely troublesome and injurious to our cow pea, perhaps even more so than any other weevil. I find it next to impossible to purchase cow peas that are not infested with them. I regret that I have no figure of this insect.

THE GRAIN OR CORN WEEVIL.

(*Calandra granaria*, Linn.)

The grain or corn weevil is a dark brown or black beetle about three sixteenths of an inch in length. This weevil can be distinguished from the grain beetle, which also infests corn, by its stouter body and by the presence of a long snout, which is wanting in the grain beetle. Figure 9 shows the grain or corn weevil enlarged at *e* and with a natural size figure just above. The snout can be readily seen by glancing at the figure. The female beetle deposits her eggs singly upon the corn, and also upon wheat in some cases. In a few days the eggs hatch, and the small larvæ enter the corn, and feed upon and burrow through it. The full grown larvæ transform to the pupa stage within the kernel. The adult beetles emerge by cutting a hole through the skin of the kernel of corn or wheat as the case may be. An ear of corn infested with these weevils will be full of holes, showing where the adult beetles have emerged.

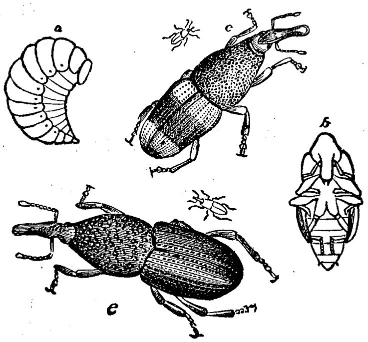

FIG. 9. e, Grain or corn weevil; c, Black or rice weevil. Natural size shown by smaller figures. a, larva; b, pupa.

The Black or Rice Weevil.

(*Calandra oryzae*, Linn.)

The black or rice weevil is a black colored beetle with four reddish brown spots on the wing covers. It is somewhat smaller than the grain or corn weevil, being about one eigth of an inch in length. Figure 9 shows this beetle enlarged at *c* and with a natural size figure just above.

As the name indicates, this beetle is frequently found in rice, but it attacks corn and wheat as well, and does its greatest amount of damage to corn in this state. The adult female makes a hole in the grain with her mouth parts, and deposits an egg in it. Frequently more than one hole and egg is deposited in a single kernel. The larvæ burrow and feed upon the inside of the grain, and when full grown change to the pupa stage within the kernel. The adult beetles soon emerge and deposit eggs for another brood. In infested corn, one can find these weevils in all stages of development. The adult beetles are also very injurious in a direct way, in that they will eat into the kernels of corn for a short distance themselves, and are not content with a single kernel. An ear of corn infested with the black or rice weevil will soon be ruined, nearly every kernel having holes eaten into it, and its interior more or less eaten away.

The Angoumois Grain Moth.

(*Gelechia cerealella,* Oliv.)

The angoumois grain moth is perhaps the most destructive insect affecting our grain. It was introduced into this country sometime before 1728 by the earlier settlers of Carolina and Virginia, who brought it with them from Europe. The original home of the moth is supposed to be South Europe, although it seems to have attracted popular attention first in Angomoise province, France, where it caused immense damage and nearly resulted in a famine. This insect is more destructive in the Southern States than in the Northern, and attacks corn and wheat not only in the granary, but also in the field. It is also said to attack cow peas, oats, and barley. This grain insect is all the more destructive from the fact that it will breed readily in confinement; and if once introduced into a granary and left to itself, it will entirely destroy it.

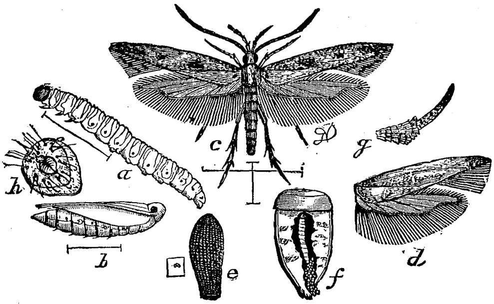

Fig. 10. Angoumois Grain Moth; a, larva; b, pupa; c, adult; d, wings; e, egg; f, kernel of corn showing work of larva; all enlarged except f.

The angoumois grain moth is a small fawn or light gray colored insect, measuring about one-half an inch across its expanded wings; it has a shiney appearance, and the hind wings have a feathery edge. The adult moth is represented somewhat enlarged at *c* figure 10, and natural size by the cross lines just beneath. A greatly enlarged egg is shown at *e;* the larva at *a,* with a line beneath representing the natural size of the fully developed larva; and at *b* the pupa is figured enlarged, with the natural size indicated by the line just beneath.

The female moth deposits her eggs on the grain in the field or in the granary. The eggs may be deposited singley or in clusters just under the thin membranes at the base of the kernel of corn or between the rows. The eggs hatch in a few days into minute active larvæ, that are frequently seen suspended by a delicate silken thread. They soon find a tender place and enter the kernel of corn or wheat. The hole in the grain made by their entrance is so small as not to be readily noticed, or it may be closed up with excrement. The larvæ mine and feed upon the interior of the grain, and in some cases leave only the outer coat entact. When full grown, they cut a circular hole through the skin, but do not disturb the plug. They then spin a delicate cocoon within the kernel, and inside of it turn to the pupa stage. In a few days or weeks, according to the climate, the adult moths appear and lay the eggs for another brood. But one larva is found in a grain of wheat; but two or more may occur in a kernel of corn. The number of broods per year varies from two in the northern states to seven or eight in the southern states. In this state one can find the insect in all stages in infested granaries.

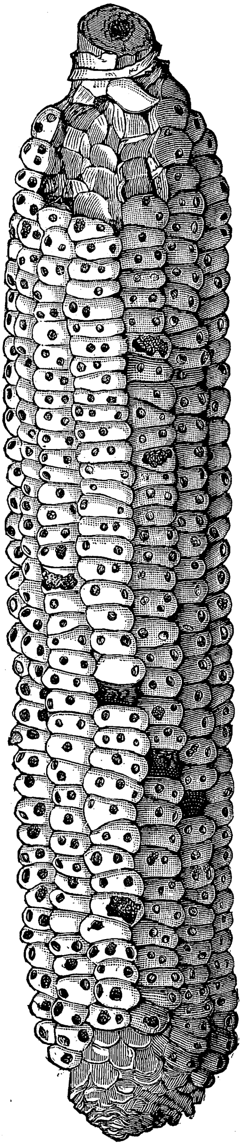

FIG. 11. Ear of corn showing work of the Angoumois Grain Moth.

The appearance of an ear of corn after the moths have emerged is shown in figure 11. Grain infested with these insects to any considerable extent will not germinate, will loose considerably in weight, and is not wholesome as food, but may even be injurious. When these insects are found in stored grain they should be exterminated at once, since they multiply with such rapidity that they will completely ruin all the grain in a short time.

The Grain Beetle.

(*Silvanus surinamensis*, Linn.)

The grain beetle is a small reddish brown colored insect, a little over one-eighth of an inch in length. It can be distinguished from the other grain beetles by its more cylindrical form, and the presence of saw-like teeth on the margin of the thorax; it also has three longitudinal ridges on the thorax, and several less distinct on the wing covers. See figure 12, which represents this beetle much enlarged.

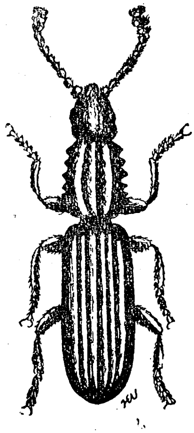

Fig. 12.
Grain Beetle.

This beetle is found in granaries usually in connection with other grain insects. The adult beetle as well as the larvæ feed upon corn or wheat, and do not confine themselves to a single kernel. The larvæ often pupate in the cracks about the granary.

The Red Grain Beetle.

(*Silvanus cassicæ*, Reiche.)

The red grain beetle is a small flat reddish brown insect, about one-ninth of an inch in length. The adult beetle is represented as enlarged at *c* figure 13; the pupa at *b*; and the larva at *a*. The lines at the side of each shows the natural size.

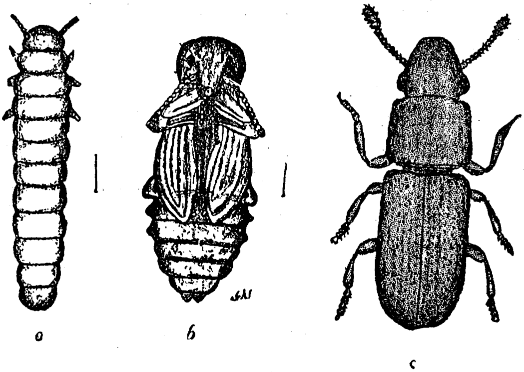

FIG. 13. Red Grain Beetle; a, larva; b, pupa; c, adult. All enlarged.

These beetles infest corn more particularly. The eggs are deposited at the base of the kernels, either in the field or in the bin. The larvæ enter the kernels, and feed as a rule only upon the softer lower portion; and when mature make their pupæ within the corn. More than one larva may develop in a single kernel. There are several broods each year; in some localities as many as nine. The beetles are quite lively, and will seek shelter when disturbed; the larvæ rarely make their presence known, and as a result these insects often remain unobserved until they have accomplished considerable damage.

The Brown Grain Beetle.

(*Tribolium ferrugineum*, Fab.)

The brown grain beetle is, as its name implies, a brown colored beetle about one-eighth or three-sixteenths of an inch long. It is represented enlarged in figure 14. It is usually found in stored grain in connection with other grain insects, but may become quite common in neglected granaries. It also feeds upon dried animal matter, and is sometimes found in museums, and in the kitchen store room.

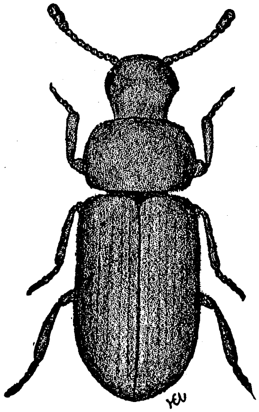

Fig. 14. Brown Grain Beetle. Enlarged.

The Corn-Sap Beetle.

(*Carpophilus fallipennis*, Say.)

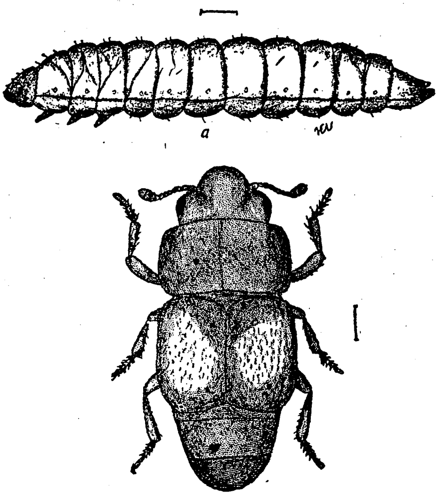

Fig. 15. Corn Sap-Beetle. Larva and adult, enlarged.

The corn-sap beetle is about one-seventh of an inch in length, of a dark brown color, with the wing covers lighter in color and not extending to the end of the abdomen. An enlarged beetle and larva is represented in figure 15, with the natural size indicated by lines at the side.

This beetle, like most of the beetles belonging to the same family, are not very destructive to healthy vegetable products, but prefer injured or decaying vegetable matter. They are to be found in injured cotton bolls, in heaps of decaying cotton seed, in decaying fruit of all kinds, and sucking the juices from injured fruit and trunks or limbs of trees. I have found them in the ear of corn only when such ears had been previously injured by other cause. It has been stated, however, that they will attack healthy kernels even in the bin; but I am inclined to think this would not occur if they had not been introduced there in the larvæ stage in diseased corn, and after eating that, were forced to eat the healthy kernels.

Remedies.

The best remedy in every respect for killing grain insects is *bisulphide of carbon.* It is cheap, effectual, and easy to apply. Bisulphide of carbon, or the new fuma bisulphide of carbon, can be obtained of the manufacturer, Mr. E. R. Taylor, Cleveland, Ohio, in fifty pound cans for ten cents per pound, or in smaller quantities at a little more per pound.

One pound of the bisulphide of carbon is ample for one hundred bushels of grain, provided it be in a comparatively tight bin or granary, and the grain is not in the husk or pod. If the bin or granary is quite open and contains many holes, it will be necessary to use more bisulphide of carbon, since it will evaporate and escape. The holes should be closed as much as possible. The grain should not be stored in the pod or husk, since it is almost impossible for the fumes of the bisulphide to penetrate through the husk of an ear of corn, and much less through the pod of a bean or pea.

In view of the fact that many grain insects attack the grain while it is in the field, and are thus carried directly into the granary, it is advisable to make one application of the bisulphide of carbon immediately or very soon after the grain is gathered and stored. The grain should then be examined at least once a month, and if there appear signs of insects, it should receive another application. Then in the spring, before the grain is taken out for planting, it should always receive an application of bisulphide of carbon, to be sure that all insects are destroyed and thus prevented from attacking the grain in the field and multiplying there.

The bisulphide of carbon is best, or at least as well, applied by sprinkling it over the top of the grain. It will soon evaporate, and as the fumes are heavy they will penetrate through the grain. The germinating properties of grain are not injured in the least by any ordinary application. Some may prefer to saturate cotton with the bisulphide and place it in the grain, or to fill shallow dishes and place them about the granary. No harm can result, however, from sprinkling the bisulphide directly on the grain, since it evaporates almost immediately, and if pure, leaves no trace of it on the grain. One can test the bisulphide of carbon to determine whether it is pure or not, by dipping a black feather in it and allowing it to dry; if the bisulphide is pure no residue will be seen.

The only precaution in the use of bisulphide of carbon is not to have the least trace of fire about; the fumes are very explosive and will ignite from a lighted cigar or lantern.

Bisulphide of carbon evaporates so rapidly that it will disappear in a few moments, if some of the grain be removed to the open air.

It is not necessary to mention any other remedy for insects in stored grain as the above is much superior to all others.

J. M. STEDMAN,
Biologist.

BULLETIN No. 62. FEBRUARY, 1895.

ALABAMA

Agricultural Experiment Station

OF THE

AGRICULTURAL AND MECHANICAL COLLEGE,

AUBURN.

CORN AND COTTON.

ALEX. J. BONDURANT.

MONTGOMERY, ALA.:
THE BROWN PRINTING COMPANY, PRINTERS.
1895.

The Bulletins of this Station will be sent free to any citizen of the State on application to the Agricultural Experiment Station, Auburn, Alabama.

CORN.

Fertilizer Experiments.

A given quantity of kainit, acid phosphate and cotton seed meal *mixed* thoroughly and applied at time of planting, *compared* with a *compost* of a certain quantity of cotton seed, acid phosphate and stable manure applied at time of planting.

Plot No. 1 was fertilized with kainit, acid phosphate and cotton seed meal, well mixed, at the rate of 1,000 pounds per acre.

Plot No. 2 with cotton seed, acid phosphate and stable manure composted, at the rate of 2,000 pounds per acre.

By referring to the following table of results, it will be noticed that plot No. 1, which was manured with a compound of commercial fertilizers made a larger yield than plot No. 2, which was manured with compost.

By comparing the cost of substances used in this experiment, it was rather more in plot 2 than in plot No. 1.

Kainit, acid phosphate and cotton seed meal in plot No. 1, *compared* with compost of cotton seed, acid phosphate and stable manure in plot No. 2.

Corn planted April 4th, and fertilizers applied in drill at the same time.

Size of plot ½ acre.

PLOT 1.

Name and Quantity of Fertilizers used per ½ Acre.		Quantity per acre.	Pounds yield of corn in shuck per plot.	Pounds yield of corn in shuck per acre.	Bushels yield of ear corn per acre, allowing 76 lbs. in the shuck to the bushel.
Kainit	100 lbs.	200 lbs.	....	....	....
Acid Phosphate	150 lbs.	300 lbs.	....	....	....
Cotton Seed Meal	250 lbs.	500 lbs.	....	....	....
	500 lbs.	1000 lbs.	815	1630	21.11-19

PLOT 2.

Names and Quantity of Fertilizers used in Compost for ½ Acre.	Quantity per acre.	Pounds yield of corn in shuck per plot.	Pounds yield of corn in shuck per acre.	Bushels yield of ear corn per acre, allowing 76 lbs. in the shuck to the bushel.
Cotton Seed..... 333⅓ lbs.	666⅔ lbs	....	....	....
Acid Phosphate. 333⅓ lbs.	666⅔ lbs.	....	....	....
Stable Manure.. 333⅓ lbs.	666⅔ lbs.	....	....	....
1000 lbs.	2000 lbs.	550	1110	14 3-5

CORN.

VARIETY EXPERIMENT.

Object of this experiment was to ascertain the best yielding variety.

Corn was planted on plots 1-14 of an acre in size—rows 5 feet wide and corn dropped 3 feet apart in drill.

Fertilizer, composed of 250 pounds cotton seed meal and 250 pounds acid phosphate, was applied in drill at time of planting, and was mixed with soil by running a scooter in the furrow. Corn came up well and was killed by the severe freeze March 25th. Replanted April 4th and several other times after. The Renfro, Experiment Station Yellow, Cocke's Prolific, Pride of America, and Clayton Bread, gave the best yields in the order named. A perfect stand was never secured upon any of the plots, though it was better on some plots than on others, and hence this fact with some inequality of the soil, prevents reaching any reliable conclusions as to the best variety. Further experiments will be necessary to arrive at correct conclusions.

The following table shows the results of the experiment:

Plots 1-14 acre. Fertilizers applied in drill March 10th, consisting of 250 lbs. cotton seed meal and 250 lbs acid phosphate per acre.

Corn planted March 17th, killed by freeze, and replanted April 4th.

Plot No.	Names of Varieties.	Seedsman.	Pounds yield per plot in shuck.	Pounds yield per acre in shuck.	Bushels yield per acre, ear corn, allowing 76 lbs. in the shuck to the bushel.
1	Expt. Station Yellow	Expt. Station	96.5	1351	17¾
2	Clayton Bread	Jas. Clayton	82.2	1151	15 1-7
3	Renfro		99.5	1393	18⅓
4	Pride of America	T. W. Woods & Son. Richmond, Va.	91.0	1274	16¾
5	Gentry's Market	" "	75.0	1050	13 4-5
6	Hickory King	" "	74.0	1036	13¾
7	Blount's Prolific	" "	75.0	1050	13 4-5
8	Giant Broad Grain	" "	61.0	854	11¼
9	Cocke's Prolific	" "	90.0	1260	16 9-10
10	Virginia Gourd Seed	" "	66.0	924	11 7-11
11	Clarke's Mastodon	" "	45.0	630	8 3-10
12	Improved Golden Dent	" "	75.0	1050	13 4-5
13	Improved Leaming	" "	25.0	350	4⅔
14	Dallas Prolific	" "	75.0	1050	13 4-5

COTTON.

Compost applied on February 1st, against compost applied at planting time.

Floats vs. Acid Phosphate.

Numerous enquiries have arisen from time to time, which pays the better, to compost green cotton seed, acid phosphate and stable manure about Feb. 1st and let it remain in bulk to be applied at planting time, or to apply it as soon as made, thereby saving any further expense and trouble.

Also to determine the *comparative* value of acid phosphate with floats, in *compost*, to be applied at time of planting.

Plot 1, applied Feb. 1st.

Plot 3, applied April 17th.

Plot 2, Floats with compost applied April 17.

For this experiment, one and a half acres of land, of uniform fertility, was selected and divided into plots of ½ acre each. The soil was sandy and poor.

On Feb. 1st, a compost of equal parts of green cotton seed, acid phosphate and stable manure was made, and on the same day was put on plot 1. An equal quantity of this same mixture was put in a heap until planting time, when it was put on plot 3.

While the results are seen from the table, one fact is worthy of note, that plot 1 remained greener and maintained its vigor a longer period than plot 3, and did not yield to the effects of rust as badly as plot 3.

In plot No. 2 as will be seen from the table, floats were substituted in place of acid phosphate as in plot 3, the same quantity of green cotton seed and stable manure being used on both.

The following table shows the results :

COTTON.

Compost Applied February 1st.

Plot Number	Name and quantity of fertilizers used on one-half acre.	Rate per acre, lb	Yield Seed Cotton Per Plot.			Total yield per plot seed cotton.	Total yield per acre seed cotton
			1st picking, Sept. 5th.	2nd picking October 2d.	3rd picking, Nov. 15th.		
	Green cotton seed, 400 lbs.	800					
	Acid Phosphate, " "	800					
	Stable manure, " "	800					
1	1200 lbs.	2400	336	187	28	551	1102

COTTON.

Compost Applied April 17th.

Plot Number.	Name and quantity of fertilizers used on one-half acre.	Rate per acre, lb	Yield Seed Cotton Per Plot. 1st picking, Sept. 13th.	2nd picking, October 2d.	3rd picking, Nov. 15th.	Total yield per plot seed cotton	Total yield per acre seed cotton
	Green cotton seed, 400 lbs.	800					
	Acid Phosphate, " "	800					
	Stable manure, " "	800					
3	1200 lbs.	2400	439	97	9	545	1090

COTTON.

Floats vs. Acid Phosphate in Plot 3.

Plot Number.	Name and quantity of fertilizers used on one-half acre.	Rate per acre. lb	Yield Seed Cotton Per Plot. 1st picking, Sept. 13th.	2nd picking, October 2d.	3rd picking, Nov. 15th.	Total yield per plot seed cotton	Total yield per acre seed cotton
	Green cotton seed, 400 lbs.						
	Floats,........... " "						
	Stable manure,... " "						
2	1200 lbs.	2400	392	138	30	560	1120

COTTON.

Comparison of Fertilizers and Compost.

The object of this experiment was to compare a given quantity of kainit and acid phosphate *mixed* with a certain quantity of cotton seed meal as is shown in plot 1, with a similar quantity of kainit and acid phosphate *composted* with a certain amount of stable manure and cotton seed as in plot 2. That is, the quantity of kainit and acid phosphate in both plots being the same, using the cotton seed meal in plot 1, against the cotton seed and stable manure in plot 2. Fertilizers in plot 1 were thoroughly mixed and applied at time of planting; on plot 2 composted and applied at same time. The plots being about equal in natural fertility, and both receiving equal quantities of kainit and acid phosphate, the results appear in favor of the cotton seed meal as against the cotton seed and stable manure. Should the improved condition of the land be considered, which thing however was not contemplated in this experiment, the question arises, which has paid the better, plot No. 1, or No. 2? In plot No. 1, the nitrogen in the cotton seed meal was more available than in plot 2, and this being true there is left in plot 2, for future crops, a larger per cent. of fertilizing matter. No conclusions however can be drawn in this particular, as it would require further trials on both plots to ascertain the comparative quantity of fertilizers now in reserve on both plots.

It is a known fact from observation that land fertilized with stable manure and cotton seed shows the effects for several years following.

The following is a statement of results:

A given quantity of acid phosphate, kainit and cotton seed meal mixed to be compared with a given quantity of acid phosphate, kainit, cotton seed and stable manure composted.

Size of plot, ½ acre.

PLOT 1.

Names and Quantity of Fertilizers used on ½ Acre.	Quantity per Acre.	Yield per Plot. 1st Picking, Sept. 13th.	2nd Picking, Oct. 9th.	3rd Picking, Nov. 1st.	Yield per Plot.	Yield per Acre.
Kainit......100 ℔s.	Kainit..... 200 ℔s.	.....	.....	.....	....	......
Acid Phos..150 ℔s.	Acid Phos. 300 ℔s.	.....	.....	.....	....	......
Cotton S. M.250 ℔s.	Cotton S.M. 500 ℔s.	.....	.....	.....	....	......
500	1000	354	285	86	725	1450

PLOT 2.

Name and Quantity of Fertilizers used on ½ Acre.	Quantity per Acre.	Yield per Plot. 1st Picking, Sept. 13th.	2nd Picking, Oct 13th.	3rd Picking, Nov. 11th.	Yield per Plot.	Yield per Acre.
Kainit..... 100 lbs.	Kainit..... 200 lbs	.....	....	.....	....	......
Acid Phos. 150 lbs.	Acid Phos. 300 lbs	.....	.....	.....	....	......
Cotton Se'd 375 lbs.	Cotton Se'd 750 lbs.	.....	.....	.....	....	......
Stable Ma. 375 lbs.	Stable Ma. 750 lbs.	.....	.....	.....	....	......
1000	2000	245	305	77	627	1254

COTTON.

INTERCULTURAL EXPERIMENTS WITH FERTILIZERS.

The object of this experiment was to ascertain whether or not, it would pay to apply nitrogenous fertilizers interculturally.

For this purpose, a piece of sandy upland of medium fertility was selected, and made into plots of 1-10 of an acre each. Rows were laid off, 210 feet long by 3½ feet wide.

Just before planting, the following mixture of fertilizers was applied to each plot alike, at the rate of 200 pounds per acre: 200 lbs. acid phosphate, 66 lbs. muriate potash and 66 lbs. sulphate ammonia. Soon after the cotton came up, it was chopped, and then sided with heel-scrape. The stalks of cotton were counted in each row and the same number allowed to stand on each plot.

On June 16th, cotton seed meal and nitrate soda, in different quantities, were applied broad-cast, at which time the cotton was plowed with heel-scrape.

From observations made during the latter part of June, the plots fertilized interculturally began to show a little difference, and by the time the second application was made, the difference was quite marked in favor of the fertilizers. Further observations later on showed a still greater and more decided improvement in the crop, that is, the stalks, were much larger, were taking on fruit more rapidly and presented a richer color than the plots not fertilized after planting. By noticing the difference in the yield of plots having the same quantity of fertilizers, it appears that a *given* amount used interculturally at an *earlier stage of crop* growth, gave better results than the same quantity, one-half applied at *the earlier stage* and the other half several weeks later. For instance, by comparing plot No. 1 with plot No. 7, it is shown that a better yield resulted from the single application to plot 7 in June than from the two applications to plot 1 in June and July.

Also in comparing No. 2 with No. 8, it is seen that a better yield was secured from the June application on No. 8, than from the June and July appiications on No. 2.

By a still further comparison of plots 4 and 9, the same fact is established, that a single application of nitrate soda in June on plot 9, gave a better yield than the same quantity of nitrate soda at different times on plot No. 4. The 100 lbs. applied *at once* to No. 9 acted more efficiently than the *two* applications to No. 4, and the inference is, that the most favorable conditions existed as to No. 9, for a maximum yield.

Taking the average yield of the three unmanured plots, which is 809½ lbs. seed cotton per acre, the difference in favor of fertilizers is plainly seen by reference to the table of results.

The following table shows the results of this experiment:

COTTON—INTERCULTURAL EXPERIMENT.

Plots 1-10 of an Acre.

At time of planting, April 14th, Acid Phosphate 200 pounds, Nitrate Potash 66 pounds, and Sulphate Ammonia 66 pounds, were mixed, and 20 pounds of this mixture applied to each plot. Subsequent fertilization is shown in the following table:

Plot.	No.	Fertilizers used per plot. Applied April 14th.	Name and quantity of fertilizers and when applied. Rate per acre.	Name and quantity of fertilizers, and when applied. Rate per acre.	Yield seed cotton per plot: 1st picking, Sept. 12th.	2nd picking, Sept. 28th.	3rd picking, Oct. 13th.	4th picking, Nov. 1st.	Total yield per plot.	Total yield per acre.
"	1	Acid Phosphate....12.05 Muriate Potash.... 3.97½ Sul. Ammonia..... 3.97½ 20 lbs.	June 16th. 100 pounds. Cotton seed meal.....	July 5th. 100 pounds. Cotton seed meal.....	48.15	55.50	31.50	13.50	148.65	1486.5
"	2	Acid Phosphate....12.05 Muriate Potash.... 3.97½ Sul. Ammonia..... 3.97½ 20 lbs.	June 16th. 200 pounds. Cotton seed meal.....	July 5th. 200 pounds. Cotton seed meal....	41.25	50.25	43.50	24.75	159.75	1597.5
"	3	Acid Phosphate....12.05 Muriate Potash.... 3.97½ Sul. Ammonia..... 3.97½ 20 lbs.	No manure...........	No manure........ ...	51.15	25 50	6.30	1.50	84.45	844.5
"	4	Acid Phosphate....12.05 Muriate Potash.... 3.97½ Sul. Ammonia..... 3.97½ 20 lbs.	June 16th. 50 pounds. Nitrate soda..........	July 5th. 50 pounds. Nitrate soda....... ...	42.60	63.75	39.30	19.50	165.15	1651.5
"	5	Acid Phosphate....12.05 Muriate Potash.... 3.97½ Sul. Ammonia..... 3.97½ 20 lbs.	June 16th............ 100 pounds........... Nitrate Soda.........	July 5th. 100 pounds. Nitrate soda..........	35.55	57.00	29.55	18.90	141.00	1410.0

COTTON.—INTERCULTURAL EXPERIMENT—CONTINUED.

Plot.	No.	Fertilizers used per plot. Applied April 14th.	Name and quantity of fertilizers, and when applied. Rate per acre.	Name and quantity of fertilizers, and when applied. Rate per acre.	Yield seed cotton per plot				Total yield per plot.	Total yield per acre.
					1st picking, Sept. 12th.	2nd picking, Sept. 28th.	3rd picking, Oct. 13th.	4th picking, Nov. 1st.		
"	6	Acid Phosphate....12.05 Muriate Potash.... 3.97½ Sul. Ammonia..... 3.97½ 20 lbs.	No Manure..........	No Manure..........	44.25	22.50	7.50	3.00	77.25	772.5
"	7	Acid Phosphate....12.05 Muriate Potash.... 3.97½ Sul. Ammonia..... 3 97½ 20 lbs.	June 16th. 200 pounds. Cotton Seed Meal....	....	55.95	78.00	30.00	21.00	184.95	1849.5
"	8	Acid Phosphate ...12.05 Muriate Potash.... 3.97½ Sul. Ammonia..... 3.97½ 20 lbs.	June 16th. 400 pounds. Cotton Seed Meal....	....	66.75	90.00	25.80	9.00	191.55	1915.5
"	9	Acid Phosphate....12.05 Muriate Potash.... 3.97½ Sul. Ammonia..... 3.97½ 20 lbs.	June 16th. 100 pounds. Nitrate Soda........	....	42.45	90.00	23.55	15.75	171.75	1717.5
"	10	Acid Phosphate....12.05 Muriate Potash.... 3 97½ Sul. Ammonia..... 3.97½ 20 lbs.	No Manure..........	No Manure..........	51.75	24.00	3.90	1.50	81.15	811.5

Average yield of unmanured plots, 809.5 pounds per acre.

BULLETIN No. 63. FEBRUARY, 1895.

ALABAMA

Agricultural Experiment Station

OF THE

AGRICULTURAL AND MECHANICAL COLLEGE,

AUBURN.

Fertilizers--Commercial and Domestic.

B. B. ROSS.

MONTGOMERY, ALA.:
THE BROWN PRINTING COMPANY, PRINTERS.
1895.

☞The Bulletins of this Station will be sent free to any citizen of the State on application to the Agricultural Experiment Station, Auburn, Alabama.

FERTILIZERS—COMMERCIAL AND DOMESTIC.

The extremely low prices of agricultural products almost everywhere prevalent, at present, and particularly the unprecedentedly low figures which the chief Southern staple brings on the market, have, of necessity, attracted attention to the importance of the practice of greater economy in all of the departments connected with the conduct of the farm.

In no single department of the farm economy is there a greater tendency to make retrenchment or to curtail expenditures than in the direction of the reduction of the amounts heretofore paid out for the purchase of commercial manures or other fertilizing materials, and it is to be hoped that this tendency will at least lead to a more thorough utilization of the valuable domestic manurial resources which have been to a great extent, heretofore, either neglected or else disregarded.

These crude supplies of fertilizing materials which are within easy reach of almost every farmer, can, if intelligently and properly utilized, be made to supplement quite advantageously the supplies of artificial fertilizers which are employed as ingredients of the best domestic mixed manures.

The rational system of fertilization of the soil demands that the chief essential fertilizing constituents removed by any crops shall be replaced by returning to the soil an equivalent amount of these constituents for the use of subsequent crops, and it is, in part, to a lack of observance of this important principle, that the exhausted condition of many of our soils is due.

At the same time, it is also true that a very large proportion of our soils have been impoverished in a most marked degree by a washing away of the surface soil with its supplies of plant food and vegetable matter, while many of our exposed soils lose by oxidation and decomposition a large proportion of their organic constituents.

To make good the losses occasioned under the several conditions above enumerated, there is a constant demand for fresh supplies of fertilizing materials for the purpose of returning to the soil the elements of plant food which have been removed, and these elements may be returned, in part, either in the form of some portion of the crop which has been produced, or by the application of supplies of manures derived from the feeding of the crops in question to farm animals.

It is the design of this bulletin, therefore, to furnish some practical information with regard to the methods of utilizing to the best advantage crude domestic manures, in conjunction with appropriate kinds and quantities of commercial fertilizers.

It is consequently not strictly within the province or scope of this pamphlet to treat of the methods of preventing or avoiding the other forms of soil exhaustion above referred to (viz: by washing and exposure), but the employment of better systems of drainage and the protection of the land by keeping it covered as continuously as possible with some vegetable growth, even if that growth be only grass, will be found to prove valuable aids in the diminution of the losses due to these sources.

Of the dozen or more elements which the soil supplies under ordinary conditions for the development and maintenance of plant life, all except three are commonly present in soils in sufficient quantities to meet the requirements of plant growth. These three important constituents of plant food are nitrogen, potash and phosphoric acid, and it is these three substances which both artificial fertilizers and domestic manures are designed to supply to the soil.

Manures are commonly divided into two classes — viz: *stimulant* and *nutritive* manures.

STIMULANT MANURES.

Stimulant manures are those whose addition to the soil does not supply directly any plant food of value, but whose presence there brings about the decomposition of other forms of plant nutriment not otherwise available for plant use. Among the more important and more commonly employed manures of this class are lime and gypsum (land plaster), and in some countries, salt also finds some employment as an auxiliary stimulant manure.

Lime is, itself, an important mineral ingredient of plant life, and some scientists and investigators (notably Ville) have classed it along with the three essential constituents of complete manures above alluded to. It so happens, however, that lime is present in sufficient quantities in almost all soils to meet the actual requirements of the plant itself for this particular element, and when it or its compounds are supplied to the soil it is almost invariably with a view to the fulfilment of its functions as a stimulant manure. One of the most important offices performed by the lime consists in the decomposition or breaking up of certain mineral forms of potash, whereby the latter becomes readily soluble and available for plant food, while in its original state of combination it was practically of no nutritive value.

Lime also corrects the acidity of so-called "sour soils" and checks in a marked degree the tendency of "running to weed" commonly exhibited by cotton and other crops grown on such soils.

The more important uses and effects of lime upon soils are very appropriately given by Dr. Hilgard in one of the Tenth Census Reports on Cotton Production, and his conclusions are reproduced herewith :

(a.) "A more rapid transformation of the vegetable matter into active humus.

(b.) The retention of such humus against the oxidizing influences of hot climates.

(c.) It renders adequate for more profitable culture per centages of phosphoric acid and potash so small that in the case of the absence or deficiency of lime, the soil is practically sterile.

(d.) It tends to secure the proper conditions of nitrification whereby the inert nitrogen of the soil is rendered available.

(e.) It exerts a most important influence upon the flocculation and therefore upon the tillability of the soil."

For many purposes, gypsum is employed instead of lime, itself, and many of the functions performed by the latter can be quite effectively accomplished by the substitution of the gypsum (or land plaster), while for certain other purposes, gypsum can be used to better advantage than the lime.

On account of the tendency which gypsum (sulphate of lime) in a moist condition, has to fix certain volatile ammonia compounds, it is highly esteemed for use in covering compost and manure heaps, and effects a saving of considerable proportions of valuable plant food, which would otherwise be lost.

The continuous employment of stimulant manures to the exclusion of nutritive fertilizers, however, is one of the surest and quickest means of impoverishing the soil, since nothing of value is added to the stores of plant food, and the pre-existing supplies of nutritive materials are all the more readily removed by virtue of the presence of the lime or kindred stimulants.

NUTRITIVE MANURES.

The nutritive manures, in contradistinction to the stimulant, contribute directly to the plant valuable supplies of nutriment, and any excess of nutritive ingredients left unconsumed by the plant or crop, adds so much to the stores of plant food available for the use of subsequent crops. The various forms and descriptions of commercial fertilizers upon the market are designed to fulfill the office of nutritive manures, and contain one, two or all three of the essential fertilizing ingredients previously referred to.

The proportions in which these ingredients are supplied, and the forms in which they occur in commercial manures exhibit considerable variations, and are largely dependent upon the manufacturerer's ideas as to the requirements of any particular crop or soil. These commercial manures are commonly divided into two classes, viz: "complete" and "partial manures," the former containing, as the term implies, all three of the chief essential fertilizing constituents of value (phosphoric acid, nitrogen and potash) while the latter contain only one or two of these ingredients.

The former are designed for general use and for direct application to soils and crops, frequently, of widely different characters; the latter are either to be employed as ingredients of home made mixed manures or composts, or else to supply some particular element, in a concentrated form, to some specific crop.

Partial manures may be advantageously considered under the following subdivisions:

(1.) Phosphoric acid manures.
(2.) Nitrogen manures.
(3.) Potash manures.
(4.) Manures containing phosphoric acid and potash.
(5.) Manures containing phosphoric acid and nitrogen..
(6.) Manures containing potash and nitrogen.

The following matter with reference to the composition, characteristics and sources of commercial manures is reproduced from the fertilizer bulletin published by the Department of Agriculture in August 1894:

(1) PHOSPHORIC ACID MANURES.

Formerly the chief source of supply of this valuable fertilizing element was bones, either raw or chemically treated, and while "bone meal" and raw bone superphosphates still have a large consumption, by far the largest proportion of phosphoric acid for artificial fertilizers, is derived from phosphate rock, from the fossilized remains of extinct animals, or from the soft phosphate deposits of tropical islands, and quite recently large supplies of this element have been furnished by the Thomas slag, a by-product of the Thomas-Gilchrist steel process. In this country, for the past twenty-five years, a large proportion of the phosphoric acid consumed by our agricultural economy has been furnished by the deposits of phosphate rock contiguous to Charleston, S. C., but within more recent years the supplies of South Carolina phosphate have been largely supplemented by the soft phosphates from South Florida.

The mechanical condition of fertilizers of all classes greatly affects the utility and availability of their fertilizing constituents, and in order to more readily meet the needs of the plant the crude phosphate rock is crushed to a state of impalpability, and the resulting powder so finely divided that its particles can "float" in the air, is placed upon the market under the name of "floats."

Phosphates from some of the tropical islands of the Caribbean sea and adjacent waters are also utilized to some extent as a source of phosphoric acid, though the deposits are being rapidly exhausted.

The phosphatic formations of this character owe their origin largely to the deposits of sea birds, and in rainless climates nitrogen in the form of nitrates and ammonia salts is also found, but in localities where the rainfall is at all considerable, the proportion of this element is extremely small, if it be not entirely absent. Large quantities of phosphoric acid are also supplied from the wastes of our large slaughter houses, and the fertilizers obtained from this source contain also considerable proportions of nitrogen.

Refuse bone black from the sugar refineries, after being utilized for the decolorization of sugars, is frequently treated with sulphuric acid and sold as a fertilizer under the name of "dissolved bone-black," or else is used in the preparation of many of our mixed fertilizers.

The phosphoric acid in most of our complete fertilizers is found in three forms, viz., the soluble, reverted and insoluble forms. The first is soluble in water, the second is soluble in neutral citrate of ammonia, and is termed by the fertilizer law "citrate soluble," while the third form is insoluble both in water and citrate of ammonia, but is soluble in acids, and is therefore designated "acid soluble phosphoric acid."

In nearly all of our fertilizers the phosphoric acid is in combination with lime, and in bones, phosphate rock and the chief mineral phosphates, is in the form of what is termed "bone phosphate" or insoluble phosphate of lime. While this form of phosphoric acid is insoluble in pure water, it dissolves slowly in water containing carbonic acid (carbon dioxide) in solution, and upon many soils, especially in the presence of organic matter, and where the particles of the fertilizer are in a finely divided condition, has been employed to good advantage.

In order to reduce crude phosphates such as bones, phosphate rock, etc., to a state of fine division, and also to convert the phosphoric acid into a form soluble in water, the crude materials are treated with sulphuric acid and a product is obtained which is known as superphosphate of lime or acid phosphate, while gypsum (sulphate of lime) is also produced and remains admixed with the phosphate.

Pure superphosphate of lime is completely soluble in water, and were the precise amount of sulphuric acid required to completely convert the insoluble phosphate into the superphosphate employed, the whole of the phosphoric acid of the acid phosphate would be in a soluble condition.

In actual practice, however, the full theoretical amount of sulphuric acid is seldom employed in the manufacture of superphosphates, and a small amount of insoluble phosphoric acid is left in the product.

This insoluble phosphate, in contact with the soluble phosphate, leads to the formation of a compound intermediate between the two in composition, and this substance is the "reverted" or "reduced" phosphate.

The term "reverted" is so applied because the soluble phosphoric acid of the fertilizer "turns back" toward its original insoluble form, and a similar behavior is noticed in soils containing good proportions of iron and alumina or lime.

The "reverted" phosphate of lime is the form previously referred to as insoluble in pure water, but soluble in a neutral solution of citrate of ammonia, this solution being assumed to approximate in solvent power the soil water with which the fertilizer will be brought in contact.

"Reverted" or "citrate soluble phosphoric acid" together with the water soluble, constitute what is termed" available phosphoric acid," and though usually assigned the same value, there is considerable diversity of opinion among scientific investigators as to the relative values of these two forms of phosphoric acid.

While the soluble phosphoric acid is soluble in water only so long as its free acid remains uncombined with some such base as lime, oxide of iron, alumina, etc., and while it speedily reverts in soils containing any considerable proportions of these substances, nevertheless it is believed to have an initial diffusive property not possessed by the reverted form; that is, it is disseminated more rapidly and fertilizes more soil in a given time than the same amount of reverted would do.

While the soluble phosphoric acid is seldom found in appreciable quantities in natural phosphates, the reverted form is frequently found in small quantities along with the insoluble in phosphate rock, and in still larger quantities in some tropical phosphates, such as orchilla guano, etc.; it is also found in bones to a considerable extent, and the phosphoric acid in many of our organic fertilizers, such as cotton seed meal, is readily soluble in ammonium citrate.

The superphosphates prepared from bones are believed by many to have a higher value than those from phosphate rock; this superiority, however, if it exists, extends only so far as the availability of its insoluble phosphoric acid is concerned, the insoluble phosphoric acid from animal sources being much more readily appropriated by the plant than the same form when of mineral origin.

The phosphoretic slag obtained by dephosphorizing pig iron in the Thomas-Gilchrist process for steel-making, has recently become an important factor in the world's supply of phosphoric acid, but has been met with but little in southern fertilizer markets.

Should the basic process of steel making be introduced in this State, an additional valuable source of phosphoric acid will be furnished to the farmers of Alabama.

The attention of this office has been called to circulars distributed by manufacturers and dealers in non-acidulated phosphates, in which a claim is advanced in favor of the natural phosphate and against the acid phosphate, to the effect that the free sulphuric acid of the latter is highly detrimental to vegetation, and therefore constitutes a valid objection to its use for fertilizing purposes.

As a matter of fact, however, the proportion of sulphuric acid used in the treatment of phosphate rock is, as stated above, very rarely sufficient to give even a slight excess of free sulphuric acid in the product and farmers need apprehend no trouble from this source.

(2.) NITROGEN MANURES.

Nitrogen is supplied in commercial fertilizers in three forms, these several forms being designated by the sources from which they are derived :

(1) Vegetable nitrogen.
(2) Animal nitrogen.
(3) Mineral nitrogen.

Among the chief forms of vegetable nitrogen may be mentioned cotton seed, cotton seed meal, and the cakes and meal resulting from the extraction of oils from various vegetable sources.

Cotton seed and its product, cotton seed meal, is the best known of any of the vegetable fertilizers to the southern farmer, and at the same time, it is the cheapest form in which nitrogen can be obtained in the Southern States.

In addition to the seven per cent. of nitrogen which the meal contains, it also furnishes a considerable supply of phosphoric acid and potash—about three per cent. of the former and two per cent. of the latter.

While the nitrogen of cotton seed meal may not act as quickly as that of nitrates and ammonia salts, nevertheless, upon the decomposition of the meal in the soil, there are formed compounds both of nitric acid and ammonia, similar in composition to some of the mineral forms of nitrogen.

In the purchase of cotton seed meal the farmer should always guard against the admixture of hulls with the meal, the presence of the hulls being readily detected by placing the meal upon an ordinary sieve and shaking thoroughly.

The dark colored cotton seed meals, which are sometimes met with upon the market, while greatly damaged so far as their utility as feed stuffs are concerned, are uninjured as regards their fertilizing value, as has been repeatedly shown by analysis. The cotton seed meal, in addition to its direct application to the soil by the farmer, is employed as a source of nitrogen in the preparation of a large proportion of the complete fertilizers manufactured in the South.

Among the chief forms of animal nitrogen met with in the markets, may be enumerated fish scrap, dried blood, tankage and various other by products from the wastes and refuse of slaughter houses.

Several of these, as tankage, fish scrap, etc., contain in addition to the nitrogen, considerable proportions of phosphoric acid, though they are in general utilized chiefly for the nitrogen they furnish.

The dried blood is a product resulting from the evaporation of the blood from slaughter houses and the thorough drying of the residue, frequently by means of superheated steam. The color of the product varies with the temperature at which the drying is effected, and the red blood is generally considered of more value than the black. The proportion of nitrogen varies from 9 to 15 per cent. and practical field experiments show that this element, in this form, is readily and quickly available for the use of the plant.

The chief mineral forms of nitrogen of importance are sulphate of ammonia and nitrate of soda, though nitrate of potash and muriate of ammonia are also met with occasionally in the fertilizer trade. The supplies of nitrate of soda are obtained chiefly from the nitrate beds of Chili and Peru, and the refined product has of recent years had quite a large consumption in this country. It contains 15 to 16 per cent. nitrogen in a highly available form and is employed in the preparation of high grade fertilizers, and also as a top dressing for grains, grasses, etc.

Sulphate of ammonia is largely prepared from the ammoniacal liquors of gas works, the crude liquor being neutralized with sulphuric acid and evaporated to dryness.

This substance is the most concentrated commercial form of nitrogen which is found, in general, upon the markets, and is used in the manufacture of complete fertilizers rich in nitrogen, or else is employed as a top dressing for certain crops.

For this latter purpose, however, both of the above mineral forms of nitrogen must be applied with great caution, since by virtue of their easy solubility, they are readily leached from the surface soil, especially if the subsoil is at all permeable.

(3.) POTASH MANURES.

The manures of this class which meet with the largest consumption, either for direct application to the soil or as ingredients of mixed goods, are the crude potash salts from the German salt deposits. The chief forms in which the potash is found in the crude commercial salts are the sulphate and muriate (chloride), the latter form containing the higher proportion of potassium. Kainite, another product of the German mines, consists of potassium sulphate, magnesium sulphate and the chlorides of magnesium and sodium. Its average proportion of potash is about 12 per cent. and it is largely employed in the preparation of composts and in compounding mixed fertilizers designed to contain a moderate potash percentage.

The muriate of potash met with in commerce generally has a purity of only 80 to 85 per cent., giving a potash equivalent of about 50 to 53 per cent., while the high grade sulphate contains from 45 to 50 per cent. potash, and the low grade sulphate only about 30 per cent. of this ingredient. These latter goods are used almost exclusively for the preparation of complete fertilizers with a high potash content.

Cotton seed hull ashes is a southern product which is quite a valuable source of potash, though its use is largely confined to the States bordering on the Atlantic.

The hulls removed from the cotton seed, preparatory to the extraction of oil, are largely used as fuel under the boilers of the oil mills, and the ashes obtained are found to contain from 15 to 25 per cent. potash, and 7 to 10 per cent. of phosphoric acid.

In mixing hull ashes with nitrogenous organic materials, great caution is to be observed, since mixtures of this kind, if kept for any length of time, especially if allowed to become moist, are likely to ferment, with consequent loss of a considerable proportion of nitrogen.

Among the chief vegetable sources of potash may be mentioned tobacco stems, which are utilized to a great extent in the tobacco growing States, and many of the complete fertilizers manufactured along the Atlantic seaboard contain potash derived from this waste product.

(4.) MANURES CONTAINING PHOSPHORIC ACID AND NITROGEN.

Bones, whether in the original crude state or treated with sulphuric acid, contain in addition to their phosphoric acid, from 3 to 5 per cent. of nitrogen derived from the gelatinous matter of the bone and constitute one of the most common forms of partial manures of this class.

The boiled or de-gelatinized bone, obtained as a by-product of gelatine manufacture, is sometimes found on the market, but this, of course, contains only phosphoric acid.

Tankage, a product of the large slaughter houses, consists chiefly of a mixture of the dessicated residues of meat and bone left from the treatment of the slaughter house wastes for extraction of grease. The proportions of meat and bone in this fertilizer vary considerably, and lead to quite large differences in the nitrogen and phosphoric acid contents of different samples, the phosphoric acid generally being in excess, though its proportion is dependent largely upon the amount of bone in the material.

Fish scrap, which is simply the dry, pulverized residue from the extraction of oil from fish, contains both phosphoric acid and nitrogen, though the latter predominates and the product is chiefly used for the nitrogen which it supplies. The fertilizing value of all the materials of this class is largely enhanced by a finely divided condition of the particles, and a mechanical analysis is frequently resorted to in addition to the chemical examination.

(5.) MANURES CONTAINING PHOSPHORIC ACID AND POTASH.

Many of the acid phosphates upon the southern market have been mixed with a small proportion of kainite or some of the higher grade potash salts, and are thus better adapted for composting than the plain super-phosphates. By the simple mixture of goods of this class with cotton seed meal a complete fertilizer is obtained, and the farmer can frequently prepare advantageously, in this way, mixtures to meet the needs of his different crops.

(6) MANURES CONTAINING NITROGEN AND POTASH.

Nitrate of potash is the only manure of importance of this class, supplying both potash and nitrogen in a very soluble form. Its cost, however, is quite high, and its consumption is somewhat limited.

COMPLETE FERTILIZERS.

As the name implies, fertilizers of this class contain all three of the chief fertilizing constituents of value, though the proportions of these ingredients are extremely variable.

The basis of the complete fertilizer is the super-phosphate, and with this are mixed some common forms of nitrogen and potash, the proportion of these elements being largely dependent upon the manufacturer's ideas of the needs of the soil or crop. Kainite and cotton seed meal are more commonly employed than any other materials to furnish potash and nitrogen to the mixed fertilizers, and planters will, in many cases, find it a good policy to prepare their own complete manures by purchasing the materials referred to and mixing them to suit the requirements of the crop or soil of their particular section.

With these materials at hand, the farmer can prepare a fertilizer of a certain composition for his cotton and a mixture of a still different composition for his corn, the proportion of nitrogen required in the latter case being in general greater than in the former.

Of course, fertilizers prepared according to any definite formula would not be equally well adapted to all soils and sections of the State, and to those who have written to this office for information with regard to the composition of fertilizers best suited to the needs of their particular locality, the formulas furnished in reply have been largely governed by the characteristics of the soil, both as regards composition and location. For instance, on many of our hill soils which consist very largely of particles derived from micaceous and feldspathic rocks, the addition of potash is of very doubtful necessity, and in some cases, quite recently, it has been recommended that for such soils potash either be omitted entirely, or else used in very small quantities. For the same reasons, the addition of excessive quantities of phosphates to some of our soils which are already well supplied with phosphoric acid is an extremely ill-advised procedure.

DOMESTIC MANURES.

Among the domestic manurial supplies of importance the manure of the more common farm animals first demands consideration.

Originally they found quite general employment in the manurial economy of the farm, but since commercial fertilizers have gained such extensive use, the supplies of domestic manures have been either partially disregarded or else not intelligently applied.

The value and importance of farm manures can possibly be better appreciated and understood when it is stated that the value of the manure produced by a well fed horse per year will be from $23 to $25, calculated according to our scale of fertilizer valuations, while the value of manure per head from our average full grown cattle will probably vary from $15 to $18 per year.

The value of farm manures is largely dependent upon the kind and condition of the animal and the character and quantity of food supplied, and even under uniform conditions the composition is subject to slight variations.

Young and growing animals excrete from one-half to three-fourths of the total fertilizing ingredients in their feed and this proportion is rarely exceeded for the reason that a considerable percentage of these fertilizing constituents are being constantly utilized in the formation of fresh quantities of bone, muscle, tissues, etc., there being in consequence much smaller amounts of waste materials than is the case with full grown animals.

With milch cows the amount of fertilizing constituents excreted is relatively smaller than with other neat cattle on account of the fact that a large proportion of these valuable elements are important constituents of milk, thereby diminishing the amounts found in the excrement itself.

Full grown animals, whether fattening or working, assimilate only a very small proportion of the three chief fertilizing elements, more than nine-tenths of the total amounts of these substances taken in the food, being found in the excreta.

The manure of the horse (or mule) is weight for weight much richer than that of cattle, though a portion of this difference is due to the extremely large percentage of water contained in the manure of cattle.

Samples of barn yard manure both from the stable and cow stalls at the experiment station were subjected to analysis with the following results:

ANALYSES OF BARN-YARD MANURE.

	Water.	Phosphoric Acid.	Nitrogen.	Potash.
Manure from cow stalls (fresh)*	83.85	0 28	0.29	......
" " " " (dry)	......	1.75	1.81	.21
" " mule " (fresh)	76.33	0.46	0 63	0.31
" " " " (dry)	......	1.94	2.66	1.31

* Solid excrement.

The proportion of water contained in the fresh manures of all animals is extremely high, as the analyses just given indicate, although the water percentages in these samples are below the average. The fertilizing value of such manures are made much more apparent when the percentages of the fertilizing ingredients in the dried material are given, as has been done in the case of each of the above samples, though in actual practice, it is best not to permit the manure to become even approximately dry, since "burning" or "fire-fanging" will almost always take place.

Since farm animals excrete such large proportions of the total fertilizing ingredients contained in their food, it is at once manifest that the character of the feed exerts a most important influence upon the composition and fertilizing value of the manure produced.

Indeed, the value of the manure of any given animal for fertilizing purposes is determined almost wholly by the proportions of phosphoric acid, potash and nitrogen contained in the feed stuffs, and analyses of manures resulting from the use of foods rich in the valuable elements of plant food invaribly show a marked superiority over those produced from a food less rich in those constituents.

For instance, carefully conducted feeding experiments have shown that the manure obtained where cotton seed meal and hulls were used, possessed a value more than 40 per cent. greater than that of manure resulting from the employment of an ordinary mixed feed.

In England and several continental countries, it is frequently the case that large numbers of cattle are fattened on high grade and concentrated feeds, either grown on adjacent land or imported, the manure carefully collected and preserved and in many instances returned to the very soils on which the feed stuffs have been produced, with only a very small net loss of the original fertilizing constituents removed by the crop from the soil.

The careful littering or bedding of the stalls of farm animals is of far greater importance than it is generally considered to be, and a disregard of the necessity of giving proper attention to this matter undoubtedly leads to considerable loss of valuable fertilizing ingredients. The chief function of the litter is to absorb the liquid manures which would otherwise go to waste and which it is very important to preserve and properly utilize.

The liquid manures of most farm animals contain relatively larger proportions of nitrogen and potash than do the solid excrements, and if these are not properly collected, it can be readily seen that there will be a loss of no inconsiderable amounts of the total fertilizing materials which are excreted. Among the materials ordinarily employed for litter or bedding may be mentioned straw of various kinds, leaves, saw dust, peat, muck, etc., though the first named substance is more extensively used than any other.

Experiments have demonstrated that dry straw will absorb frequently more than twice its weight of water, while dry peat and muck are almost perfect absorbents and at the same time add very greatly to the fertilizing value of the manure.

Dry straw contains only from one-half to three quarters of a per cent. of nitrogen and considerably less of potash and phosphoric acid, so that it's presence in a state of admixture with the manure does not add materially to the fertilizing value of the latter.

Straw and similar materials, however, in addition to their utility as absorbents, serve to decrease the compactness of manure, to check and regulate fermentation and in many cases promote chemical action in the manure.

The decomposed and disintegrated straw or litter will also supply humus to the soil, a not unimportant consideration in the case of many of our soils, which are almost destitute of organic matter.

The preservation of stable manures is a subject to which too much importance cannot be attached and their value is frequently much diminished by reason of the careless exposure to which they are subjected. Frequently manure heaps are left in an unprotected condition, under the eaves of barns and stables, and the leaching, which takes place with each rain fall, causes a considerable proportion of the fertilizing constituents to be washed out and lost.

Exposure to wind and variable conditions of weather also causes a loss, by reason of the escape of some of its constituents, particularly ammonia, in a gaseous form.

Carefully conducted experiments at the Cornell Experiment station have demonstrated that the reckless exposure of loose manure heaps to wind and weather may cause a loss of as much as 42 per cent. of its original fertilizing value during a period of only six months.

MUCKS.

In localities contiguous to swamps or low marshy bottoms where a dense vegetable growth has prevailed at some time in the past, mucks form a desirable proportion of the manurial supply of the farm, and in some sections of this country, as well as in Europe, mucks and peat form an article of commerce.

Materials of this character owe their value largely to the quantity of vegetable matter they contain, though the character of the vegetable growth from which they are derived influences very appreciably their composition.

Nitrogen is the most important fertilizing constitnent of mucks, though it is present in quite varying proportions, ranging from one half per cent. in a low grade article to 4 per cent. in mucks of extreme richness.

In addition, there are small proportions of phosphoric acid and potash, but these are of minor importance as compared with the nitrogen contained in the muck, and the large supplies of organic matter, which constitute a ready source of humus.

The thoroughly air dried muck may either be employed in composting, or is used as bedding in stables, it being especially adapted to this latter purpose on account of its great absorbent properties, readily taking up and retaining liquid manures with comparatively small loss of ammonia.

In composting, it can be used along with acid phosphates, either as a substitute for, or in conjunction with, stable manure.

The addition of moderate proportions of lime to muck composts is frequently practiced and in most cases to good advantage.

Two samples of muck from the southern part of the State have been examined in this laboratory quite recently and showed on analysis the following composition:

ANALYSES OF MUCK.

SAMPLE.	Phos-phoric Acid.	Nitrogen.	Potash.
No. 1. From Baldwin county, Alabama..............	Trace	0.70	0.04
No. 2. From Escambia county, Alabama...	0.58%	0.98	0.31

MARLS.

Throughout a very considerable area of the State, particularly in the cretaceous formations, marls are found in comparative abundance and many samples of high quality have been analyzed in this laboratory.

Marls, properly speaking, consist of carbonate of lime admixed with varying quantities of sand, clay or loam.

The carbonate of lime is ordinarily the chief constituent of value in marls, though small proportions of phosphoric acid and potash accompany the lime in many cases.

The carbonate of lime contained performs the functions of a stimulant manure, decomposing and rendering available some of the ordinarily inaccessible mineral forms of potash present in the soil, and also promoting the formation of humus and the nitrification of the otherwise inactive nitrogen of the soil. The chief difficulty in the way of the more extensive utilization of marls lies in the fact that they will not admit of transportation to any considerable distance, and the soils in the immediate vicinity of the marl deposits are in most cases quite well supplied with lime.

Light and sandy soils, however, will in most instances be benefited by the application of good quantities of well pulverized marl and such soils are sometimes found within easy reach of marl deposits.

"Green sand marls," or glauconitic marls, have been found in a number of localities in this State in sufficient quantities to prove of value for local use. They contain potash (in the form of the mineral "glauconite," in quite considerable proportions, and somewhat smaller quantities of phosphoric acid. Materials of this class act quite slowly when employed for fertilizing purposes, but as this action extends over quite a long period, the application of green sand marls constitutes quite an important contribution to the permanent plant food supplies of the soil.

The following are the analyses of two samples of green sand marl examined in the station laboratory within the past year.

ANALYSES OF GREEN SAND MARLS.

	Phosphoric Acid.	Potash.
Green Sand Marl, No. 1. From Silas, Ala.	2.24	3.78
" " " " 2. " " "	2.74	3.86

Marls of this high quality can be employed to quite good advantage, locally, either by direct application to the soil, or in conjunction with cotton seed and stable manure in the form of composts.

MISCELLANEOUS MANURIAL SUPPLIES.

In addition to the above described manurial supplies, there are other crude natural fertilizing materials which are incidental to certain localities in the State. Especially is this the case in North Alabama where valuable deposits of bat manure have been found in a number of caves. These deposits of bat excrement show considerable proportions of nitrogen and fairly good proportions of phosphoric acid and potash.

The following results of analysis of several samples of this material will serve to illustrate its composition and value as a fertilizer.

ANALYSES OF BAT MANURE.

SAMPLE.	Phosphoric Acid.	Nitrogen.	Potash.
Bat Manure, No. 1. From North Alabama, exact locality not known	2.79	3.20	0.85
Bat Manure, No. 2. From North Alabama, exact locality not known	5.56	8.26	2.02
Bat Manure, No. 3. From Lauderdale county	2.27	5.40	0.85

Samples No. 1 contained 65 per cent. moisture, while sample No. 2 had been air dried.

Deposits of cave earth, when employed locally, are of no small manurial value by virtue of the phosphoric acid and nitrogen contained, as the following analyses will show:

SAMPLE.	Phosphoric Acid.	Nitrogen.
Cave Earth, No. 3. From North Alabama, exact locality unknown	0.86	0.36
Cave Earth, No. 4. From North Alabama, exact locality unknown	1.63	0.29
Cave Earth, No. 5. From North Alabama, exact locality unknown	2.20	0.53
Cave Earth, No. 6. From North Alabama, exact locality unknown	3.31	0.20
Cave Earth, No. 7. From Lauderdale county, Alabama	6.84	0.94
" " " 8. " " " "	Trace	0.41
" " " 9. " " " "	3.65	

The bat manure, in a moderately dry condition, is of sufficient fertilizing value to admit of its transportation and it can be employed in mixed fertilizers as a source of nitrogen.

As a top dressing for grains, grasses, clover, etc., it can also be used to considerable advantage.

COMPOSTS.

The most advantageous form in which the crude manurial materials of the farm can be utilized, is, in general, in the compost heap.

Among the advantages offered by composting may be mentioned the better proportioning of the fertilizing ingredients designed for use on some specific soil or crop, which the proper preparation of the compost heap permits; the rapid disintegration and decomposition of the organic materials which may be employed as litter or else as ingredients of the compost; the promotion of nitrification, which is generally believed to be facilitated by the employment of carbonate of lime or marl in the compost; the retention and preservation of ammonia, which is possible in properly managed composts, the loss of which element constitutes one of the most objectionable features of the exposure of loose heaps of stable manure.

In addition, the stable manure by admixture with the other materials in composts, ordinarily becomes less compact, the material is more easily handled, and when applied to the soil, the fertilizing constituents contained are in a condition of more ready availability for the use of the plant. The most common ingredients of composts in the South are acid phosphate, cotton seed and stable manure, though in some cases mucks, marls, ashes, lime, etc., are employed.

For cotton the following compost formula is recommended for use on the average soil:

Acid Phosphate (14 per cent. available Phosphoric Acid)	500 lbs.
Cotton seed	700 "
Stable manure	800 "
Total	2,000 lbs.

In the preparation of composts, a layer of stable manure is spread out evenly in a level place to a depth of several inches; upon this a corresponding quantity of acid phosphate is placed, next a layer of cotton seed, this alternation being continued until the materials are exhausted.

The cotton seed employed in the compost should be moistened thoroughly, and the heap after its completion, should be saturated with water containing 100 pounds of Kainite in solution. The heap should be covered with a layer of rich earth or vegetable mould, or better still with a thin layer of gypsum; any liquid drainings from the stable which may be at hand, can be used to advantage in moistening the heap from time to time. The bed should be protected from rains by a shelter, and the heap should be left undisturbed for a period of from three to six weeks. When ready for use, the heap is broken up and the materials are thoroughly mixed and incorporated with each other. The quantities of this compost applied to the soil should be just about double the quantities of the average complete fertilizer ordinarily used on the soil or crop in question, i. e.—from 300 to 600 pounds of the compost per acre.

The composition of such a compost would be approximately as follows:

	Available Phosphate Acid.	Potash.	Nitrogen.
500 ℔ Acid Phosphate	70 ℔	......	....
700 " Cotton Seed	7 "	8 ℔	21 ℔
800 " Stable Manure	2.4 "	4.8 "	4.81 "
Total	79.4 ℔	12.8 ℔	25.81 ℔

The percentage composition would be:

Available phosphoric acid 3.97%.

Nitrogen 1.29%.

Potash .64%.

The addition of the kainite will increase the potash percentage to about 1.2, and the fertilizing value of the complete mixture, calculated on a fertilizer basis, will be about $9.70.

Instead of stable manure, muck can be employed, if deposits of this material of a good quality are at hand, and straw and decaying leaves in moderate quantities, may also be used if the heap is to be allowed to stand for some time.

A compost for corn will require relatively larger proportions of nitrogen and smaller quantities of phosphoric acid, and the following formula will furnish the desired elements in fairly satisfactory proportions :

Acid Phosphate (High Grade)	300 lbs.
Cotton Seed	900 lbs.
Stable Manure	800 lbs.
Total	2,000 lbs.

Kainite to be added as before.

Mixtures adapted to corn can be used to some advantage also with sugar cane, especially where the latter is grown on light sandy lands.

FRAUDULENT FORMULAS FOR COMPOSTS.

Several times during the present season there have been forwarded to this office, formulas for the preparation of composts and home mixed fertilizers, these formulas having been sold for as much as $5 by the parties who have adopted this fraudulent means of earning a livelihood.

The character of the materials recommended, and the forms and proportions in which the several ingredients are to be supplied, show upon the face of the formulas, evidence of the fraudulent and deceptive character of the latter.

Two of these formulas are given below, in order that the sham and deception involved in the sale of such recipes may be exposed.

FORMULA NO. 1.

Ammonia	5 lbs.
Phosphoric Acid	2 "
Nitrate of Potassium	5 "
Saltpeter	10 "
Sulphur	5 "
Potash	10 "
Lime	50 "
Ashes	100 "
Dirt or lot scrapings	1800 "

FORMULA NO. 2.

Nitrate of Ammonia	4 lbs.
Soda Ash	4 "
Saltpeter	2 "
Potash	4 "
Bluestone	2 "
Lime	50 "
Salt	25 "

Mix in 10 gallons of water and add to green vegetable mold or barn yard scrapings.

It will be observed that in the first formula, commercial ammonia is recommended, although it is one of the costliest forms of ammonia and a form in which its complete loss is best assured. The amount per ton of actual ammonia thus supplied is insignificant, and were the ammonia not already in a free condition, it would soon be liberated by virtue of the presence of caustic alkalies in the mixture.

Potassium nitrate and saltpeter are one and the same substance, although they are mentioned separately in this formula.

This salt is one of the costliest and most concentrated forms of nitrogen and potash obtainable, and its use in a compost would be entirely inadvisable, when so much cheaper forms of nitrogen can be easily secured. The sulphur in this formula, as well as the bluestone and other substances (soda, etc.) in the other formula, is entirely superfluous and unnecessary, and supplies but another evidence of the untrustworthiness of such recipes.

The presence of caustic alkalies in the second formula, along with ammonia salts would of course lead to an almost total loss of this last ingredient, while the proportions in which it is recommended that these mixtures should be applied, would furnish extremely small quantities of the important fertilizing ingredients to the soil.

For instance, the commercial value of the materials in formula No. 1, would be only about $1, though one of these ingredients, phosphoric acid, is not on the market in a free state, as the formula might lead one to suppose.

The commercial value of the fertilizing constituents in formula No. 2, is even less than that in No. 1, and the mixture is as equally untrustworthy.

It is to be hoped that the sellers of these formulas have met with but little success, and that the farmers will prepare their composts or home mixed manures out of the crude materials which they have at hand, used in conjunction with acid phosphate, kainite, etc.

GREEN MANURES.

The practice of green manuring, or the plowing under of certain green crops grown especially for this purpose, is one of the oldest systems of fertilization at present in use, and has been followed in the South with advantage for many years, though only one or two particular crops have been utilized for this purpose. While it has been long known that the cow pea and many other leguminous plants possessed in a most marked degree the capacity of collecting and assimilating large quantities of the chief fertilizing constituents, and particularly, nitrogen, nothing has been definitely known as to the causes underlying their remarkable properties as nitrogen collectors until within quite recent years.

So readily does the cow pea grow upon many soils which fail to respond to the requirements of other crops, that when it is desired to convey the idea of an almost total lack of fertility in a soil, we often hear the expression—"the land is too poor to grow cow peas."

It was formerly supposed that this capacity of collecting plant food so successfully, even on very poor soils, was due to the long and deep reaching roots which were presumed to readily take up supplies of plant food beyond the reach of many other crops. The amounts of nitrogen assimilated by the pea and similar plants on rather unfertile soils were frequently so out of proportion to the available supplies of nitrogen in these soils, that investigators have for years sought to determine whether or not these plants possessed the power of assimilating the free nitrogen of the atmosphere. The researches and experiments of a number of German investigators, extending over a long period of years, have at last shown that leguminous plants are capable of taking up and assimilating the nitrogen of the atmosphere, and this property is known to be dependent upon the presence of bacteria or minute microscopic forms of life, which are found in the tubercles or excrescences which occur quite profusely upon the roots of thrifty and vigorous plants of this character.

Certain particular bacteria are found to be peculiar to certain specific plants, and plants grown in a soil destitute of the organism peculiar to them, are observed to have few if any root tubercles.

By adding to the soil in question small amounts of soil from land on which similar plants are observed to develop root tubercles, it will be found that the plants grown on the former soil will also soon have tubercles formed upon their roots, and at the same time, the growth of the plants becomes vigorous and rapid. The presence of these bacteria in the tubercles of the roots of leguminous plants, in connection with the functions which the bacteria perform, constitutes an example of what is termed by scientists "*symbiosis*" (*life together*), the plant, itself, and these micro-organisms being mutually dependent upon each other. Since nitrogen is the costliest form of plant food obtainable, and since many of the commercial forms of nitrogen are either inaccessible to, or beyond the means of, many of the farmers, it will be readily seen that this system of green manuring, which provides a means for the collection of this valuable element from the atmosphere and a medium through which it can be stored up for the use of subsequent crops, is of the highest importance and utility to the farmer. Experiments conducted at this station several years since, showed that a crop of pea vines, grown on a sandy loam, of only moderate fertility, contained the following amounts of phosphoric acid, potash and nitrogen (calculated from actual analyses) per acre.

	In vines.	In roots.	Total.	Value.
Phosphoric Acid	39.05 lb	6.90	45.95	$ 2 30
Potash	88.79 "	13.12	101.91	1 02
Nitrogen	115.54 "	7.70	123.24	21 56

The values are calculated according to our scale of fertilizer valuations, and it will be seen that the value of the nitrogen alone, exceeds that of a ton of ordinary complete fertilizer, while the nitrogen is equivalent in amount to that contained in 1750 pounds of cotton seed meal, though this crop was considerably above the average yield.

In addition to the advantages derived from turning under a crop which has a peculiar adaptability to securing plant food from the air, and from the soil and soil water, such a crop supplies an immense mass of organic matter to the soil.

This vegetable matter on oxidation and decomposition, gives off large amounts of gaseous matter of which carbonic acid forms the chief proportion, and this last substance is highly instrumental, especially when in a state of solution, in the breaking up and dissolving the chief constituents of the soil.

The organic matter is also the source of supply for large amounts of humus which is so essential to soils in promoting the absorption and retention of moisture, and in the improvement of the mechanical condition and physical characteristics of the soil.

Humus is a material of somewhat complex composition and is the result of the partial decomposition of organic matter (whether vegetable or animal) in the soil.

Its color varies from brown to black, owing to the stage of decomposition it has reached, and the dark color of our most fertile soils is due to the presence of considerable proportions of this substance.

Very light, quickly drained soils, to which the term "thirsty" is often applied, are especially benefited by the addition of large quantities of humus forming material, which enable the soil by its increased absorptive and retentive capacity to withstand drought much more readily.

It also improves to a marked degree the texture of stiff, difficulty tillable soils, enabling them to be worked more easily, at the same time that it permits of more thorough aeration by virtue of their increased porosity.

Gases, such as carbonic acid, are more readily retained, and in conjunction with the water with which they are brought in contact, render the solution of certain forms of plant food comparatively easy.

It is also a most important agent in effecting the decomposition and disintegration of the mineral constituents of the soil, and in supplying some of the conditions most essential to nitrification.

In addition to the cow pea, which is the favorite crop for plowing under in the South, the clovers and alfalfa (or lucerne) rank very high as crops adapted to green manuring.

BULLETIN No. 64 FEBRUARY, 1895.

ALABAMA

Agricultural Experiment Station

OF THE

AGRICULTURAL AND MECHANICAL COLLEGE,

AUBURN.

TOBACCO.

ALEX. J. BONDURANT.

MONTGOMERY, ALA.:
THE BROWN PRINTING COMPANY, PRINTERS.
1895.

STATION COUNCIL.

ASSISTANTS.

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PART I.

TOBACCO EXPERIMENTS.

Experiments in tobacco were continued the past year with Plug and Cigar varieties. These experiments were undertaken to ascertain the best method of raising tobacco plants in Alabama, to find out the best kinds of tobacco for this climate and soil, the most suitable fertilizers for the tobacco crop, and for investigating some of the different methods of curing tobacco.

Methods of raising the plants.—The first bed for raising the plants was made at the Horticultural Grounds Jan. 31st. A frame was made of boards, 8x16 feet, such as is used for hot-beds, and into this frame rich woods mould was placed, well fertilized with equal portions of cotton seed meal and acid phosphate. The seeds were sown in drills a few inches apart, and the different varieties labelled. The bed was then covered with cheese cloth sewn together to make a close covering to keep in as much heat as possible and fastened to the planks with tacks. In three weeks from time of seeding, the plants came up. In this bed the plants made a good growth and would have been large enough for setting-out early in April, but for a freezing spell which occurred March 25th, destroying corn that was up and gardens generally. This unusually cold weather so late in the Spring in this climate, continued for three days, and owing to this bed being in a cold, exposed position, most of the plants were killed. In this connection, I found that the thin cheese cloth used for covering, in this instance, was not sufficient to protect the young plants from freezing. A thicker and better covering for the beds upon which oil is used in its make, and which will last more than a year, is prepared by T. W. Woods & Son, Richmond, Va.

The Woods bed.—This bed was prepared in a moist bottom in the woods, well protected by being surrounded with pines, and was seeded about a week later than the first bed. The bed was well burnt, the heavy coals taken off and the ground gotten in a finely pulverized condition with hoes and rakes. It was fertilized after the same method as before mentioned, seed sown and labelled, and covered in the same way as the first bed.

Boards about one foot broad were placed around this bed for the laths to rest on to which the canvass was tacked. In addition to this purpose, when a plant bed is inclosed with boards in the manner described, there is not much danger of its being attacked by the hopping flea beetle.

The plants came up well in this bed and were not so large as those in the first bed, when the dreadful March freeze came. Comparatively few of these plants were killed, which is accounted for, by the bed being so well protected from the cold winds by the dense pine forest.

After recovering from the effects of the cold, the plants grew off rapidly and many were ready for setting out in the month of April. These plants were not attacked at all by the flea beetle, which fact is explained by the beds being surrounded with boards and covered with cheese cloth.

From experiments made in raising plants in open beds, we find that they are liable to be destroyed by the flea beetle and other insects. Hence, we can reasonably infer that the best results will be obtained by having the plant bed in a well sheltered moist place in the woods, by surrounding the bed with boards, covering it with cloth and placing a light dressing of short pine straw on the bed after burning and before putting on the cloth.

Again, it is better to use cloth of a heavier thickness than the ordinary cheese cloth. It can be safely stated, that in the experiments conducted for three years in raising tobacco plants on the station, that fertilizing the plant beds with equal parts of cotton seed meal and acid phosphate have given better results than any other method of fertilization.

Preparing for Planting.—The land used for the Variety Experiment was poor, sandy up-land. It was cultivated in tobacco the year previous and after the crop came off, the land was plowed, fertilized and seeded with rye for winter soiling. After the rye was used for feeding purposes, the stubble was plowed-under the 23d of April and this plot of ground prepared for the tobacco Variety Experiment.

The rows were laid-off with a shovel plow, and the amount of fertilizers, as is shown in the table, was applied to each plot, mixed with the soil with a shovel furrow and then bedded-on with a Dixie plow. On May 1st, afternoon, planting commenced on the Variety Experiment by hauling water, and a few rows were set out. In the afternoon of May 2d and morning of the 3d, sufficient rain fell and all the plots of this Experiment were planted.

May 14th. Gentle rain commenced at 12.30 this day and continued until night.

The next day this Experiment was replanted—that is, plants were put in all missing hills. Most of the plants used at this time were overgrown and spindling, and were taken from the burnt bed in the woods. The few plants that were not killed in the bed at the Horticultural Grounds were overgrown even before the time of planting and on that account were not used in any of the experiments.

May 23d. The missing hills in this Experiment were again re-planted. More of the Cigar varieties were missing than the plug varieties.

June 18th. Slight rain in the evening, the first rain sufficient to moisten the ground since the 23d of May.

June 19.—Another light rain and this with the rain of the 18th made a fair season for putting out plants. All the plots in this experiment were gone over and every missing hill replanted. There was no further replanting done on this Variety Experiment as a fair stand was secured. The experiment was worked mostly with plow, receiving one or two workings with the hoe. Notwithstanding the season was dry, some of the first plants set out grew rapidly, and on

June 18th a few plants of the Havana tobacco were putting out fruit buds and were topped.

July 3d.—The dry weather has continued, but the plants have made a good growth and a general topping was done on the cigar varieties. The plug varieties were not so forward in their growth and at that time, very few of these varieties required any topping.

About July 5th it commenced raining, and for several weeks there were occasional showers and heavy rains. Soon after that time, both the plug and cigar varieties in this experiment attained their growth.

HARVESTING AND CURING.

The gathering of the leaves for curing was begun August 20th, by first taking off the ground leaves of the plug varieties, placing them in baskets used for this purpose as fast as gathered and then taking them to the curing barn. The gathering continued through the 21st and the barn was filled on the morning of the 22nd.

August 24th 6 a. m.—Started fires for curing. Tobacco had yellowed fairly well in the house. Temperature outside and inside of barn 75° before starting fires.

After starting the fires, the temperature in the barn for 24 hours ranged from 80° to 86°

August	25.—	Temperature	ranged	from	90° to 95°
"	26	"	"	"	95 to 100
"	27	"	"	"	100 to 110
"	28	"	"	"	120
"	29	"	"	"	125 to 130

and fires stopped at sun-set.

Tobacco seemed to be thoroughly cured with a fair proportion of bright yellow tobacco.

Sept. 1st.—Sprinkled floor of tobacco barn about 4 p. m. preparatory to taking it down.

Sept. 3rd, Monday.—Took tobacco out of barn and bulked it down in another building, so as to have the barn ready for another curing.

The tobacco remained in bulk until about Nov. 1st, when it was opened, assorted and put into hands. At this time samples were selected for the Montgomery Exposition.

The tobacco having been taken down out of the curing house in good, safe keeping order, that is, without the leaves being *too moist* or in *too high case*, and the *stems being thoroughly cured* by fire in the barn, the bulk after standing more than *two months* was found to be perfectly sound and with a good flavor.

Just here it may be well to note, that in this case, flue cured tobacco underwent *but littte*, if *any fermentation*, when *placed in bulk*, which condition is favorable for chewing tobacco, but not suitable for cigar and smoking.

August 22nd the cigar leaf of this experiment was gathered.

The method of harvesting and curing was different from the one followed with the plug varieties. The stalk was cut off close to the ground, after first splitting it half way down from the top. The tobacco was then placed in a well ventilated house, with doors at each end and windows in the sides—for air curing. In a few weeks the leaves were air-cured. When it was taken down, which was about the same time that the plug kinds were taken down, all of the main stems were pretty well cured, though some parts of the stalks were not fully cured.

The cigar types were managed, after being taken down, the same as the plug kinds, samples of which were on exhibition at the Montgomery Exposition in Nov. 1894.

The following facts from investigations concerning the cigar varieties are of some importance.

(1) *Comstock Spanish*—Large, broad, thin leaf good cinnamon color. Size sufficient to make cigar wrappers.

(2) *Connecticut Seed Leaf*—Fine, large size, rather lighter color than No. 1, and not so large a leaf. Leaf large enough for cigar wrapper.

(3) *Havana*—Rather small for wrappers—makes good fillers and binders.

(4) *Havana Seed Leaf*—Larger than Havana. Not so

large as Nos. 1 and 2. Makes good fillers and binders and some leaves large enough for wrappers. The flavor of all these is decidedly cigar, and having been cured by the *air process* will ferment well, and after undergoing fermentation, should make cigars of fine quality.

(5) *Brazil Gold Leaf*—This variety was from seed sent by Mr. R. D. Martin, Florence, Ala. When cured, it was of a brighter color than any of the other cigar varieties. Leaf thin and silky, but not so decided a cigar flavor as the others mentioned. Yield much less. Mr. Martin has been growing this variety for several years and informed me that he had sold last year's crop for thirty cents a pound.

The yield of the plug and cigar varieties in this experiment is shown by table No. 1, which is hereto appended.

TOBACCO. TABLE NO. 1.

VARIETY EXPERIMENT.

Plot ½ Acre. 11 Plots 1-22 Acre each.

Plot No.	Name and Quantity of Fertilizers per Plot.	Names of Varieties.	How cured and when.	Yield per Plot Dry.	Yield per Acre Dry.
1	Cotton S. Meal 27.3-11. Acid Phos.....13.7-11. Kainit......... 9.1-11.	Comstock Spanish............	Air Oct. 31.	39.6	871.2
2	Cotton S. Meal 27.3-11 Acid Phos.....13.7-11. Kainit.......... 9.1-11	Connecticut Seed Leaf............	"	34.1	750.2
13	Cotton S. Meal 27.3-11. Acid Phos.....13.7-11. Kainit......... 9.1-11.	Pure Havana....	"	39.1	860.2
4	Cotton S. Meal 27.3-11. Acid Phos.....13.7-11. Kainit......... 9.1-11.	Havana Seed Leaf.	"	59.3	1304.6
3	Cotton S. Meal 27.3-11. Acid Phos.....13.7-11. Kainit......... 9.1-11.	Conqueror........	Snow Barn Sept. 3d.	32.4	712.8
6	Cotton S. Meal 27.3-11. Acid Phos.....13.7-11. Kainit......... 9.1-11.	Hyco............	"	41.7	917.4
7	Cotton S. Meal 27.3-11. Acid Phos.....13.7-11. Kainit......... 9.1-11.	Long Leaf Gooch.	"	39.7	873.4
9	Cotton S. Meal 27.3-11. Acid Phos.....13.7-11. Kainit......... 9.1-11.	Yellow Oronoco..	"	34.3	754.6
14	Cotton S. Meal 27.3-11. Acid Phos.....13.7-11. Kainit......... 9.1-11.	Yellow Pryor....	"	39.2	862.4
10	Cotton S. Meal 27.3-11. Acid Phos.....13.7-11 Kainit......... 9.1-11.	White Stem Oronoco............	"	35 6	783.2
16	Cotton S. Meal 27.3-11. Acid Phos.....13.7-11. Kainit......... 9.1-11.	Brazil Gold Leaf.	"	23.8	523.6

SPECIAL NITROGEN EXPERIMENT.

As the cultivation of tobacco in the State of Alabama is a new industry, it is important to find out the best method of fertilizing on this soil.

The experiment which follows was undertaken with this in view—to ascertain how the tobacco plant responds to the use of nitrogen in different forms and qualities when added to a *basal mixture* of phosphoric acid and potash. By a *basal mixture*, is meant a specific amount of fertilizer, in this case, phosphoric acid and potash being used as a basis for comparison in studying the effect of some fertilizing constituent, nitrogen being used in different forms and amounts, in the experiment to show the increased yield in the produce due to its action.

Phosphoric acid and potash are supplied in the proportions that are thought sufficient for a good yield, and nitrogen is supplied in one-third, two-thirds and full quantities. Nitrogen is used as nitric acid in nitrate of soda, as ammonia in sulphate of ammonia and as organic nitrogen in dried blood.

Twenty plots are provided for in the *field plain*—eighteen of which received the experimental manures while two plots received none.

Figure 1 shows the appearance of some of the plug varieties while growing.

NOTES ON FERTILIZER TEST, AUGUST 20.

No. 1.—No manure. Tobacco only medium in size. Ripened unevenly and seems to belong to the cigar variety.

No. 2.—About one-third larger than No. 1. and at this date (Aug. 20) about one half of the plot is ready for cutting. Seems to be the same variety as No. 1, and from general appearance would call it Havana. Inclined to ripen with a yellow color.

No. 3.—Evidently a cigar variety. The entire plot has ripened quite yellow and it is very evident that this fertilizer will cause tobacco to ripen yellow.

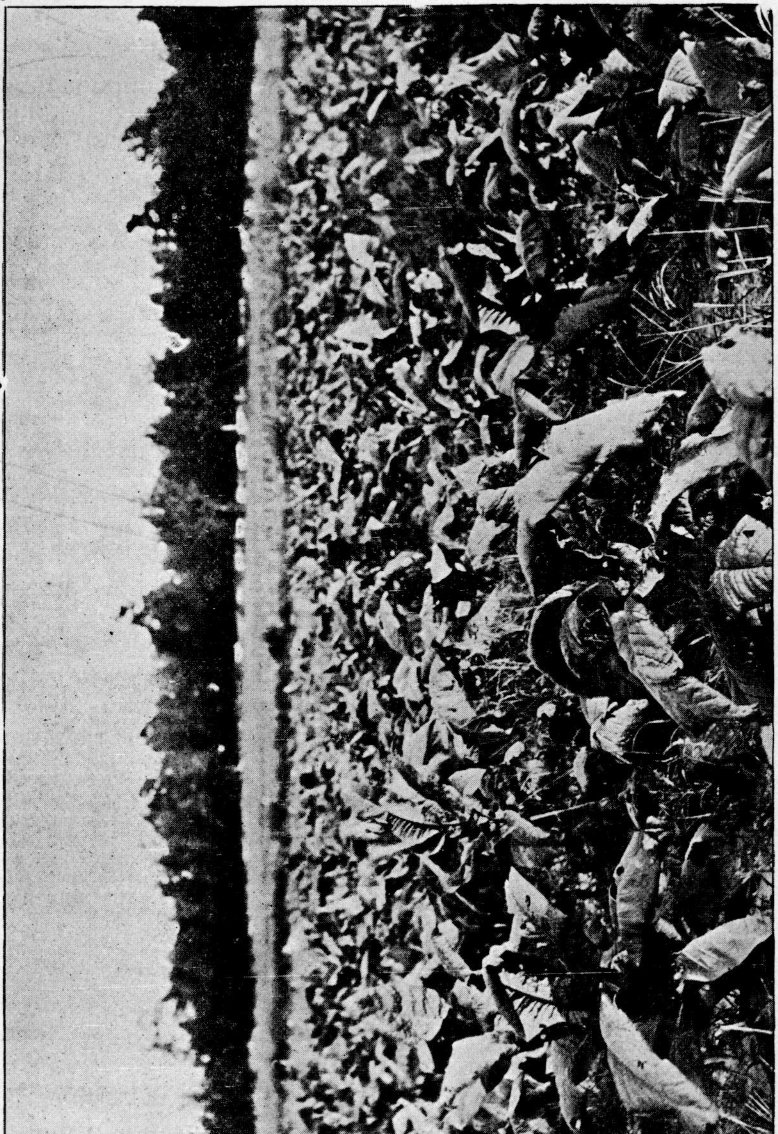


Figure 1

No. 4.—Cigar variety. Smaller than No. 3. Ripens quite yellow on stalk.

No. 5.—Plug variety. Greenish appearance, seems to fire badly at bottom of stalk. I am inclined to the opinion that the fertilizer used on this plot is too caustic, or it may be due to too much rain for this soil.

No. 6.—Evidently a plug variety. The fertilizer on this plot seems to have acted fairly well for this kind, good size growth, light tea green color and at this date but little ripe.

No. 7.—This plot though not yet ripe, the indications are that it will ripen yellow, and that the fertilizer used will make yellow tobacco.

No. 8.—Evidently a plug variety. At this date it is decidedly larger, and greener in appearance than any of the preceding plots. The fertilizer used is for extra large stemming which this seems to be.

No. 9.—Plug variety. Larger than No. 8; very large stemming; dark green, and from the appearance the indications are that the fertilizer, in quantity and quality used, is a complete fertilizer for large stemming tobacco.

No. 10.—This plot quite large, dark green and shows that the fertilizer used is suitable for a large dark tobacco.

No. 11.—Plug variety. Medium size, beautiful yellow color, and indicates that the fertilizer seems to be the kind for making yellow tobacco.

No. 12.—Tobacco good size; light green, but little burnt at bottom. Fertilizer seems to suit a dark tobacco.

No. 13.—Very large; ripening pale green, and the indications are that this application of fertilizer is very fine for making a large tobacco suitable for stemming.

No. 14.—Compares favorably with No. 13, and does not seem to be superior to it.

No. 15.—Medium size and compares favorably with No. 7, with the exception of not being so bright.

No 16.—Medium in size; shows yellow tint in ripening.

No. 17.—Large; green color, and shows color and size for stemming.

No. 18.—Decided stemming type. Resembles No. 17 in color, but leaf much larger than 17.

No. 19.—Quite small and indifferent, slight yellowish tint.

No. 20.—No manure. Very small and indifferent, and shows plainly that tobacco can not be raised on soil like this without fertilizers.

By reference to the following table, and by comparing these plots in groups of threes, it appears that the nitrogen in the form of nitric acid, contained in nitrate of soda, in plots 8, 9 and 10, of group 1, gave the best results. Dried blood, in the form of organic nitrogen in plots 16, 17 and 18, of group 2, gave the next best, and ammonia, in sulphate ammonia in plots 12, 13 and 14, group 3, gave the poorest results.

Group 1.	Plot No. 8.	Nitrate Soda, yield per acre	964 lbs.
	" " 9.	" " " " "	1020 "
	" " 10.	" " " " "	972 "
			2956
Group 2.	Plot No. 16.	Dried Blood, yield per acre	800 lbs.
	" " 17.	" " " " "	996 "
	" " 18.	" " " " "	1072 "
			2868
Group 3.	Plot No. 12.	Sulphate Ammonia, yield per acre	508 lbs.
	" " 13.	" " " " "	1000 "
	" " 14.	" " " " "	952 "
			2460

CONTINUATION OF NITROGEN EXPERIMEMT.

This test was made on plots contiguous to one another and as nearly alike as possible in physical conditions and fertility.

The soil upon which it was made was poor sandy upland. Every application contained the same amounts of potash and phosphoric acid, and practically the same amount of nitrogen, but in different forms, thus giving at the same time all the fertilizing constituents required and full effect to the nitrogen employed.

The plots upon which the sulphate of ammonia was used suffered more from *field-fire* or *blister* than any of the others. To sum up the results of this experiment, it appears that the unmanured plots gave the poorest returns, that nitrogen was most effective in the form of nitric acid in nitrate of soda and in the form of organic nitrogen in dried blood, and was least effective in the form of ammonia in sulphate of ammonia.

Owing to circumstances, it was impossible to have all the plots of the same variety of tobacco.

Table No. 2, attached, gives the experiment in full. Figure No. 2, which follows this table, shows the appearance of several kinds of tobacco before harvesting.

TOBACCO. TABLE NO. 2.

Special Nitrogen Experiment, to ascertain how the *plant responds* to the use of Nitrogen in different forms and quantities, when added to a *basil mixture* of Phosphoric Acid and Potash, one.half acre, plots 1-40 acre.

Pot No.	Names and Quantity of Fertilizers used per Plot.	Names of Varieties.	How Cured.	When Cured.	Yield per Plot Dry.	Yield per Acre Dry.
1	No manure............	Brazil Gold Leaf..	Air...	Oct. 31.	....	.....
2	Nitrate Soda ... 8 lbs.	" " " ..	" ..	"	....	.....
3	Diss. Bone Black.16 "	" " " ..	" ..	"	....	.....
4	Sul. Potash......12½"	" " " ..	" ..	"	....	.....
5	Nitrate Soda.... 8 " Diss. Bone Black.16 "	Yellow Pryor....	Snow Barn.	Sept. 3.	15.1	604.
6	Nitrate Soda.... 8 " Sul. Potash......12½"	" "	" ..	"	31.3	1252.
7	Diss. Bone Black.16 " Sul. Potash......12½"	" "	" ..	"	6.6	264.
8	Diss. Bone Black.16 " Sul. Potash......12½" Nitrate Soda.... 8½"	Yellow Oronoco..	" ..	"	24.1	964.
9	Diss. Bone Black.16 " Nitrate Soda... 16 " Sul. Potash .....12½"	" " ..	" ..	"	25.5	1020.
10	Diss. Bone Black.16 " Nitrate Soda....24 " Sul. Potash......12½"		" ..	"	24.3	972.
11	Diss. Bone Black.16 " Sul. Potash......12½"	White Stem Oronoco. .	" ..	"	22.2	888.
12	Diss. Bone Black.16 " Sul. Potash......12½" Sul. Ammonia.6.1-10"	" "	" ..	"	12 7	508.
13	Diss. Bone Black.16 " Sul. Potash......12½" Sul. Ammo.12.2-10 "	" "	" ..	"	25.0	1000.
14	Diss. Bone Black.16 " Sul. Potash......12½" Sul, Ammo.18.3-10 "	Conqueror.......	" ..	"	23.8	952.
15	Diss. Bone Black.16 " Sul. Potash..... 12½"	"	" ..	"	16.3	652.
16	Diss. Bone Black.16 " Sul. Potash......12½" Dried Blood..16 6-10"	"	" ..	"	20.0	800.
17	Diss. Bone Black.16 " Sul. Potash......12½" Dried Blood..23.2-10"	Hyco............	" ..	"	24.9	996.
18	Diss. Bone Black.16 " Sul. Potash......12½" Dried Blood..34.9-10"	"	" ..	"	26.8	1072.
19	Diss. Bone Black.16 " Sul. Potash......12½"	"	" ..	"	10.9	436.
20	No manure............	"	" ..	"	....	.....

FIGURE 2.

Tobacco—Table No. 3.

EXPERIMENTS WITH FERTILIZERS WITH THREE POPULAR CIGAR VARIETIES.

This was the last experiment, planted May 14th. Fertilized with 225 lbs. sulphate of potash, 150 lbs. sulphate ammonia and 150 lbs. acid phosphate, for ½ acre. One plot was unmanured in addition to the ½ acre.

The land upon which this experiment was made was very poor, was planted in peas the year previous which yielded a very poor crop on account of the extreme poverty of the soil.

The yield of these three cigar types can be seen from table No. 3 which follows.

Plot No.	Size of Plot.	Name of Varieties.	Pounds yield per Acre.
1	1-6 Acre. ...	Connecticut Seed Leaf............	519.4
2	" "	Havana Seed Leaf.................	827.8
3	" "	Pure Havana......................	387.5
4	....	Unmanured........................	made nothing.

Figure 3 shows the appearance of the plots while growing and before cutting. Also shows the unmanured plot on the left side of picture, which was a total failure on account of the extreme poorness of the soil.

MANUFACTURING INTO PLUG AND CIGARS.

The tobacco raised on the station in 1893, was manufactured into chewing tobacco and cigars by a firm in Richmond, Va.

The cost of manufacturing for chewing was twenty-six cents a pound. After the flavoring necessary for its manufacture into plug had been put on, the tobacco weighed as much as it did before it was stemmed for manufacture. In

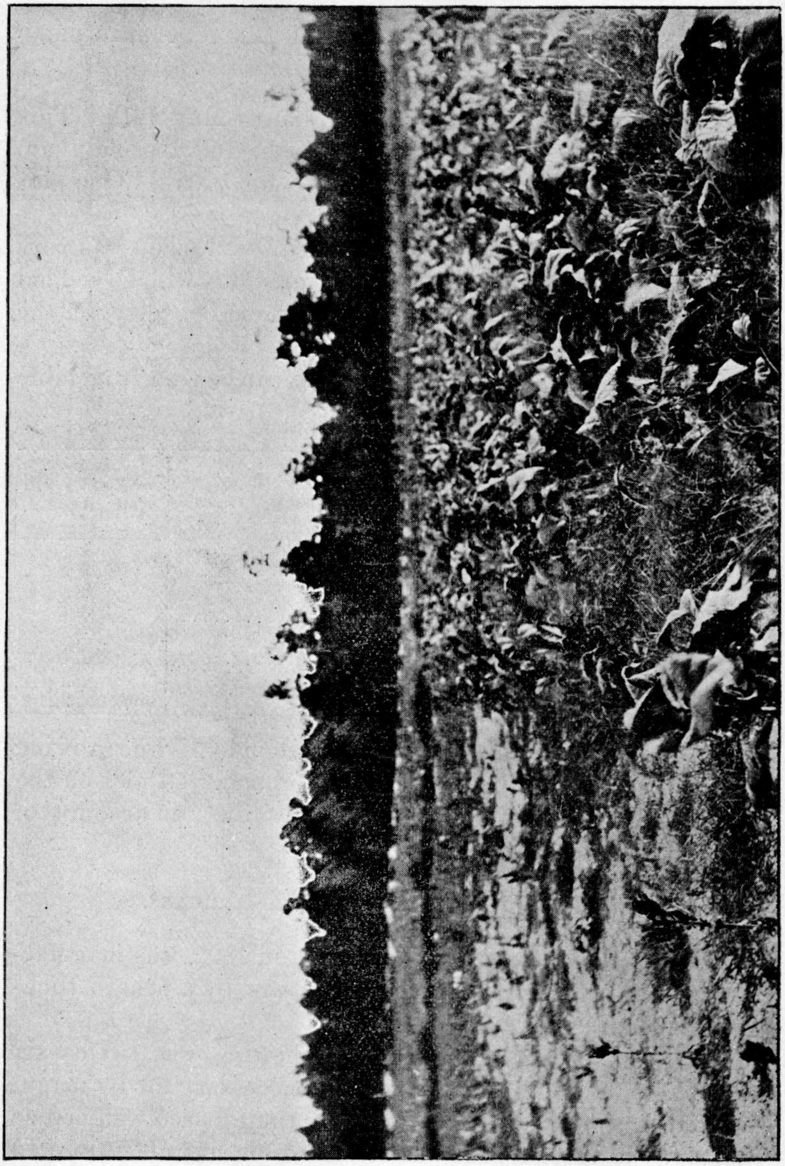


Figure 3.

other words, in this case, 100 pounds of unmanufactured tobacco made 100 pounds ready for chewing. The leaf sent from the station was of good quality, and the manufactured article was pronounced excellent by competent judges. In order to test the merits of this tobacco it was placed in the hands of merchants for sale in different localities, and the prices realized at retail were 40, 50 and 55 cents per pound.

Several boxes were sold by a merchant in Montgomery, Ala., at 30 cents a pound wholesale. These are better prices than are obtained for much of the Virginia and North Carolina plug tobacco sold in this State.

The manufacturer of this tobacco used the best quality and a high priced flavoring material, which made the cost more than the common grades. A fair chewing tobacco, with less costly seasoning, can be manufactured for about 14 or 15 cents a pound.

Notwithstanding the cost of manufacture in this particular case, it left a reasonable profit for the tobacco.

This tobacco was on exhibition at the late Montgomery Exposition, and much of it was distributed to the lovers of the weed and to those who are interested in this new industry in Alabama.

MAKING CIGARS.

The tobacco sent to be made into cigars had to go through several months fermentation before being manufactured. A few boxes were received in November and some sent to the Montgomery Exposition and distributed. None have been sold as the supply made up was limited. Judges of cigars value them at \$25 to \$50 per thousand. It requires about twenty pounds of tobacco to make a thousand cigars such as we had made. The cost of making was \$20 per thousand.

MARKETING THE CROP.

Much trouble is found in marketing the tobacco raised here on account of the high rates of freight to the Eastern and Western markets, and to remedy this tobacco *should be manufactured at home.*

Since this industry was started on the station, parties who have gotten instructions from us as to the growth and management of the tobacco plant, are growing their own tobacco and making cigars.

The cost of an out-fit for manufacturing plug is small, and if enterprising farmers would grow tobacco in sufficient quantities and co-operate in establishing manufacturing plants in different parts of the State the undertaking should prove profitable. The culture of tobacco will add materially to the prosperity of the farmers when they learn to give it proper and careful attention.

This industry has become quite a prominent feature in South Carolina agriculture and has proven one of the best paying crops introduced. It has been demonstrated beyond question to be a success in certain parts of the State. In the Pee Dee section it has succeeded well, but it has had its most satisfactory development in Darlington county. Ten years ago tobacco was not grown for market in South Carolina. Last year 1,000,000 pounds were raised and marketed in Darlington county. The acreage devoted to the cultivation of tobacco was not 5 per cent. of what was devoted to cotton, yet the value of the tobacco product was 16 per cent. of all the cotton raised in the county. The money value of the tobacco crop of Darlington county was $120,000.

This station has sent out this winter, on application of farmers, a large quantity of tobacco seed raised here. There is yet a limited quantity on hand which will be furnished to those asking for them.

PART II.

Inasmuch as the interest in tobacco culture has increased in the State during the last two years, the demand for the Tobacco Bulletins has exceeded the number published by the station; and owing to this fact, it becomes necessary to reproduce in this issue some inportant information contained in previous Bulletins, especially in the illustrated number, 44, issued May, 1893.

The scientific facts pertaining to agriculture, so far as they have been discovered, are scattered through many books and agricultural publications; few of these publications are accessible to the ordinary farmer.

Some service may be done to the farmers generally, and especially in the Cotton States, by stating some important facts that are accurately and certainly known, and the experience of intelligent farmers and scientific men on the subject of tobacco culture and by presenting these in compact form.

Tobacco growing is one of the most profitable branches of tropical and semi-tropical agriculture; the subject has been much neglected by writers of agricultural literature. The importance of the subject to the farmer may be estimated when it is considered that next to the cereals used as staple articles of food, there is probably no plant so widely and generally grown as tobacco, and certainly none that is used by a greater number of the human race. It is proposed in this Bulletin to notice some of the leading varieties, some instructions for its successful cultivation and management with a view to encourage the cultivation of a plant that can be generally grown in this State, the climate and soil of which, it is believed, suit it admirably in sufficient quantity, not alone to satisfy all local demands, but to open up a large and profitable export trade.

The investigation of this subject was commenced in 1892, and methods of cultivation and management of this crop were given in Bulletins No. 37, March 1892, No. 44, May 1893, and No. 54, February 1894.

I.

RAISING THE PLANTS.

It has been demonstrated from experiments made in the raising of tobacco plants that the young plants were easily affected by cold and quickly killed by freezing weather, in this climate, in fact, they seemed to be affected sooner in this respect than in many localities in the old tobacco raising States. To avoid this difficulty, it is advisable to raise the plants under covered beds, in preference to open air beds. Another important discovery has been made in raising plants on the station, viz: That the flea beetle, commonly called tobacco fly in the old tobacco States, seems to be abundant in this section, attacking the plants soon after they come up, and in uncovered beds destroying them, unless insecticides be promptly applied.

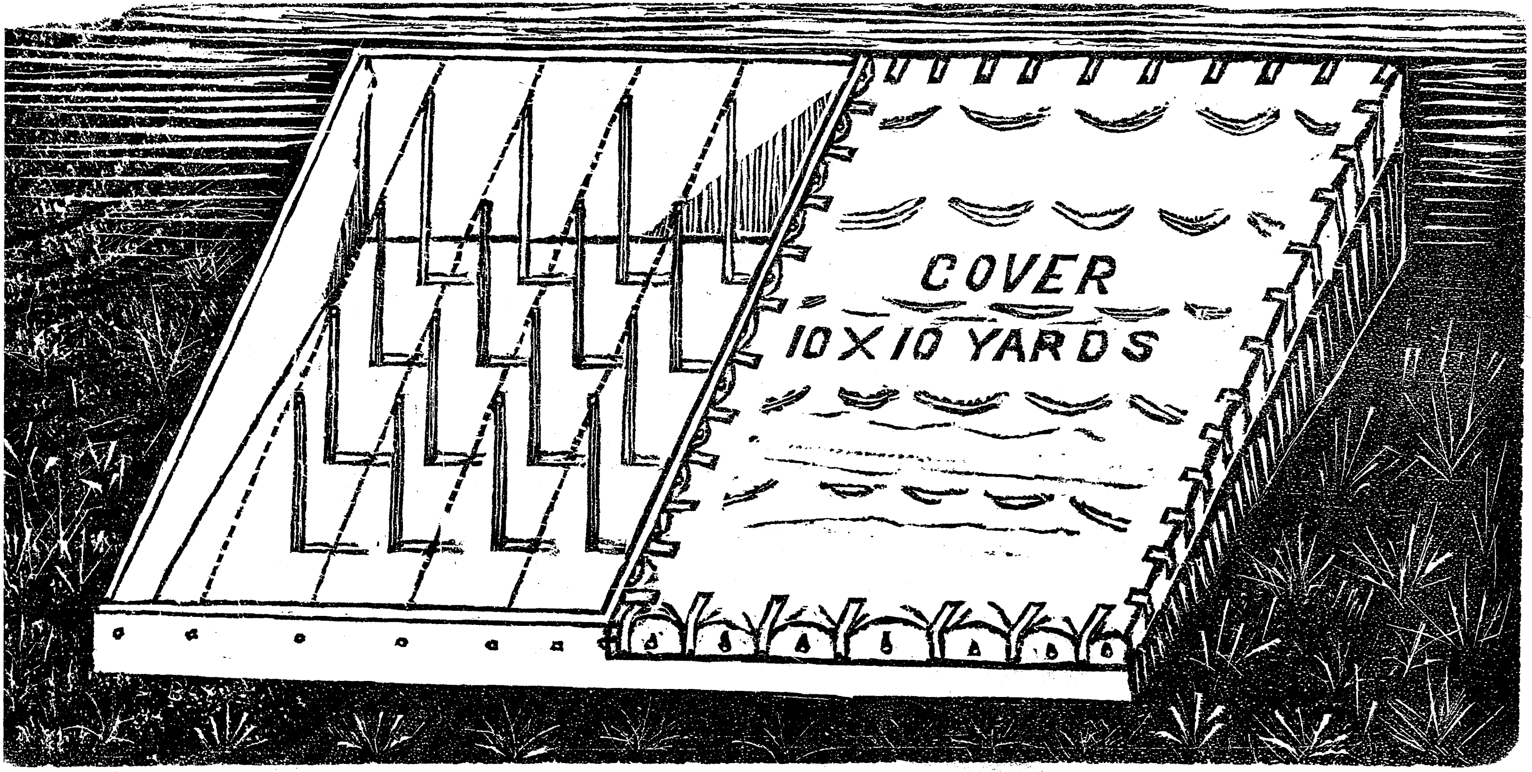
As a remedy for the flea beetle and other insects I would advise spraying the bed with the following solution: One ounce of Paris Green well mixed with fifteen or twenty gallons weak soap suds. This same application can also be used after the plants reach the surface.

Pyrethum, commonly called insect powder, can be used in place of Paris Green, either dry or mixed with water, but it is not considered so effective as Paris Green, and besides it is costlier and more difficult to procure unadulterated.

It has been ascertained from these experiments that the plants raised under canvass made a more rapid growth and presented a healthier appearance and were ready for transplanting much earlier than those from open air beds.

The first operation necessary in starting tobacco growing is the making of a seed-bed for raising the plants. A warm sheltered position should be selected for this. It is a common plan to burn a pile of brush-wood, on the land selected for raising the plants, to supply potash and at the same time for destroying the seeds of weeds or the eggs of insects.

A more recent plan of raising the plants is under a covering of cheese cloth in a hot bed. Plate No. 4 is an illustration of the modern method of covering the plants during their growth, both in the open air and hot beds. The area of the seed-bed will of course depend upon the extent of the proposed cultivation and as usually about one square inch in space is allowed to each young plant in the seed-bed, it will require a seed-bed of thirty-six square feet, say nine by four feet, to supply plants for an acre planted at equal distances of three feet apart.


COVER
10X10 YARDS

An ounce contains enough seed to plant from six to seven acres, but as the seed do not possess a high percentage of vitality, it is usual to sow at the rate of half an ounce for an acre. The bed ought to be covered with a covering of cheese cloth, or fine brush or short-leaf pine straw. A bettter cloth, however, than cheese-cloth for this purpose, is prepared by T. W. Woods & Son, Richmond, Va., which will last more than one season. This not only protects the plants from the cold, sudden freezes, which are common in the early spring in this latitude about the time germination commences, but checks too rapid evaporation from the earth, keeping the surface moist. When the young plants first appear above the surface, they are very tender and require frequent watering of weak liquid manure and top dressing with fertilizers.

All weeds must be carefully removed, and the flea beetles, which often destroy the young plants in a few days, must be watched for and the insect remedies before mentioned applied. In from five to six weeks from the time the plants appear on the surface, they will be ready for transplanting.

The bed for producing the plants should be well fertilized. A complete fertilizer has given good results. We have also raised excellent plants by fertilizing with equal portions of cotton seed meal and acid phosphate. When these too, however cannot be supplied, stable or hog manure, free from seeds, well chopped into the soil at the time of preparing bed for planting, will answer a good purpose.

II.

CLIMATIC CONDITIONS.

Of the many conditions which affect the quality of tobacco, the most important is climate; other conditions may be, in a measure, modified, but very little can be done with regard to climate. The most rational mode of overcoming this difficulty would be in the selection of seed of the varieties which have been grown with success under similar climatic conditions as prevail in the district proposed to be cultivated.

In this State, with its range of climate from semi-tropical to temperate, a wide margin is permitted to the grower, and seed can be procured suitable to all parts of the State. In tobacco, as in all other crops, the aim of the grower should be to produce the kind which will command the highest price. The most valuable tobaccos are the Cuban and Manilla, and they owe their fame mostly to the favorable conditions under which they are grown. These places possess a tropical heat, but at the same time are tempered with the sea breeze, and there are, no doubt, parts of the coastal districts of this State which may produce an article that could favorably compare with these tobaccos.

Tobacco thrives best in a good rich soil, rich in vegetable mould, but light soil containing a good amount of organic matter and well drained will produce an excellent smoking tobacco, and on such soil the finest leaves are grown. The more clay in the soil the thicker the leaves become, and the aroma becomes less, and is consequently less suited for the finer qualities of smoking tobacco, although the weight of yield may be heavier.

From the many samples of tobacco sent to this station to judge of their value, I find that the black prairie land will yield more to the acre than any other kind of land in this State, but the tobacco will not possess so fine a quality—on such soil it grows larger, has coarser stems and a heavier leaf, and is not so good for wrappers, or fine cut or cigarettes and cigars as the upland tobacco on sandy soils. Though tobacco is a hardy plant and will grow under varied conditions, yet to become a profitable crop, it must not be grown in a situation very different from that to which it is suited by nature. It must be remembered that the plant is a native of a warm climate, and thrives best in a moist atmosphere; therefore, in such a climate, by employing ordinary means, tobacco may be made to yield a profit not attainable in less favored situations. A warm, moist climate will permit of the selection of the varieties that sell at the highest price in the market, and in a suitable soil the profit will be such as is not often or easily realized from any other crop.

As the Havana tobaccos command the highest price, growers everywhere attempt to introduce and cultivate them. The difficulty in growing these varieties is, they speedily degenerate if the conditions are not favorable. To prevent this deterioration it is important to import and use Cuban seed every one or two years. Virginia tobacco is the most favored in temporate climates, as it does not require such a high temperature, but on account of its botanical characteristics it is not much liked by cigar or cut tobacco manufacturers. A high price is generally commanded, no matter of what variety, which possesses either a light mahogany, cinnamon, or golden color, and fine aroma, with thin ribs far apart and even. The wider the leaf and the less they are worm eaten, or torn, the greater the number of wrappers which can be cut from a pound for making cigars, consequently manufacturers will pay more for grades possessing these qualities than for others.

It may be said of the varieties most generally grown in America, that the Kentucky, Virginia and Maryland are employed for chewing, pipe and cigarette smoking, while the Connecticut seed leaf and Havana are most in use for fillers and wrappers in the manufacture of cigars.

During the last half century the plant has been developed to a greater extent than during the three hundred years succeeding its discovery. Its cultivation and management have been reduced to an approach to an exact science, and the quality of the leaf is, in a great measure, within the control of the growers of the plant; until quite recently it was supposed that the varieties that grew in the tropics could not be cultivated with success in the temperate regions, but recent experiments have demonstrated the fact that the tobacco of Cuba can be grown with success in many parts of the United States. The tobacco raised in the tropics is the finest in flavor, while the more temperate regions produce the finest and best colored leaf.

The tobacco of the tropics, as to the uses to which it is put, is limited, while the tobacco of the more temperate regions can be used for all the purposes for which the plant is needed.

Formerly but little attention was paid to the color and texture of the leaf, the principal object being the production of a leaf of large size, rather than one of good color and of silky texture. Now, these are most important conditions, and give value to the tobacco in proportion to the perfection of these qualities.

III.

FIELD CULTURE.

Land on which it is intended to grow tobacco should be well ploughed; on compact soils the ploughing should be deep. An intelligent rotation of crops carried out with an intelligent knowledge of the needs of the tobacco crop will be the aim of the practical farmer. Before transplanting the young plants from the seed-bed the land should be ridged, the distance between the ridges depending on the kind of tobacco to be planted—the larger kinds requiring more room than the smaller-leaved and tall sorts. Generally from three to three and a half feet apart between the rows, and the same between the plants will be sufficient. Where the surface is level the plough may be run lightly over the field at right angles, thus forming small hills on which the plants are planted.

Choice of Soil.—The growers of the plant are very particular in the selection of suitable soil for tobacco growing. The selection of soil will depend upon the color of leaf in demand, as the soil as well as the fertilizers determine to some extent the color and texture of the leaf.

The effect produced by planting tobacco too near the sea is injury to the leaf, which is apt to be thick and unfit for a cigar wrapper. In some countries, however, notably Cuba, the leaf grown near salt water is equal in color and texture to any grown in the interior.

Generally the plant obtains its finest form and quality of leaf on lands bordering the largest rivers. This is true of the tobacco lands of Connecticut, Kentucky, Virginia and North Carolina, as well as of those in the islands of Cuba and San Domingo; but some of the finest tobacco grown in the United States is grown in localities some distance from large rivers.

When possible, select the kind of soil for tobacco that will produce the color and texture desired. For Connecticut seed leaf a light moist loam is the best soil. For the bright tobaccos, such as are raised in Virginia, North Carolina, South Carolina and Maryland, the soil should be light, or what is commonly called a sandy loam, not too flat, but of a rolling, undulating surface not liable to overflow in excessive rains. New cleared in these last named States is considered better than long cultivated soils. In Cuba the planters select the red soil as the best for fine tobacco. Some planters, however, prefer a soil mixed of one-fourth sand and one-half to three-fourths of decayed vegetable matter.

Both the Cuban and Americnn planters concur in the opinion that a large quantity of silicious matter in soils is essential for the growth of good cigar tobacco. The rich clay loams on the banks of the James River in Virginia do not grow the highest price tobacco, while the less fertile silicious soils of other sections will produce tobacco of superior quality for chewing and smoking. Tobacco of high grade will not grow in the calcareous regions. A better soil is one that rests upon the primary foundation.

IV.

TRANSPLANTING.

Figure 5 shows the plan of placing and setting the plants.

FIGURE 5.

Transplanting should be done in the evening or on a cloudy day. Before transplanting, the seed-bed should receive a good watering so that the plants can be drawn without injury to the roots.

The planting is similar to the planting of cabbage and is no more difficult. A good plan is, for a boy to walk between the ridges, placing the plants alternately to right and left, being followed by the planters, who place the plants in the hills or ridges, taking the precaution to leave the bud well above the surface.

In a few days any missing hills which occur should be replanted, and during the early growth a close watch must be kept for the cut worm, bore worm, and other injurious insects. When the plants have taken root they grow very quickly and subsequent cultivation is simple, though requiring care.

When the plants are from six to nine inches high they require to be hilled, by mounding the earth around the plants, to protect them from falling when the soil is wet or from being blown down by heavy winds. One or two hoeings are necesary during the growing period to keep down the weeds, as everything that detracts from the growth of the plant is detrimental to the quality of the leaf.

V.

FERTILIZING.

To be of good burning quality, tobacco should not contain more than 0.4 per cent. chlorine to 2.5 per cent. potash (that is, six times as much potash as chlorine), consequently, fertilizers for smoking and cigar tobacco should contain at least six parts of potash for every part of chlorine that is at the disposal of the plant. The closer the relation between potash and chlorine in a fertilizer the less it is adapted for smoking tobacco. A number of experiments have been made, with potassium nitrate, potassium sulphate, potassium muriate, gypsum and common salt as fertilizers for tobacco.

The chlorine compounds always injure the burning qualities, and the potassium sulphate and potassium nitrate often improve this quality, though not always—the failure being due, it is believed, to the potash not being sufficiently distributed through the soil, or where heavy applications are made to the formation of too concentrated solutions.

The tobacco plant gets its growth and maturity rapidly, and requires a constant supply of plant food from the soil, but on the other hand it is exceedingly sensitive to concentrated solutions. It is important that the fertilizer, especially the potash, be thoroughly mixed with the soil to a depth to which the roots extend. This may be accomplished in a measure by applying the fertilizer sometime in advance of planting.

Previous Culture of Land for Tobacco.—The quality of the soil and the manuring are largely responsible for the early and late ripening and the regular and irregular ripening of tobacco.

Tobacco plants ripen later on soils rich in organic matter, except in the case of sandy soils, where the organic matter decomposes rapidly. Heavy applications of nitrogenous manures retard ripening. Tobacco richly manured with liquid manure, night soil, barnyard manure, or nitrate of soda, ripens late.

If the plants are set late on the fields so manured, or those rich in organic matter, the leaves may not have time to ripen, and a greenish leaf will result, which, in burning, gives an unpleasant odor and bitter taste, and bitter taste in chewing also.

Formulas for Fertilizing for Tobacco.—The following formulas for fertilizing tobacco are recommended:

Formula No. 1.—From 900 to 1250 pounds of wood ashes, or 350 pounds of potassium sulphate per acre, the applications being made to deep soils late in the fall, or to shallow soils before the first plowing. In the spring before setting the plants 135 to 180 pounds of nitrate of soda may be applied when the land is not heavily manured. In rainy seasons, when the plants lose their dark green color, and fail to grow well, 90 to 135 of nitrate of soda per acre may be applied while the plants are small.

Formula No. 2.—Two hundred and seventy-five (275) pounds of low grade sulphate of potash, 250 pounds of acid phosphate (12 per cent.) and 100 pounds of sulphate of ammonia (a by-product of gas liquor) or 280 pounds of cotton seed meal. Sulphate of ammonia, is one of the most concentrated forms in which ammonia can be applied to the soil, and is, at the same time, one of the most active and readily available forms, being decidedly quicker in its action than any form of organic-nitrogenous matter.

Magnesium carbonate, a new product of the Stassfurt industry, of Prussia, Germany, containing 18.5 per cent. of potash, is said to possess good properties in improving the quality of tobacco. In the Connecticut valley, where fine cigar leaf is raised, nearly all kinds of domestic, commercial, and special fertilizers are used. Of domestic fertilizers, horse manure is considered the best, as it produces the finest and lightest colored leaf of any known fertilizer. Cotton seed meal, when used with domestic manure, is an excellent and strong manure.

Mapes formula is a favorite with many growers of fine cigar leaf in Connecticut.

VI.

THE PLANT.

The plant bears from eight to twenty leaves, according to the species of the plant.

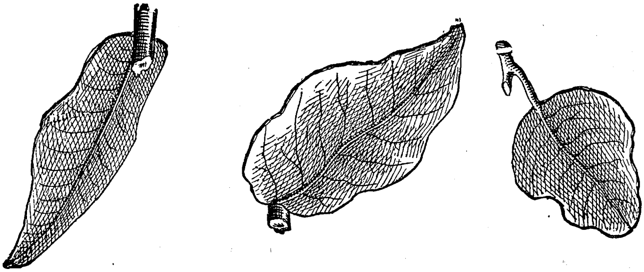


FIGURE 6.

They have, as represented in figure 6, various forms; ovate, lanceolate, and pointed. Leaves of a lanceolate form are the largest, and the shape found on most varieties of the American plant.

The color of the leaves when growing, as well as after curing and sweating, varies, and is frequently caused by the condition of the soil. The color, while growing, may be either a light or dark green, which usually changes to a yellowish cast as the plant ripens. The ground leaves generally ripen first, turning yellow and during wet weather will rot and drop from the stalk if not gathered. The color of the leaf, after curing, may be determined by the color of the leaf while growing; if dark green while maturing in the field, the color will be dark after curing and sweating, and the reverse if of a lighter shade of green. If the soil be dark, the color of the leaf will be darker than if grown upon light soil. The kind of fertilizers applied to the soil, as well as the soil itself, has much to do with the texture of the leaf, and should be duly considered by all growers of the plant.

The Sucker.—The sucker makes its appearance at the junction of the leaves and stalk, as indicated in figure 7.

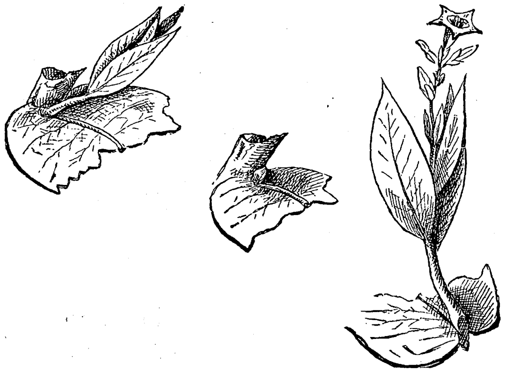


FIGURE 7.

Uusually these are not seen until after the plant has been topped, when they come forward rapidly and if not plucked off in a short time develop into strong, vigorous shoots. The growth of the suckers is injurious to the leaf, retarding their size and maturity, and affect the quality as well as the maturity of the plant. When the plants are fully ripe and ready to harvest, the suckers will be found to be growing around the root of the plant.

This is one of the most reliable evidences of its maturity, as it denotes the ripening of the entire plant.

Breaking off the suckers hastens the ripening of the leaves and gives a lighter shade of color, no matter on what soil the plants are grown.

Topping.—Topping is simply breaking off the bud at the top of the stalk, as represented by figure 8,

FIGURE 8.

to prevent the plant running up to flower and seed.

By this means the best growth of the leaves is secured, and they at once develop to the largest possible size; will ripen sooner, while the quality is much better.

There are various methods of topping, as well as different periods. Some planters top as soon as the capsules appear, while others wait until the plants are in full blossom. If topped before the plants have come into blossom, it should be done as soon as possible, as a longer time will be required for the leaves to grow and ripen than when topping is delayed until the plants are in bloom. Top the plants at a regular height, leaving from nine to twelve leaves, so that the field will look even and also make the number of leaves to a plant uniform. The above method of topping refers more especially to cigar rather than cutting leaf. Those varieties of tobacco suited for cutting leaf should be topped as soon as the flower bud appears; top low, thereby throwing the strength of the stalk into a few leaves, making them large and heavy. Let it grow from five to six weeks after it is topped, so as to have it thoroughly ripe, thereby giving it the bright, rich, golden color, entirely different from cigar leaf, but desirable for chewing leaf. The custom in the old tobacco States is to top for English shipping from eight to ten leaves; for coal and flue curing, from ten to twelve. In some sections of the United States the plants are not topped at all; the leaves are left upon the stalk until they are fully ripe, when they are taken off.

VII.

INSECT PESTS.

The two most destructive pests that prey upon the tobacco plant after being transplanted to the field are the "cut worm" and the "horn worm," as shown by figure 9.

FIGURE 9.

The cut worm commences its work of destruction in a few hours after transplanting in the field.

During the night this worm begins by eating off the small or central leaves, and often so effectually as to destroy the plant. The best time to find and destroy these pests is early in the morning, when they can be found nearer the surface; with the heat of the sun they burrow deeper in the soil.

Soon after they disappear, the fight with the horn worm commences.

Figure 10 shows the Sphinx, or moth, the parent of the horn worm, the larvae and the horn worm.

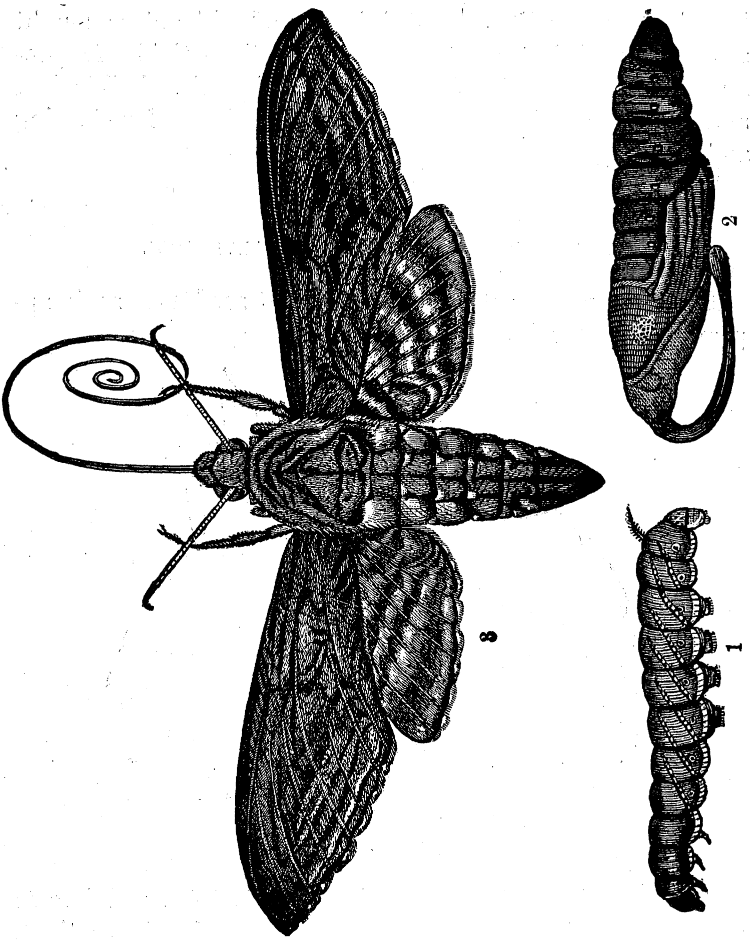


FIGURE 10.

The horn worm feeds upon the finest and largest leaves; eats the leaves in the finest parts of them. They leave large holes which render the leaf worthless for a cigar or chewing wrapper, leaving it fit only for fillers. As the Sphinx, that lays the eggs usually deposits two crops of eggs on the tobacco plant during its growth, it will require much time and labor to destroy the eggs and worms. If this is neglected, the crop will be much injured and will not be sought after by good judges of tobacco. An insecticide for destroying the worms has been advertised by a firm in Virginia and when applied does not injure the tobacco for chewing and smoking.

VIII.

VARIETIES OF TOBACCO AND HARVESTING.

Figue 11 represents the Connecticut seed leaf as it appears ready for harvesting.

FIGURE 11.

The varieties cultivated in the United States and known as "seed leaf" tobaccos, are grown mostly in Connecticut, Massachusetts, Vermont, and eastern and western States.

All of the seed-leaf of the United States is used exclusively in the manufacture of cigars, and is celebrated for cigar wrappers from the superiority of its color and texture, and the good burning quality of the leaf.

This variety grows to the height of about five feet, with leaves from two and one-half to three feet in length, and from fifteen to twenty inches broad. The color of this tobacco after curing is either dark or light cinnamon.

There are two principal varieties of Connecticut seed-leaf broad and narrow leaf—of these two, the broad leaf is considered the finest, cutting up to better advantage in cigar making, and ripening and curing fully as well.

This tobacco has not that fine flavor of Cuban tobacco, but in texture is considered equal to it. It burns freely, leaving a white or pearl colored ash, which is one of the best evidences of a good cigar tobacco.

The leaf is firm and strong, and sufficiently elastic to bear considerable manipulating in manufacture. Thorough cultivation by the growers has made this quality of tobacco one of the most profitable of any cigar tobacco grown in the United States.

Figure 12.

This figure represents a plant of Virginia tobacco maturing seed. Virginia tobacco has acquired a reputation which has gradually increased for more than two hundred and fifty years.

The plant grows to the height of from three to five feet; the leaves are long and broad, and when cured are of various colors, from a rich brown mahogany, cinnamon, to a fine golden yellow.

The finest quality of Virginia tobacco comes from the southside counties, but the amount is small compared to the quanitties of dark raised on the lowlands of the Dan and James rivers and their tributaries. The tobacco grown in the southside and southwestern counties of Virginia is much lighter in color, and of much softer and finer texture than the ordinary Virginia tobacco.

Havana Tobacco.—This famous variety of tobacco, as is shown in figure 13 is considered the finest flavored for cigars that is now cultivated.

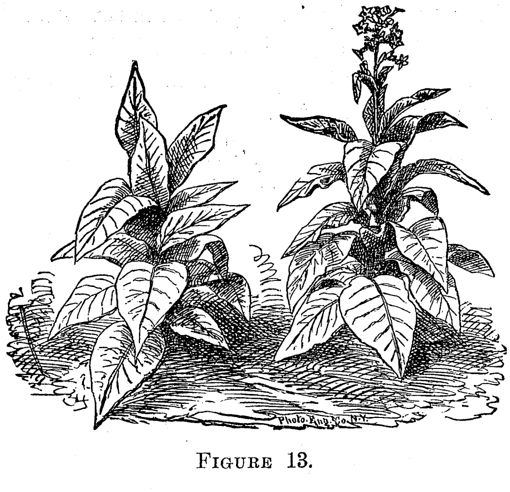


FIGURE 13.

This variety grows to a height of from six to nine feet, with oblong, spear-shaped leaves. The leaves when young are of a dark green color, and have rather a smooth appearance, changing at maturity into a yellowish green. It grows quickly, and by careful pruning a fine colored leaf is obtained, varying from a straw color to a dark brown or black.

The finest is grown in Vuelta de Abajo, which is celebrated as a fine tobacco producing district. The Havana tobacco ripens in from eight to ten weeks after being transplanted.

The stalk and leaves are not as large as the Connecticut seed-leaf, but it is better in flavor.

Cutting the Plant.—Figure 14 represents harvesting the plant.

FIGURE 14.

There are two methods of harvesting, cutting down the whole plant or gathering the leaves singly. The former is the one that has been practiced for a long time by tobacco planters; the latter, which is of recent origin, is regarded by many as the most scientific method.

Both these plans of gathering have their advantages, the first is the easier, and permits of quicker handling.

For cutting, a heavy knife is used, and the method is similar to cutting sugar cane, the plant being held with the left hand and cut close to the ground.

The plants should be removed to a shady place to prevent their becoming sunburnt.

IX.

CURING.

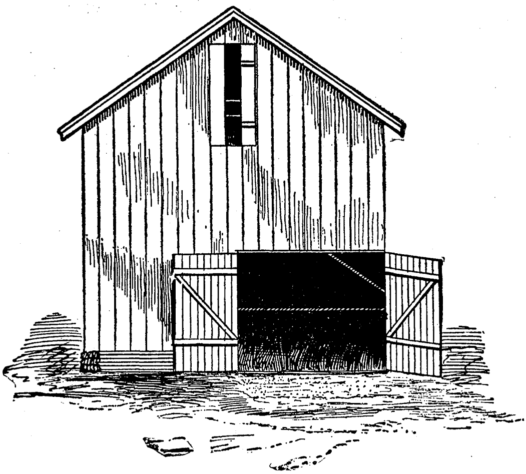


FIGURE 15.

The process of curing now commences, and on the success of this operation depends in a great measure the ultimate value of the crop. No matter how fine the plants may be, or how large the production, an error in curing is sufficient to destroy, in a great degree, the work of the season. The tobacco barn should be built with windows and doors sufficient to insure a free current of air. The barn should be high enough to permit three rows of plants being hung one above the other, say 16 to 18 feet from floor to roof. Figure 15 represents an inexpensive framed barn used for curing where heat is applied with open fire or with furnaces.

There are several methods of curing, viz: With open fires, as shown in figure 15; curing by flues, air curing and sun curing.

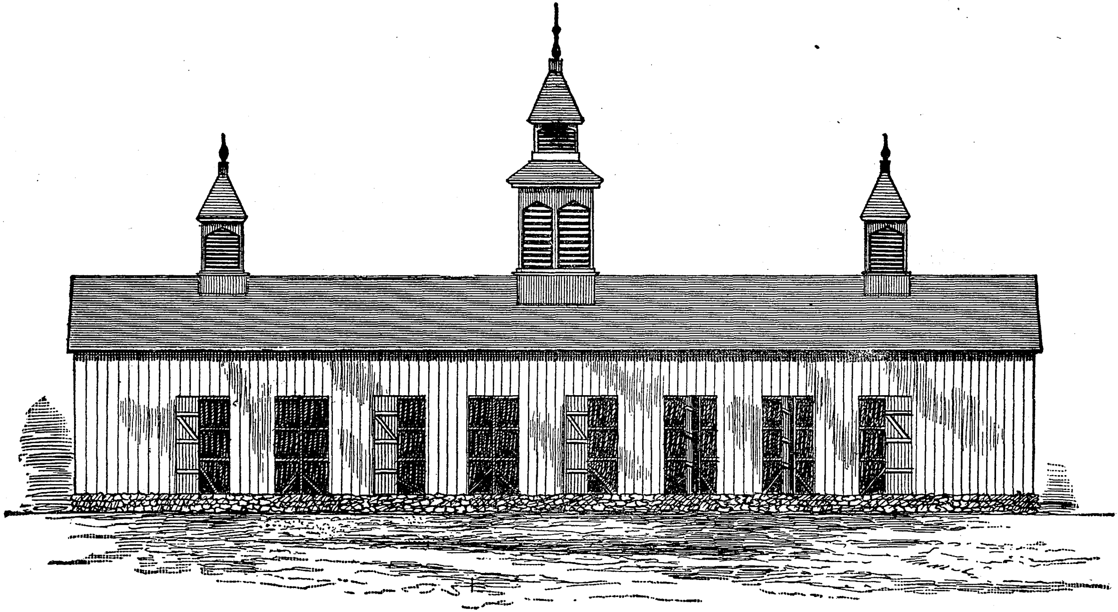


FIGURE 16.

Air curing is the process of curing the plant in the barn, as seen in figure 16. This cut illustrates a barn 32 feet wide, 60 feet long and 27 feet high, with ventilators in the sides and ends, so constructed that they may be opened or closed to admit or exclude air as the condition of the tobacco and weather demands. A barn thus constructed should be closed in very dry or windy weather, closely or partially to give plenty of air during the curing stage, closing the ventilators during the day and opening them at night so that the tobacco may receive moisture to give it a uniform good color, or closing day and night during warm wet weather to prevent mould.

This illustrates a principal of curing cigar tobacco which should never be cured with fire, especially with flues, as the burning qualities will be impaired thereby.

Sun curing is the method of curing in the open air, while firing is the process of curing as above stated, either by open fires or flues in the tobacco barn. The latter method is the one generally practiced in the tobacco sections in Virginia, North Carolina, and to some extent in the West, and is considered the best way of curing chewing tobacco.

Handling for Curing.—There are two common methods practiced of handling tobacco for curing,—the older and long favored method of cutting and hanging the whole stalk with the leaves attached, and the method of detaching the leaves from the stalk before hanging,—a method which is comparatively new in this country, but is employed to considerable extent in Germany and France.

These methods are too long to be discussed fully in this bulletin for the purpose of passing on the merits of either.

SNOW'S MODERN TOBACCO BARN.

This new process of harvesting and cutting tobacco was introduced by W. H. Snow of High Point, North Carolina.

Figure 17 shows the view of this modern barn, which is in operation on this Station.

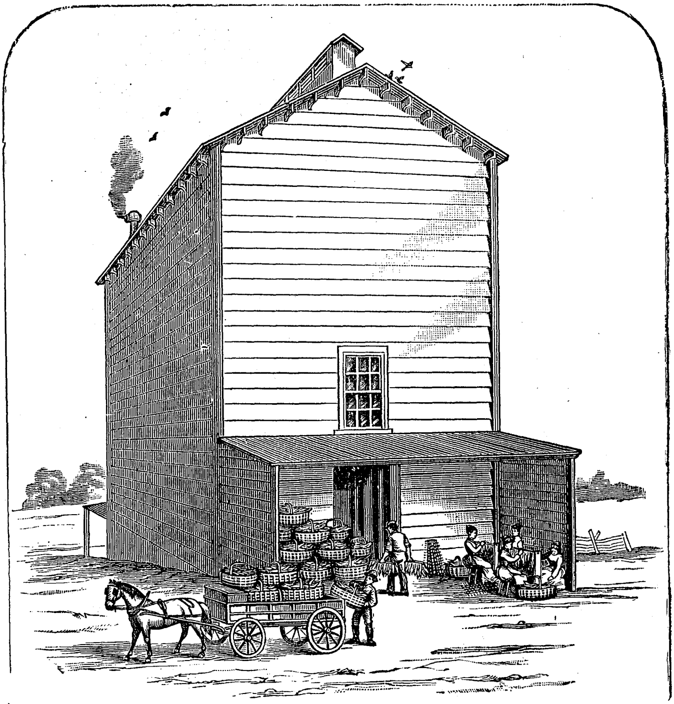


FIGURE 17.

It is not necessary at present to give details for the construction of this barn and apparatus. This system of curing tobacco in the Snow Modern Barn has important advantages. The leaves are stripped from the stalks in the field and brought to the barn in baskets, and strung about the width of a finger apart on pointed wires which project at right angles from a wooden stick. As the sticks are filled they are placed in movable racks in the barn, and as fast as a rack is filled it is raised by a simple device to the top of the building. This is continued until the barn is filled, leaving only as much space between racks as is required for the hanging leaves.

Plan of Housing.—The plan of housing in this barn is illustrated by figure 18.

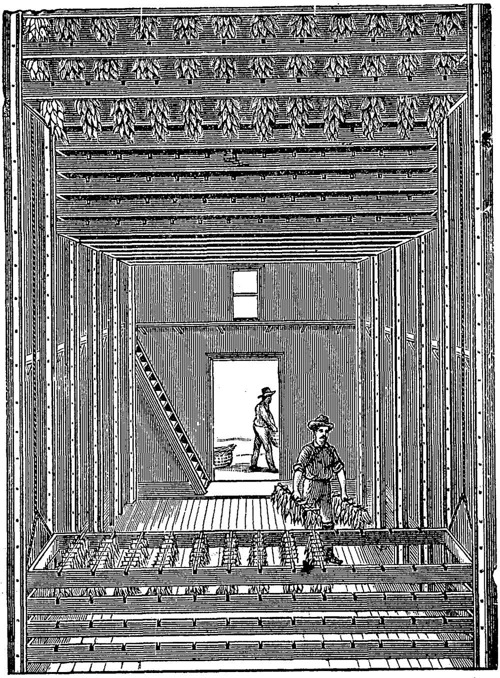


FIGURE 18.

Advantages of the Method.—The following are some of the important advantages in favor of the Snow process over the old:

I. The planter can begin to house his crop from two to four weeks earlier, as the bottom leaves which ripen first can be taken off and cured as soon as they are ripe.

II. As the lower leaves are pulled off those left on the stalk ripen up more rapidly, which enables the planter to get in his crop earlier in the season.

III. The tobacco can be stored in a much smaller space and with no risk of losing color or moulding when bulked down.

IV. Tobacco can be cured with a more uniform color.

V. Less fuel will be required, and the risk of setting fire to the barn will be greatly lessened.

Flues and Flue Curing.—Flues are extensively used instead of open fires for curing yellow tobacco for chewing purposes, and is a better method. The heat is more readily controlled by the use of flues, and tobacco cured by this process is cleaner, brighter and sweeter. The flue is the best mode for applying heat in the curing process for any type of tobacco requiring the application of heat.

X.

STRIPPING.

After the tobacco is thoroughly cured it has to be stripped. The leaves become soft and pliant in damp weather and can be readily taken down out of the barn for stripping. After taking down, the plants should be packed, in order to be kept moist until stripping.

This operation consists in taking the leaves from the stalk and tying them in bundles after assorting the various qualities and keeping them separate. Each hand or bundle of the best grades should contain at least twelve leaves. In the old tobacco States the plant is usually made into three grades—long, short, and lugs, or worm-eaten leaves.

In Cuba the leaves are divided into four classes—first, the leaves at the top of the plant, which constitute the best quality, from the fact that they get more equally the benefit of the sun's rays by day and the dew at night; second, the leaves which are next to the above; third, the inferior or small leaves; fourth, the lug leaves, or those nearest the ground.

The assorting of the plant previous to putting in hands or bundles is an operation that requires judgment and a practiced eye. This mode of assorting colors in stripping is similar to that of shading cigars, in which the utmost care is taken to keep the various colors and shades to themselves. Assorting the plant does not imply that it is carried to its fullest extent in point of color, as in shading cigars, but simply keeping those general colors by themselves, like light and dark brown leaves. Figure 19 shows the bundle after it has been stripped, assorted and tied.

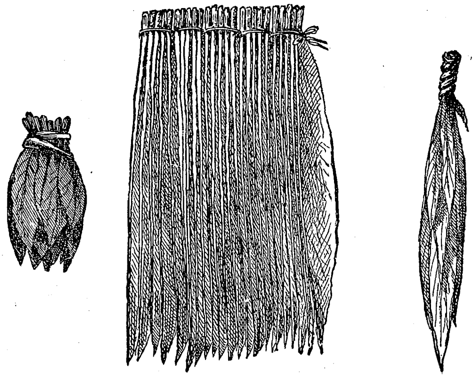


FIGURE 19.

Packing.—After the process of stripping is completed the hands should be packed to keep them moist, or as near as possible in the same condition as when stripped. Select a cool, dry place in the center of the floor of the tobacco barn. Hand the tobacco to the packer, who presses the hands firmly with his knees and hands, laying the tobacco in two rows—keeping the pile about the same height, filling in occasionally with a middle row until all is packed. The different qualities should be packed separately. They can be packed any height or length desired, but usually from three to five feet high will be found a convenient height, while the length may be proportioned to the height or not. After the tobacco is packed, it should be covered with boards and gently weighted with stone or pieces of timber. If the tobacco is packed down in a good case, or keeping condition, which requires experience to determine, it can remain packed until ready for prizing.

It is important to have tobacco in right case for packing. If too dry, it is broken and damaged to a great extent; if too moist, fermentation is so rapid and extensive as to destroy the vitality of the tobacco, and induce mould or rot and spoil its flavor. The right condition for packing is, when the large stems are dry enough to break on pressure several inches down from the butt ends, while the lower part of the leaves should be just soft and pliant enough to not break in handling.

The process of sweating or fermenting perfects it in color, improves the flavor, corrects the acid or pungent taste and increases its burning qualities.

Where tobacco is fermented for cigar purposes, it takes from three to four months to get it ready for working into cigars. In fact, it is believed, that the best cigars can not be made unless the tobacco undergoes a second fermentation the ensuing year, which adds much to its quality.

Prizing Casing and Baling.—This is shown by figure 20.

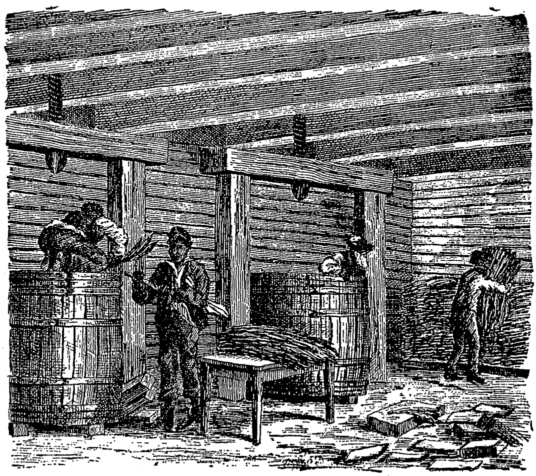


FIGURE 20.

The term prizing originated in Virginia. In the sense in which it is to be taken here is a local word, which the Virginians claim the credit of creating. It is the act of pressing or squeezing the article which is to be packed into any package by means of certain levers, screws, or other mechanical force—this requires the combination of judgment and experience, otherwise the tobacco may become bruised, or crumbled.

All leaf used for cutting purposes and export in America is prized in hogsheads; cigar leaf is usually cased or baled. In some tobacco sections about 800 pounds net is packed in one parcel, while in others from 1000 to 1800 pounds. Tobacco in good condition to prize must be damp enough to bear the pressure without breaking and crumbling, while it must not be too moist or it will rot in the case.

The hands or bundles are packed in the hogshead, or the case in two tiers—when nearly filled, it is subjected to a strong pressure as is shown in figure 21.

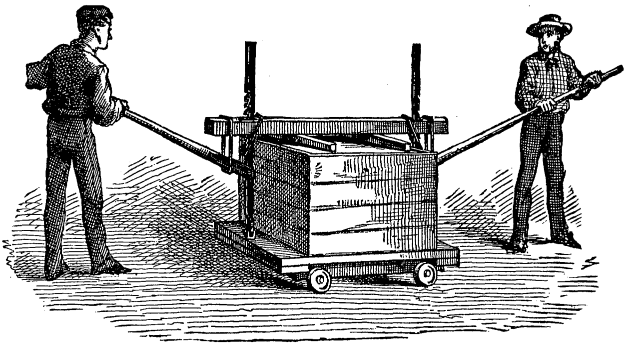


FIGURE 21.

The tobacco should be cased hard so that the mass will rise but little when the pressure is removed. When tobacco is prized or cased in the spring, it will commence to "warm up" as the summer comes, and will go through a sweat. After "going through a sweat" the leaves take on a darker color, and lose the rank flavor which they had before.

BULLETIN No. 65 JUNE, 1895.

ALABAMA

Agricultural Experiment Station

OF THE

AGRICULTURAL AND MECHANICAL COLLEGE,

AUBURN.

CO-OPERATIVE SEED TESTS.

ALEX. J. BONDURANT.

MONTGOMERY, ALA.:
THE BROWN PRINTING COMPANY, PRINTERS.
1895.

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☞The Bulletins of this Station will be sent free to any citizen of the State on application to the Agricultural Experiment Station, Auburn, Alabama.

CO-OPERATIVE SEED TESTS.

The Department of Agriculture at Washington, directed that the names of farmers in different sections of the State should be furnished by the Agricultural Department of this Station to conduct co-operative experiments with seed. The names of fifty farmers living in different parts of the State, in accordance with this request, were sent to the Department at Washington, the seed were sent direct from Washington, the reports were forwarded to the Station on blanks furnished to the experimenters, and this Bulletin is a report of these experiments.

REPORT OF Mr. L. C. ADAY,

NEWBURGH, FRANKLIN COUNTY.

Cotton—Egyptian Afifi.—Level red loam soil with red clay sub-soil, manured heavily; culture thorough. Planted April 10th. First open August 25th. Yield 732 lbs. per acre. Quality good; growth vigorous, but the yield poor as the bolls are too small.

Cotton—Bamia Egyptian.—Soil, same as above, manured same as above, and same culture. Planted April 10th. First open August 30th. Yield about 600 lbs. per acre. Quality good; growth vigorous and large, but the bolls are too small for it to be a desirable cotton.

White Millo Maize.—Soil as above, no manure. Land ridged, seed planted and plowed four times. Planted April 25th; harvested September 13th. Quality good; yield very good, and growth good.

Yellow Millo Maize.—Conditions same as for the white, but the yield was less and the quality of product not so good.

Red Kaffir Corn.—Level loam soil, no manure. Land ridged and plowed four times after seeding. Planted April 25th; harvested September 13th. Quality good; growth vigorous and yield good.

Sweet Clover.—Planted March 13th, and was killed by freeze on March 25th while in the sprout.

Alfalfa.—Planted March 13th, and was killed by freeze on the 25th while the seed were in the sprout.

Awnless Brome Grass..—Planted March 13th, and killed on the 25th in sprout.

Spurry.—Same result as with the Awnless Brome.

Crimson Clover.—Same result as with Sweet Clover.

REPORT OF Prof. H. BENTON,

UNIONTOWN, PERRY COUNTY.

Tobacco, Hester.—Black soil, well drained, fertilized with compost. Shallow culture with sweep. Planted May 15th; harvested September 29th. Yield good; growth large; quality of product coarse. Insect enemies, *Macrosila Carolina.* (Linn.)

Tobacco, Havana Seed Leaf.—Soil same as above, fertilized, planted and gathered same as above. Yield fair; growth good; quality of product good. Insect enemies› *Macrosila Carolina.* (Linn.)

Tobacco, Connecticut Seed Leaf.—Conditions of planting, culture and harvest same as the foregoing. Yield good; growth good, and quality fairly good. Insect enemies, same as above.

Red Kaffir Corn.—Decomposed lime rock soil on hillside. Manured with stable manure. Culture, shallow with sweep. Planted April 3rd. Gathered August 30th to October 16. Yield not quite so large as sorghum; quality good; growth good.

Cauliflower.—Soil, well-drained red prairie, heavily manured with compost. Planted seed in beds, set out plants in April; growth poor, quality poor, and yield about nothing. Not suited for this climate; insect enemies, *Pieris rapœ* (Schran.)

Onion—Prize Taker.—Soil same as above, manured with kainit, cotton-seed meal and stable manure composted. Cultivated with hoe and plow. Planted March 16, harvested September 29. Quality good; average yield. Growth and yield would have been better but for drought.

Sugar Beet.—Soil as above, manured with compost; cultivated with hoe and plow. Quality good; average growth, and yield good.

Turnip—Golden Ball.—Soil as above, manured same as onions. Cultivated around plants with hoe and rake. Planted March 19. Quality of product excellent; growth good and yield good; turnips large.

Lathyrus Sylvestris.—Seed did not germinate.

Spurry.—Seed did not germinate.

Yellow Millo Maize.—Soil, decomposed lime rock, hill side; fertilized with stable manure. Culture shallow, with Hartselle sweep. Planted April 3d; harvested from August 30th, to October 16th. Quality fairly good; growth good; yield poor on account of poor stand.

White Millo Maize.—Same report as for the yellow.

Bromus Indicus.—Seed did not germinate.

Cotton; Kuppan, India Cotton.—No. 1. Soil, black cotton land; culture, shallow with sweep. Planted April 9th; harvested last of November. Quality poor; growth, large stalks; yield very poor; staple short, and is inferior to any of our native varieties. Insect enemies, boll worm; plant diseases, rust. Professor Benton says the yield was too poor to take the trouble to record.

Cotton; India No. 2.—Soil same as the foregoing, and culture the same. Quality poor; growth of stalk very large; yield too little to record; staple very short. Insect enemies, boll worm; plant diseases, rust.

Cotton; India No. 3; Bourbon.—Same as Nos. 1 and 2 in all respects.

Cotton; India, Nagpur Jari, No. 4.—Quality of product poor; yield almost nothing.

Cotton; Painaa, White India Cotton, No. 5.—Poor. See Nos. 1 and 2 for report.

Cotton; India No. 6.—Poor. See Nos. 1 and 2 for report.

Cotton; Desila Koposh, India No. 7.—Poor. See Nos. 1 and 2 for report.

Cotton; Desila Bango, India No. 8.—Poor. See Nos. 1 and 2 for report.

Cotton; Niurari Bani L. S. Kopas, India.—Poor. Nos. 1 and 2 report.

Cotton; Huigumbot Bani, L. S. Kopas; India.—Poor. See Nos. 1 and 2 for report.

Cotton; Chuidwan Jari, India.—Poor. See 1 and 2 for report.

Cotton; Karunganni, India.—Poor. See Nos. 1 and 2 for report.

Tomato; Matchless.—Soil black and well drained; fertilized with compost. Plants set April 4th. Quality good; growth large; yield large. Insect enemies, *Macrosila Carolina.* (Linn.)

Tomato No. 175.—Soil same as above, and fertilized same way. Plants set April 4th. Quality fairly good; growth good, and average yield with other varieties. Insect enemies, *Macrosila Carolina.* (Linn.)

REPORT OF Mr. M. A. BISHOP,

MADISON, MADISON CO.

Cotton; Egyptian Bamaia.—Soil, dark brown stiff land; red clay sub-soil.

Manured with	200	lbs.	acid phosphate,
	800	"	stable manure, composted.
Per acre, -	1000	"	

Planted April 17. First open August 25th, last, November 1st. Gathered in November. Quality of product—staple about ⅞ inch, very fine and silky and of medium strength. Growth rather slow, but stood the drought well. Height from 3 to 5 feet.

Mr. B. will plant again, and although hard to gin, owing to the length and strength of staple, thinks it wlli do well when it becomes acclimated.

No enemies except the beetle, which disappeared after the nights got cooler.

Yield per acre about 500 pounds.

Cotton; Affifi-Egyptian.—Soil, and fertilized about same as above. Planted April 17th. First open September 1st, last November 10th. Gathered in November. Quality of product—lint cream colored, medium length and very fine and silky. Appears to be hardy as to cold; was not injured by spring frosts when other varieties were damaged. Grows from 6 to 10 feet high. Yield about 300 pounds per acre. Small insect, resembling a beetle, did damage to the squares by puncturing them just before the bloom appeared. Mr. B. thinks that this insect was imported with the seed, as it was not found in any other variety.

Unknown Pea.—Soil dark loam, high upland, manured with 200 lbs. acid phosphate and cotton-seed meal per acre, in drill between the corn at second plowing. Cultivated twice with walking cultivator. Planted in corn-field May 21st. First ripe September 22nd. Gathered October 10th. Yield, about 12 bushels per acre. Quality, perfect. A large, late stocky growth, producing peas in bunches around the base of vine. Should be planted earlier, as this crop was caught by frost November 2nd and many killed.

Mr. Bishop says that this pea will take the place of clover to improve worn-out soils, and regards it as a very fine pea. Dealers sold it at $12.00 per bushel in his town last spring. No diseases.

Red Kaffir Corn.—Soil, chocolate loam, red clay sub-soil. Good natural corn land, no manure. Culture, same as corn or sorghum crop. Planted April 16. First ripe August 5th. Began to gather August 10th, last ripe October 10th. Quality of product, perfect. Yield, about equal to common corn. The injury by English sparrows was such as to lessen the yield. It made three crops.

Spanish Pea Nuts.—Soil, almost exhausted of vegetable matter, manured with 125 lbs. acid phosphate per acre, in drill at time of planting. Planted May 5. First ripe August 15. Gathered September 8th. One quart in the hull made two bushels. Quality perfect. An exceedingly early variety, would mature on ground following a wheat or oat crop. Farmers in Mr. Bishop's vicinity are beginning to raise them for fattening hogs, and Mr. B. says it is one of the best things that they have tried. No insect diseases.

Awnless Brome Grass.—Soil, loam and clay. Land plowed just before planting. Planted March 22. Imperfect stand owing to dry, cold spring. Stood drought and heat well, revived with first fall rains and bids fair to afford a good yield of hay next spring. It is regarded as a success, and many farmers are anxious to procure seed.

Sweet Clover.—Thin upland, gravelly loam, manured lightly, broad-cast. Planted broad-cast, March 22nd. Stand perfect, stood the drought better than Japan Clover. Made a growth of ten inches by July 1st, at which time stock was turned on. At this time, Nov. 24th, it is green and bids fair to stand the winter. Stock exceedingly fond of it.

Alfalfa or Lucern.—Dark loam moist soil, good land for corn and clover, no manure. Sowed broadcast. Planted March 22nd. Came up well and grew well until June 14th, when it died out. Will plant again in the spring and cultivate in the drill, and if it can be made to stand one season will be a success.

Crimson Clover.—Dry ridge land, dark loam, red clay sub-soil, and highly manured by turning under green vegetable matter and pasturing. Land thoroughly prepared by plowing and harrowing before seeding.

Planted March 22nd. Owing to extremely dry spring, the growth was stunned and did not grow large enough to mow. Crimson Clover is being extensively grown in this country in the last two years. Seed sown in August makes fine grazing in November. It is fast taking the place of Red Clover, as the yield is equal and comes off in time to plant corn and get two crops.

Rape—Dwarf Essex.—Dark loam soil, 10 inches deep, very rich in plant-food. No manure applied. Ground thoroughly prepared as for turnips, and seed sown broadcast. Planted April 14th. Ready for use in six weeks. Yield per acre at least 3½ tons. Quality of product good and good for hogs and cattle. The growth was enormous. By repeated sowings it will, and did carry more hogs through our dry, hot summers than four times the amount of land planted in any thing else ever grown here. Forty-nine head of hogs lived on it six weeks and did well. I would recommend it to all southern farmers.

Spurry.—Dark loam, very rich soil. Planted April 14th. Prepared land as for turnips, sowed broad-cast, but supposed on account of the dry season the seed did not germinate. Consider it a failure.

Jerusalem Corn.—Light, gray sandy soil, rather thin, had rested two years previous, no manure. Bedded ground in February. Planted one foot apart in drill, May 5th. Not properly cultivated. First ripe August 10th. Gathered August 27th. Yield about 20 bushels per acre. Quality of product light and chaffy; had to gather too early on account of devastation by English sparrows. Did not tiller out like Kaffir Corn or Yellow Millo Maize.

Yellow Millo Maize.—Dark gray soil, mixed with sand, clay sub-soil, no manure. Land prepared as for common field corn. Planted May 14th. First ripe September 1st, harvested September 10th. Yield about 33 bushels per acre. Quality of product perfect. Much the best non-saccharine sorghum for this country ever tried. One peculiarity was, while the English sparrow destroyed all other grains, this was left untouched. With good seasons, can make as high as 50 or 60 bushels per acre, and the fodder is relished by all stock. A successful crop.

REPORT OF Mr. J. M. BRANNON,

SEALE, RUSSELL COUNTY.

Millo Maize.—Fresh soil, home mixture fertilizer used. Planted April 10th, harvested July 25th. Yield was satisfactory, and quality of product good. Thinks it unnecessary to put aside sorghum as a stock feed.

Red Kaffir Corn.—Stiff, sandy hill-side. Quality good. Yield good. Fed to stock while green. Gave a larger yield of forage than sorghum.

Spanish Pea-nut.—Poor sandy soil unfit for anything else, no manure. Planted April 20th, harvested October 2d. Quality good. Is common in this section and fruits better than any other kind.

Jerusalem Corn.—Sandy loam, clay sub-soil. Stable manure, phosphate and cotton-seed meal composted. Planted May 25th. Plant grew well and large enough and headed out properly, but contained no seed. Considers it a poor crop in that locality.

REPORT OF Mr. T. W. BRADLEY,

WALKER SPRINGS, CLARKE COUNTY.

Alfalfa—Planted June 20. Light sandy soil. Acid phos. and cotton seed meal 100 lbs per acre. Died out on account of the hot summer sun. Replanted Oct. 10th, and at the time this report was made, the prospect flattering for a crop.

Rape.—Planted June 20th. Black sandy soil—stable manure. Quality of product good. Fed cows, sheep, goats and hogs on it and expected to save a good quantity of seed.

Red Kaffir Corn.—Planted May 10. Hill side; 100 lbs. cotton seed meal and 50 lbs. acid phos. per acre, harvested Sept. 1st. Product only fair. Came up and grew off well, but the drought came on it about the time of heading and cut off the crop.

Yellow Millo Maize.—Black bottom soil, no manure. Planted June 15, harvested Oct. 12. Quality of product very fine. No diseases.

Unknown Cow Pea.—Level gravelly land, stable manure broadcast. Planted April 15, harvested Aug. 25th. Product very fine. 1 quart was planted and the yield 3 bushels.

Jerusalem Corn.—Hill side, black soil, 100 lbs. cotton seed meal and 50 lbs. acid phos. per acre. Planted May 10, harvested Aug. 20. Product good; yield per acre 20 bushels.

Spanish Peanut.—Level sandy land, lot manure broadcast. Planted June 1st, harvested Oct. 27th. Product very fine.

REPORT OF Mr. D. L. BROWN,

RANDOLPH, BIBB COUNTY.

Unknown Pea.—High, dry sandy soil, no manure. Cultivated with heel-scrape, two plowings. Planted June 3rd, first ripe Sept. 15th, harvested Oct. 15; quality very fine; rapid growth.

Mr. B. says "it is a very fine pea and I can not say too much in its favor."

Clover—Red and White.—All killed by extreme drought.

Egyptian Cotton.—Sandy soil, oak and hickory flat, manured with compost of phosphate and barnyard manure about 250 lbs. per acre. Cultivation thorough, with scrape and hoe. Planted April 14th; first open boll August 15th, and continued opening until frost. Yield per acre very poor; quality inferior; lint short and yellow.

Mr. Brown considers this cotton a "flat failure" for this country.

REPORT OF Mr. G. W. COMPTON,

WAYNE, MARENGO COUNTY.

Alfalfa.—Soil sand, clay sub-soil, no manure, fresh land. Land broken, seed sowed broad-cast and brushed in. Planted April 20th, grew to a height of 4 to 6 inches about August 1st, and then died. Melilotus had been tried on the same soil, but would never prove successful.

Spurry.—Soil same as for Alfalfa, no manure. Planted April 22nd, like the Alfalfa, grew to a height of 4 to 5 inches and died out about July 1st.

Red Kaffir Corn.—Soil same as above, no manure. Land prepared like that for cotton crop and cultivated same as cotton. Planted April 28th, harvested Oct. 1st. Quality of product poor. Growth not very good and the yield was poor, grains being very scattering in the heads.

White Millo Maize.—Soil same as above, no manure. Culture same as cotton. Planted April 28th, harvested Oct. 1st. Quality of product good; growth good; yield good. Gathered a wagon body, that holds 15 bushels corn, full from 4 rows 70 yards long.

Awnless Brome Grass.—Seed did not germinate.

REPORT OF Mr. W. D. CRENSHAW,

HACKNEYVILLE, TALLAPOOSA COUNTY.

Jerusalem Corn.—Soil, red clay; hillside, manured with compost in drill. Cultivated as other corn. Planted April 10th. Did not mature; results perhaps would have been better on good land.

Spanish Peanuts.—Soil, clay. no manure. Cultivated same as cotton. Planted May 1st, first ripe Aug. 10th; harvested Oct. 1st, large yield. Quality good. Vines grew upright, very prolific and excellent for hogs.

Red Kaffir Corn.—Soil red, thin hillside, manured in drill with compost. Cultivation not good. Planted April 1st, first ripe Aug. 15; harvested Sept. 10th. Yield about 5 bushels per acre. Quality of product not good—not equal to sorghum for any purpose.

Alfalfa. Sowed broad-cast and choked out with weeds and grass. No report.

Unknown Pea.—Dark sandy soil, no manure. Cultivated every ten days. Planted May 5th, first fruit ripe Sept. 1st; harvested Sept. 20. Yield per acre about 15 bushels.

Quality of product good. Foliage dense, grows upright and better than the ordinary pea. An excellent pea for hogs.

Egyptian Cotton.—Soil, black upland loam, manured broadcast with lot manure and some guano in drill. Planted April 12th, first open Oct. 1st. Gathered during October and until frost. Yield about 600 lbs. per acre. Lint very long and strong.

Another variety of Egyptian cotton, Mr. Crenshaw says, is worthless on account of the smallness of bolls and being so few on the stalk.

REPORT OF Prof. C. C. L. DILL,

DILLBURG, PICKENS COUNTY.

Jerusalem Corn.—Land sandy, manured 10 bushels cotton seed per acre. Planted June 1st, harvested Sept. 15th. Yield about 15 bushels seed per acre. Quality of product fair, not equal to sorghum as a forage.

White Millo Maize.—Land sandy, manured with cotton seed. Planted June 1st, harvested Sept. 15th. Yield about 15 bushels seed per acre. Quality of product fair.

Egyptian Cotton.—Sandy loam, manured with compost from cow pen. Planted June 8th, harvested October and November, first open October 1st. Yield per acre about 200 lbs. Quality of product, fine strong fibre, dingy color. Stalk large, bolls small, does not pay for cultivating.

Awnless Brome Grass.—Planted June 5th. Seed did not germinate on account of drought.

REPORT OF Mr. D. B. EDWARDS,

POLK, DALLAS COUNTY.

Spanish Ground Pea.—Soil red and sandy, no manure. Cultivated same as for cotton. Planted March 1st, first ripe July 15th, gathered July 25th. Quality generally good. Yield good and well matured. Unless dug as soon as matured, will sprout in the field if the seasons be wet.

Kaffir Corn.—Sandy soil, no manure. Cultivated as other corn. Planted March 15th, first ripe July 1st, last ripe July 15th. Yield fair, product ordinary, injured by the early six weeks drought.

Lucern (*Alfalfa.*)—Soil same as above, manured with cow pen fertilizer. Planted March 1st, in drills. Has not made much headway, but hope to have a fine patch next year as it is very tenacious of life and requires time.

Jerusalem Corn.—Soil as above. Planted 1st of March. Ruined by early long drought.

Unknown Cow Pea.—Soil, gray bottom and sandy, no manure. Planted May 15, on beds between corn rows. First ripe September 1st. Began to gather as they ripened. Yield very large, large pods and 20 peas to the pod. Quality very fine; growth very luxuriant, and surpasses all other varieties ever before tested. Vines continued green up to frost.

Mr. Edwards says he is thankful that he got it and will continue its culture.

Cotton—Foreign Fijii.—Soil, sandy loam, manured with 200 lbs acid phos. and cotton seed meal per acre. Planted April 28th, first open August 15th. Yield about 700 lbs. per acre. Generally 5 locks to the boll. It rained 23 days during July, causing it to shed many blooms. Insect enemies, boll worm. No rust, though other varieties suffered from the rust. The lint is very fine, has a stained color resembling wool and Mr. E. says when it is dyed it is a difficult matter to tell it from wool. This may prove a very valuable variety as a wool substitute or rather for mixing with wool.

REPORT OF Mr. R. T. EWING,

CENTRE, CHEROKEE COUNTY.

Rape—Brassica Riapus.—Good loam soil. Complete failure.

Sweet Clover.—Good loam soil. All died during the drought.

Alfalfa or Lucerne.—Good loam soil. Seed did not come up.

Crimson Clover.—Black loam soil. All died within a month after coming up.

Awnless Brome Grass.—Soil sandy. Seed did not germinate.

Yellow Millo Maize.—Good sandy soil, no manure. Cultivated same as field corn. Planted May 10th, first ripe Aug. 15th, gathered Sept. 15th. Yield very good, quality good, growth vigorous.

White Millo Maize.—Good sandy soil, no manure. Planted in rows April 10th. Quality good, yield good considering the poor stand. A heavy rain just after planting packed the land and prevented its coming up better.

Red Kaffir Corn.—Soil sandy and low, no manure. Planted April 10th. Sowed broad-cast. Failure.

Jerusalem Corn.—Good sandy soil with red clay sub-soil, no manure. Planted May 5th, poor stand. What was made was of good quality and the growth was good.

Spurry.—Light sandy soil, no manure. Prepared the land, which was fertile, in good condition and sowed broad-cast. Planted May 15th. All died out from drought.

Spanish Peanuts.—Gray sandy soil. Planted May 5th, first ripe Aug. 1st, gathered Oct. 15th. Quality very fine. Growth and yield fine.

REPORT OF Prof. J. B. ESPY,

ABBEVILLE, HENRY COUNTY.

Japan Cotton.—Sandy soil, clay sub-soil, manured with 250 lbs. guano per acre. Cultivated with heel-scrape and shovel. Planted April 10th, first open boll Sept. 8th. Yield 344 lbs. per acre seed cotton, 112 lbs. lint. Quality of staple excellent. Grows about $4\frac{1}{2}$ feet high, hardy and thrifty, long limbed, fruits poorly, bolls small and contain only three locks.

REPORT OF Mr. URIAH JOHNSON,

TRINITY, MORGAN COUNTY.

Jerusalem Corn.—Sandy soil. Planted June 15th, harvested Sept. 15th. No manure. Seed crop good, forage short and hard.

Yellow Millo Maize.—Sandy soil, no manure. Quality of product not good. Poor yield. Bottom blades fired before seeds commenced to mature. Stalk large and light. Not so good as sorghum. Small insects injured it very much.

Spurry.—Sandy land, no manure.

Egyptian Cotton.—Sandy land, red clay sub-soil, no manure. Planted April 15th. Yield about 200 lbs. per acre. Lint very fine and weak. Stalks from 3 to 6 feet high, very few limbs and bolls.

Spanish Peanut.—Land same as above. Planted May 1st, harvested Oct. 1st. Quality good.

Rape.—Land same as above. Planted on land that had been used for cow pen, and it was rich. Planted June 15. Eaten up by a beetle unlike any insect he ever saw. Only eats the *Rape.*

Unknown Cow Pea.—Land same as above, no manure. Product good.

Melilotus.—Land same as above. Planted April 1st, no manure. Good product. Growth slow in Spring, but in August and September the roots grew large and deep into the ground.

REPORT OF Mr. J. A. LOGAN,

CLANTON, CHILTON COUNTY.

Turnip—Purple Top, White Flat Dutch, Snow Ball and Golden Ball.—Light soil, fertilized with guano and Ala. Fertilizer. Planted in rows in September. Yield about 100 bushels per acre. Quality of product as fine as can be grown.

Cotton—Hawkin's Improved.—Light soil, manured with compost. Cultivated as other cotton. Planted April 15th, first open Oct. 31st. Yield one-half bale per acre. Growth tall, very full of bolls, rather small, but a good cotton. Some rust.

Egyptian Cotton.—Soil mixture of red and gray pine land, manured with compost. Cultivated as other cotton. Planted April 25th, harvested September and October, Yield about one-third bale to the acre. Lint short, bolls scattering, very large growth.

Spanish Peanut.—Ordinary fresh soil, manured with compost. Planted in April. Quality good. Yield 50 bushels per acre. Very fine variety.

Jerusalem Corn.—Failed to germinate.

Spurry.—Fresh land, manured with compost. Planted in March. Came up and grew about 10 inches high and died. Considered worthless.

Unknown Cow-pea.—Soil red; had been in cultivation several years, manured with phosphate. Culture same as cotton. Planted in May. First ripe in August. Yield good, and growth fast and vigorous.

Awnless Brome Grass.—Light gravelly land, manured with compost of lime and phosphate. Sown broadcast in March. Came up, but was choked out by crab grass.

Alfalfa.—Soil as above. Planted in March. Came up a fine stand, but after reaching 12 inches high, died out from dry weather.

Red Kaffir Corn.—Soil as above. Planted in May. Manured with stable manure and phosphate. Yield about 25 bush. per acre. Quality good, and grew well although the weather was extremely dry.

REPORT OF J. H. LOVEJOY.

ETOWAH COUNTY.

Alfalfa.—Sandy upland, no manure. Planted March 10. Badly killed by March freeze, and the few stalks remaining did not do well for want of culture.

Unknown Cow-pea.—Sandy upland, no manure. Planted July 10th; gathered October 1st. Products *very fine indeed.* Consider them the best pea I have ever grown, and shall discard all others for them.

Yellow Millo Maize.—Sandy upland, broadcast five wagon loads stable manure per acre. Planted May 9th; harvested September 10th. Quality of product seemingly as fine as it could be. Rapid growth; made a large quantity of foliage, and the seed a most excellent feed, especially for chickens, *Spanish Peanuts.*—Sandy, no manure. Planted May 20; harvested August 30. Quality good; about 50 bu. per acre. A desirable variety, as the vines grow in a bunch straight up and the nuts grow close to the vine and adhere in gathering, which makes them easy to gather.

Kaffir Corn.—Sandy upland, five wagon loads stable manure per acre, broadcast. Planted May 10th; harvested September 10th. Crop would have been very fine, had it not been injured by English sparrows at the time the seed began to form.

Sweet Clover.—Sandy upland, no manure. Planted Mar. 10. Did fairly well; cut twice, fair crop each time. Horses very fond of it.

Crimson Clover.—Sandy upland, no manure. Planted March 31. Killed out by summer drought.

Spurry (Spergula Arensis.)—Sandy soil, dressing of stable manure. Planted March 31. Quick growth, but very low; not high enough to cut. Made a good crop of seed.

Awnless Brome Grass.—Sandy upland, no manure. Planted March 31. Got a good stand, but died out on account of the summer drought. "Not the grass for my soil."

Egyptian Cotton.—Complete failure.

Tobacco.—Sandy upland, manured with a small quantity in the drill. Plants set about May 1st; harvested September 10th, quality pronounced by judges to be excellent. Yield about 800 pounds per acre. Think tobacco a paying crop for this section, and am convinced that it is more profitable than cotton. Only wormed it two or three times.

REPORT OF Mr. S. PERCY JONES,

JOSEPHINE, BALDWIN CO.

Spanish Peanut.—Soil sandy, manured with cotton-seed meal, at rate of 500 pounds per acre. Plowed twice; hoed once. Planted April 1st; harvested August 1st. Yield per acre, 32 bush. Does well in this soil and climate.

Spurry.—Soil sandy; no manure. Planted April 15th; harvested June 5th. Grows about 15 inches high. Not so good as Giant Spurry.

Alfalfa.—Low land; manured with 500 pounds cotton seed meal per acre. Planted March 5th. Killed out by drought. No yield.

REPORT OF Mr. R. D. MARTIN,

FLORENCE, LAUDERDALE COUNTY.

Yellow Millo Maize.—Soil, gray red clay sub-soil, on south hill-side, no manure. Culture same as for corn and sorghum. Planted May 1st. Gathered August 1st. Yield not measured, but was large. Growth vigorous, about eight feet high. It is a valuable addition to the forage crop; can be cut several times, and comes out very rapidly. Seasons were the dryest ever known.

Kaffir Corn.—Soil as above, no manure. Culture, same as corn. Planted May 1st; harvested September 1st. First ripe August 1st. Owing to extreme drought, did not estimate the yield. Heads measured from eight to eighteen inches in length, and one solid mass of large grains. Stock fond of it. Have saved nearly all for seed.

Jerusalem Corn.—Soil on edge of basin, no manure. Planted May 1st; harvested September 15th. Not so tall a growth as Millo Maize; will grow it another year. Stock like it very much.

Unknown Cow Pea.—Light thin soil, well drained, no manure. Cultivated as directed on package. Planted May 29th. Gathered in September. Yield 15 to 20 bushels per acre. Quality very fine. Pods extra long, and on account of the extremely dry weather, many were lost from shattering out. Had the seasons been better, the crop would have been larger.

Crimson Clover.—Soil in a low place, no manure Planted in March. The extremely dry spring caused it to die-out some, and on account of dry weather did not grow tall enough to cut.

Lucerne.—Soil as for clover, no manure. Planted in March. Owing to drought, grew about 12 inches high and seeded. Stood the drought remarkably well.

Brome Grass.—Soil as for Lucerne, no manure. Planted in March. Did not develop sufficiently to authorize a report. May do better the next experiment.

Egyptian Cotton.—"No good" for this climate, will not mature.

Spanish Pea-nut.—Soil, light sandy, no manure. Planted May 1st, harvested in October. Yield per acre, *large; quality good.*

Tobacco, Brazil variety.—Cured bulk of crop by pulling off the leaves as they would ripen and hanging them on sticks in a log house. Sold most of it at 30 cents per pound. Took premium at the county fair.

REPORT OF Mr. WM. MARTIN,

GREENSBORO, HALE COUNTY.

Egyptian Cotton.—Soil, level, sandy upland, no manure. Cultivated by first barring-off, and afterwards by plowing with sweep, and hoeing. Planted April 10th. First open August 1st. Last open October 1st. Gathered in September and October. Yield per acre, 1,200 lbs. Quality good. No insect enemies; no plant diseases.

REPORT OF Mr. J. W. MIZE,

REMLAP, BLOUNT COUNTY.

Spanish Pea-nut.—Light sandy soil, clay sub-soil, manured light with stable manure. Cultivated with hoe and small shovel. Quality of product very good, and the crop good.

Egyptian Cotton.—Flat branch land, manured with dry pulverized stable manure. Cultivated with small scooter' heel-scrape and hoes. Planted April 20th. Yield, about 400 lbs seed cotton per acre. The quality of lint was very fine and yellow. The growth tall, limbs long, bolls very small and scattering. Same ground in common cotton would make 1,600 lbs.

Jerusalem Corn.—Soil dark, red sandy, manured with small quantity of stable manure. Planted May 7th, harvested September 20th. Nothing good but the heads or tops, which grew compact and is relished by stock. Stalks low and pithy.

Red Kaffir Corn.—Gray, sandy soil, no manure. Planted April 26th, harvested September 17th. Nothing good but the *heads*. Quick growth.

Tobacco.—Branch, sandy loam, no manure. Planted in May; harvested in September. Hester variety after cureing was strong and had a rich color and fine flavor. Comstock Spanish, cured yellow, with a fine flavor.

REPORT OF Mr. S. H. PRUITT,

SHADY GROVE, PIKE COUNTY.

Egyptian Cotton.—Soil sandy, manured with 150 pounds guano per acre. Planted last of May. Gathered first December. Yield about 300 lbs. to the acre. Growth rapid, stalks from 6 to 10 feet high.

Brome Grass.—Soil sandy, Cow-pen manure. Planted March 1st. Matured first seed June 11th. Yield good. Product very good. Rapid growth.

Spurry.—Land and manure as above. Planted March 1st. First ripe seed May 10th. Quality very fine and yield good.

Alfalfa.—Level sandy soil, Cow-pen manure broad-cast. Quality good. Growth fine and rapid, and is recommended in that section.

REPORT OF Mr. T. A. SNUGGS,

HOLLY POND, CULLMAN COUNTY.

Kaffir Corn.—Soil gray, manured with 100 lbs. guano per acre. Cultivated same as cotton. Planted May 15th; harvested October 1st. Yield about 30 bushels per acre. Quality a little better than sorghum. Mr. Snuggs considers this a fine food for stock, but it should be threshed and the grains crushed as stock fail to masticate it.

Spurry.—Gray sandy soil, no manure. Planted March 20th. Dry spring season; grew to be about three inches high. Failure.

Jerusalem Corn.—Seed did not germinate.

Unknown Cow Pea.—Soil, gray sandy, manured with mixture of acid phosphate and cotton-seed meal. Planted June 15th, between corn rows. First ripe September 15th; harvested October 10th. Quality of product good and well adapted to this soil and climate.

Rape.—Soil gray, manured with stable manure. Cultivation same as rutabaga turnips. Planted July 20th. The drought was too prolonged to determine its merits.

Millo Maize.—Soil, gray hill-side, manured with 100 lbs. guano per acre. Cultivated in three feet rows, same as cotton. Planted May 1st; harvested October 15th. First ripe October 15th. Last ripe November 1st. Did not mature well. Not adapted to this soil and climate.

Spanish Ground-pea.—Soil, gray, south hill-side, manured with compost of cotton-seed and stable manure. Cultivated in 2½ feet rows. Planted May 15th; harvested October 1st. Quality good, and is a very fine ground-pea for this climate and soil.

Crimson Clover.—Soil sandy and trod. Planted April 1st. The spring drought was fatal to this crop.

Egyptian Cotton.—Soil gray, east hill-side, manured with 150 lbs. guano per acre. Cultivated like ordinary cotton. Planted April 26th. First open September 1st. Yield about 200 lbs per acre. Quality of product not good. Not adapted to this country, bolls too small and scattering and too slow in maturing.

Hawkins Improved Cotton.—Soil, sandy, south hill-side, manured with compost of stable manure and cotton-seed. Cultivated as other cotton. Planted April 26th. First open boll September 1st. Yield per acre about 700 pounds. Quality of product good. This cotton is very prolific, but the bolls are too small.

REPORT OF Mr. ROMEO TAGLEABUE,

DAPHNE, BALDWIN COUNTY.

Unknown Cow Pea.—Soil, high gray, red clay sub-soil, manured, kainit 280 lbs. bone dust 100 lbs. per acre. Not cultivated. Sown broad-cast. Planted May 18th. Harvested from last of June until the last of October. Yield very large. Product very good. Insect enemies, common pea beetle.

Crimson Clover.—Plateau on an elevation, gray soil, manured with 100 lbs. lime, 200 lbs. kainit, and 40 lbs. bone dust, per acre. Not cultivated. Failure.

Yellow Millo Maize.—Soil same as above, manured with 330 pounds kainit, and 130 pounds bone dust per acre. Culture, one hoeing and one plowing. Planted May 24th; harvested October 25th. First ripe 15th September. Yield about 40 bushels per acre. Quality good. Growth of grains and stalk enormous, some stalks 14 feet high and some heads weighed $2\frac{1}{4}$ pounds. This plant is highly recommended. Insect enemies, yellow winged beetle, same as attack cow-peas.

Brome Grass.—High, gray soil, manured with 200 lbs. kainit, 40 lbs. bone dust per acre. Planted May 28th. Did not germinate.

Spurry.—High elevation, gray soil, manured with 160 lbs. lime, 330 kainit, 100 lbs. bone dust per acre. Planted May 28th. A few seed sprouted, but soon all signs of the plant disappeared.

Spanish Peanut.—Soil same as above, manured with 600 lbs. kainit, 330 lbs. bone dust, 130 lbs. cotton seed meal per acre. Cultivated with two hoeings soon after the plants came up, and nothing more. Planted May 26th; harvested October 15th. Yield per acre about 70 bushels. Quality small, but good. Growth good, but suppose the results would have been as large with less manuring. The vines are good for horses and cattle.

Red Kaffir Corn.—Plateau upon a high elevation, sandy gray soil, manured with 200 lbs. kainit, 140 lbs. bone dust' 60 lbs. cotton seed meal per acre. Cultivation, hoed one time, and then hilled. Planted May 21st; harvested August 25th. First ripe July 31st. Yield about 35 bush. per acre. Quality good. Growth and yield satisfactory, though there were some missing hills.

Mr. T. thinks the growth and yield could have been increased by better culture and by cutting the stalks earlier than this was cut.

Jerusalem Corn.—Soil same as above, manured with 330 lbs. kainit, 130 lbs. bone dust per acre. Culture same as the *Kaffir*. Planted May 23d; harvested August 25th. First ripe last of July. Yield about 30 bush. per acre. Quality good. A good many seeds did not come up. The growth and yield very satisfactory; at the same time better culture would have given better results. Well pleased with it.

Rape.—High elevation, gray soil, manured with 330 lbs. kainit, 160 lbs. bone dust, 100 lbs. cotton seed meal per acre. Cultivation, several hoeings. Planted May 26th. Quality of product good. Only a few seeds sprouted, and they made enormous bunches of leaves that were as good as cabbage. Will try it again with a heavier manuring. Insect enemies, the common cabbage worm.

Alfalfa.—Soil same as the foregoing, manuring—100 lbs. lime, 200 lbs. kainit, 40 lbs. bone dust per acre. Planted May 26th. Sprouted June 2d, and up to Nov. 26th, rootlets had grown about a foot long. Prospects good for its doing well after it becomes firmly rooted. Growth continues from year to year.

Sweet Clover.—Soil as above, manured with 100 lbs. lime, 200 lbs. kainit, 100 lbs. bone dust, 40 lbs. cotton seed meal per acre. Planted May 20th. Complete failure.

REPORT OF Hon. J. C. OTT,

FLORENCE, LAUDERDALE COUNTY.

Egyptian Cotton.—Soil level, on Cox's Creek, fertilized with acid phosphate, and cotton seed meal. Cultivated like ordinary cotton. Planted April 17th, first open boll Sept. 21st; harvested Nov. 1st. Yield about 250 lbs per acre. Quality of product good. Growth vigorous, 3 to 5 feet high. Yield poor on account of maturing so late. Peerless cotton on the same land produced 1,100 lbs. per acre.

Egyptian Cotton (Afifi).—Soil same as above, manuring same as above. Cultivated same as ordinary cotton. Planted April 17th, first open Oct. 1st. Yield practically nothing. Growth extremely vigorous, from 6 to 10 feet high. All labor and fertilizer and use of land lost.

Spanish Peanut.—Soil level, on creek, manured with cotton seed meal. Cultivated about the same as cotton. Planted April 27th; harvested Sept. 18th. Yield per acre about 63 bushels. Quality very good. Growth vigorous.

Yellow Millo Maize.—Soil about the same as above, manured with cotton seed meal. Cultivation: Broke land in Nov. and again in April, just before planting. Planted May 1st; harvested at intervals. First ripe middle of August. Last ripe Oct. 1st. Quality of product, very best. Vigorous growth, abundant yield of green feed, the use of which I mostly made of it.

Mr. Ott says it is very valuable as a green feed and for fodder, producing two or three crops from the same planting.

Jerusalem Corn.—Soil similar to that on which the foregoing were planted, manured with cotton seed meal. Cultivation: Broke land in Nov. and again in April and plowed with double shovel. Planted May 1st, first ripe last of July, last ripe Aug. 20th; harvested Aug. 28th. Yield and quality not good, on account of excessive rains, causing the seeds to mould before maturing. Growth very vigorous.

Red Kaffir Corn.—Soil same as preceding experiments, manured with cotton seed meal. Land was broken in November and re-broke in April, cultivated with a double shovel. Planted May 1st, first ripe Sept. 1st, last Oct. 15th; harvested at intervals. Quality of product very good Growth vigorous, yield heavy as a forage plant. Foliage heavy.

BULLETIN No. 66. OCTOBER, 1895.

ALABAMA

Agricultural Experiment Station

OF THE

AGRICULTURAL AND MECHANICAL COLLEGE,

AUBURN.

CANE SYRUP.

B. B. ROSS, Chemist.

MONTGOMERY, ALA.:
THE BROWN PRINTING COMPANY, PRINTERS,
1895.

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THE MANUFACTURE OF SYRUP FROM CANE.

The manufacture of syrup for home use or local consumption has been carried on upon a small scale in southern and middle Alabama for many years, and in many of the villages and towns of this section, home made cane or sorghum syrup is found upon the market during the fall and early winter months.

Even during the period of the year referred to, however, the home made product only partially supplies the demand for this article, while during the spring and summer months the syrup of home manufacture is not to be obtained at all, and the demand is supplied by syrup from the outside markets.

These imported syrups are frequently adulterated with corn glucose or else have been obtained by reboiling syrups and molasses which have undergone partial fermentation, while in still other cases the syrups consist of low grade and originally dark colored products which have been bleached or brightened by chemical processes.

That a portion of the local demand for syrups throughout such a large section of the State can be successfully supplied during a small portion of the year, is already an established fact, and with an increased cultivation of cane and an improvement in the present crude methods of manufacture, it is not too much to say that within a comparatively short period, the demand for syrup for the greater portion of the State, throughout the entire year, can be satisfactorily filled with a product of high quality, manufactured within the borders of the State. The composition of cane produced on hill lands in this State, as indicated by analyses made during a number of seasons, exhibits a marked superiority as regards saccharine content when compared with the cane grown upon the alluvial lands in

Louisiana, the proportion of sugar contained in the former being from 2% to 4% in excess of that found in the latter.

Experiments with regard to the adaptability of cane to soils of varying quality and character have almost invariably shown that light, easily drained soils produce a cane of higher sugar content than rich alluvial or bottom lands, though the latter soils give the larger yield in almost all cases. While the lands throughout such a large portion of this State are capable of producing cane with such a high sugar content, there has been made, as yet, very little progress in the employment of intelligent and improved methods in the manufacture of syrup from sugar cane, and the processes at present in use are extremely crude and in most cases quite uneconomic.

The process of manufacture, as carried out at present, makes little if any provision for the clarification or purification of the juice prior to evaporation, the only impurities removed being those which come to the surface as froth or scum during the process of evaporation, the skimmings being removed by means of a small perforated ladle.

As the cooking of the juice to syrup is commonly effected in the ordinary shallow copper evaporator, the evaporation is of course quite rapid, and in many cases considerable proportions of the impurities escape the skimming ladle and are boiled down along with the syrup, contaminating the product and giving a darker color to the syrup.

In ordinary practice, no appliance of value is employed to ascertain when the syrup has reached the proper density, and in most cases the evaporation is carried too far, a product being obtained which permits the deposition or crystallization of it's sugar within a comparatively short time.

Owing to this tendency on the part of the thicker syrups to crystallize, it is quite difficult to obtain the home-made article for more than a few months after the period of manufacture, while syrups that may have partially escaped this defect will be likely to ferment somewhat later in the season.

The presence of organic impurities has the effect of increasing the tendency of syrups to ferment, so that a failure to properly clarify or defecate (remove impurities from) the syrups during the process of manufacture will almost invariably lead to the fermentation of the syrup, after the lapse of a few months, at least.

A lack of care in regulating the heat during the cooking process frequently results in the scorching of a portion of the syrup and a consequent darkening of the liquid, owing to the formation of caramel or similar substances.

While a dark syrup may equal a syrup of lighter and brighter shade as regards sweetness and flavor, the lighter and brighter syrups almost invariably command a higher price on the market, so that it is advantageous to make as clear and bright an article as possible, if the syrup is being manufactured for sale.

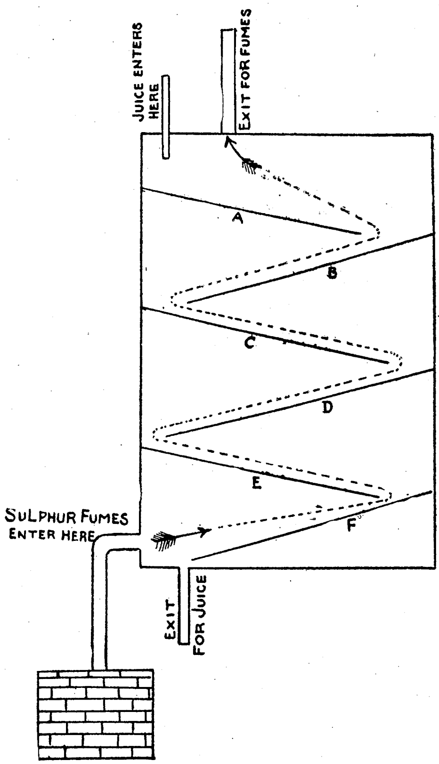
The materials and appliances for the proper clarification or purification of syrups are quite simple in character, and in order to show that they could be successfully employed in syrup making on a small scale in this section, a series of experiments were conducted by the writer during last November.

As it was found difficult to secure a portable furnace or mill for use at the Experiment Station, it was found advisable to conduct the experiments at the adjacent place of Mr. M. Floyd, where both furnace and mill were in operation.

For effecting the clarification or defecation of the juice, both sulphur and lime were employed as raw materials, the former being converted into sulphur di-oxide or sulphur fumes by burning in a small furnace, while the latter was employed in the form of milk of lime.

Both of these agents are successfully employed in Louisiana and in other sugar producing sections upon a large scale, but the manner of applcation with the small outfits at our disposal was necessarily somewhat different.

The apparatus for sulphuring the juice was constructed of an ordinary box about 1 x $2\frac{1}{2}$ x 4 feet and in order to more fully illustrate its construction the following cut is inserted, which gives a vertical cross section of the box, showing interior arrangement of shelves and also the sulphur furnace and pipe connections.



As indicated by the diagram, the shelves *a, b, c, d, e, f*, are arranged in a gently sloping position in order to permit of the easy, but not too rapid, flow of the juice through the apparatus, the sides and joints of the box being made as nearly air and water tight as possible, in order to provide against waste of either the juice or sulphur fumes.

The raw juice as it comes from the mill is placed in a vessel above the sulphur apparatus, and is allowed to enter the box through the pipe shown at the top of the diagram.

As soon as the stream of liquid encounters the first shelf it spreads out over the whole of the surface exposed to it, and flows in a thin layer down shelf after shelf until it reaches the exit tube at the bottom of the apparatus.

The sulphur furnace can be constructed of a few bricks laid either in moist clay or mortar, while the pipe connecting the furnace with the box can be constructed of sheet iron, or else a piece of $1\frac{1}{2}$ or 2 inch gas pipe can be employed.

An opening is left in one side of the furnace to assist the draught, while the sulphur is burned in a small iron pot or pan, ordinary roll sulphur or brimstone being the form best adapted to this purpose.

The fumes enter the apparatus near the bottom as shown in the cut and, in passing through the box, follow the course indicated by the arrows and dotted lines, the juice as it flows downward being continually met by a stream of sulphur fumes passing upward.

The employment of this form of apparatus insures the ready absorption of the sulphurous acid gas by the juice, and a very marked change is observed in the character and color of the juice as it flows from the box, as compared with the juice fresh from the mill.

The juice, after sulphuring, is allowed to flow into the first compartment, of the evaporator, and when it has almost reached the boiling point, a small amount of a thin milk of lime is added, the juice, however, being left distinctly acid as indicated by litmus test paper.

As soon as boiling commences, and frequently before the boiling point is reached, it will be observed that large quantities of froth and scum have accumulated on the surface, and can be removed in the usual manner as fast as they are formed, a very clear bright juice being obtained in a very short time.

The evaporation is now conducted, in the usual manner, avoiding sudden or excessive heating of the pan, the syrup being drawn off when it has attained the proper density or thickness.

To ascertain when a sufficient degree of concentration has been reached, it will be found convenient to employ what is known as the Baume hydrometer or saccharometer, which consists of a hollow glass spindle, with graduations on the stem for indicating the density of liquids in which it may be immersed.

In reading the instrument, the point to which the spindle sinks in the syrup is noted, the boiling being continued, if a sample, tested in an ordinary pickle jar with the spindle, is found to be of too thin a consistency.

Ordinarily, it will be found best to boil the syrup to a density of about 32 degrees, as indicated by the Baume spindle, immersed in the hot liquid, since with syrups of greater density, the crystallization of a portion of their sugar will take place in a short time.

(A hydrometer or spindle of the above description can be purchased of I. L. Lyons & Co. of New Orleans for about 75 cents.)

In the experiments conducted last fall, a portion of the syrup was clarified with the use of sulphur fumes alone, while another portion was defecated by means of sulphur fumes, followed by treatment with milk of lime in the evaporator.

The latter treatment gave more satisfactory results in almost every test, the syrup obtained being clear, bright and of excellent flavor.

The advantages resulting from the use of sulphur fumes are as follows:

1st. It bleaches the juice thoroughly and yields a clear, bright product.

2nd. It aids in the defecation or removal of impurities from the juice, the impurities removed consisting largely of easily fermentible organic substances, which interfere with the preservation of the syrup.

3rd. The sulphurous acid remaining in the syrup is of value in tending to prevent or check fermentation, since this substance possesses marked anti-fermentive properties.

The milk of lime is of advantage in partially neutralizing the excess of sulphurous acid and in precipitating albuminous matters and other organic impurities, which would otherwise be difficult of separation.

As previously stated, a great objection to the methods of syrup making in common use is that no attempt is made to thoroughly clarify or defecate the juice, and further that the syrup is boiled too thick a consistency, thus facilitating the crystallization of the sugar contained. Where sulphur fumes have been employed, any excess of free sulphurous acid remaining in the juice will aid in the conversion of the cane sugar into uncrystallizable sugars, and the same result can be attained by the employment of other acids such as acetic and muriatic, though their use for this purpose is not to be strongly recommended.

If, instead of removing the upper green joints of cane preparatory to grinding, the whole stalk is passed through the mill, it will be found that the syrup obtained will have much less tendency to deposit sugar, than where the former plan is adopted, although the product is more susceptible to fermentation and quite likely to be darker in color.

The experiments conducted during the season of 1894, were performed with the aid of an ordinary shallow copper evaporator, together with the sulphuring apparatus previously described, and the results secured were quite satisfactory in almost every particular.

The syrup obtained was much brighter and clearer than the syrups made during the same season without the use of clarifying agents, and portions of this syrup, preserved for almost six months in open vessels, gave no perceptible sign of fermentation at the end of that period, and there was only a partial deposition of the sugar contained.

THE PRESERVATION OF SYRUP.

As before stated, the two chief difficulties in the way of the satisfactory preservation of syrups are—first—the deposition of sugar, and second—fermentation, which frequently takes place at a somewhat later period.

While some of the syrup manufactured in the experiments referred to was kept quite satisfactorily in open vessels for a period of about six months, it is almost invariably difficult to preserve syrups in bulk from fermentation during the summer months.

To show that cane syrup could be successfully preserved, even through the long heated term, without undergoing any material changes, several large glass bottles were filled with the hot syrup and immediately sealed tightly, after which they were set aside in a secure place and were left undisturbed until the first of October, nearly eleven months after the date of making the syrup.

The bottles were about two-thirds of a gallon capacity each, and were rinsed with hot water before being filled with the hot syrup to the full capacity of the bottle.

On opening the bottles there was not the slightest indication of fermentation, nor had any deposition of sugar, whatever, taken place, while at the same time the flavor and taste of the article could not be distinguished from that of a syrup fresh from the evaporating pan.

At the time of filling the large bottles, a small bottle was filled with the same syrup, in order to make comparative analyses of the two samples, the small bottle being labeled "Sample 1" and the large bottles "Sample 2."

The following is the analysis of sample 2, made immediately after unsealing one of the large bottles.

Total solids, - - - -	71.2	per	cent.
Cane sugar, - - -	46.4	"	"
Glucose, - - - -	22.9	"	"
Solids not sugur, - -	1.9	"	"

On comparing these figures with the analysis of Sample 1, it will be seen that the syrup has undergone scarcely an appreciable change in composition when preserved in bulk sealed vessels, and the preservation in still larger vessels can be effected with fully as satisfactory results.

ANALYSIS OF SAMPLE 1.

Total solids, - - -	71.2	per cent.
Cane sugar, - - -	46.7	" "
Glucose, - - - -	22.4	" "
Solids not sugar, - -	2.1	" "

Instead of employing large bottles, one gallon jugs can be utilized to good advantage, provided that a thoroughly glazed ware is used and that care is observed in sealing the vessels.

In conclusion, it is scarcely necessary to add that by employing intelligent methods both for the clarification and preservation of cane syrup, the greatly enhanced quality of the product will obtain for it better prices upon the market, while the local demand for syrup can be supplied throughout the entire year, instead of for only a few months as at present.

Experiments in syrup making will be continued at the Station this fall, and it is expected that small steam evaporators will be tried as a substitute for the common form of evaporator heretofore employed.

BULLETIN No. 67. NOVEMBER, 1895.

ALABAMA

Agricultural Experiment Station

OF THE

AGRICULTURAL AND MECHANICAL COLLEGE,

AUBURN.

BOVINE TUBERCULOSIS.

C. A. CARY, Veterinarian.

MONTGOMERY, ALA.:
THE BROWN PRINTING COMPANY, PRINTERS.
1895.

☞ The Bulletins of this Station will be sent free to any citizen of the State on application to the Agricultural Experiment Station, Auburn, Alabama.

BOVINE TUBERCULOSIS, (1)

BY

C. A. CARY.

The history of medicine informs us that Hippocrates (400 B. C.) described many of the characteristic symptoms and lesions of tuberculosis in man and animals. During the middle ages tuberculosis in animals was considered contagious and the flesh of infected carcasses was condemned by law as unfit for human food. Many of those old laws are still in force in Italy and Spain (Law).

During the first eight decades of this century the common and accepted theory was that tuberculosis was hereditary and this was its chief, and possibly only, method of transmission.

In fact, the history of tuberculosis has been checkered by numerous and various theories, because the exciting or essential cause remained unknown until 1882, when Robert Koch discovered the *bacillus tuberculosis.*

No other disease is so widely distributed geographically; it is found in all climates and in all lands. It attacks man and nearly all the domestic animals. It accompanies the progress of civilization and seems to be most active during the transitional stage from savagery or barbarism to civilization. Artificial modes of living, without intelligent and scrupulous sanitation, fosters and increases its virulency and frequency.

Tuberculosis annually claims more victims than smallpox, cholera and yellow fever. An average of 14 per cent.

(1) The term Tuberculosis embraces all forms of disease caused by the *bacillus tuberculosis*, namely: consumption (tuberculosis of the lungs), tubercular meningitis, tubercular peritonitis (pearl disease), scrofula, consumption of the bowels, lupus (tuberculosis of the skin) and, in fact, tuberculosis of any part of the body.

(one out of every seven) of all the deaths in the human family is due to tuberculosis [1]. In some of the largest cities and in some of the older and most densely populated countries the average per cent. is 25 (1 death in every 4 a result of tuberculosis).

It is said that the civilizing (?) influences, as applied to the American Indian, have increased the mortality to 50 per cent.—one-half of all the deaths result from some form of tuberculosis (Law).

In Alabama during the years 1889–90–91–92–93, the annual average number of deaths from tuberculosis was 1009; or 11.44 per cent. (1 in every 9) was due to tuberculosis (2).

The annual average among the white people is 373, or 4.23 per cent. of all the deaths; the yearly average among the blacks is 636, or 7.21 per cent. of all the deaths. This indicates that the superior intelligence of the white people with their better observance of the laws of health tends toward decreasing the ravages of this disease. The ignorance of the negro with his disregard of the laws of hygiene

(1) One authority claims that 20 per cent. of all the deaths in the United States (1 out of every five deaths) is due to tuberculosis.

2. Total No. of deaths in Alabama in 1889–90–91–92–93, was 44,096
The No. of deaths from tuberculosis during the same time, was:

Total.	Annual Average.	White.	Black.	Male.	Female.
5048	1009	1867	3181	2106	2942

These records were derived from Dr. Cochran's annual reports to the State Board of Health. Dr. Cochran informs me that these reports are accurate for the cities, but they are more or less incomplete from country districts.

It is very probable that the reports of deaths among the white people are more complete and accurate than those from the black race. It is also very probable that the number of deaths from tuberculosis among the negroes is greater than the reports show; because many deaths are not reported, that occur in localities where the inhabitants are nearly all black, propogates tuberculosis at a frightful rate. During slavery times the negro was as free from tuberculosis as were the white people at that time.

The constant and uniform appearance of deaths from tuberculosis are accepted by the people as inevitable. This constant contact breeds a tolerance which merges into an indifferent fatalism that is more becoming to the ignorance and superstition of the heathen than the intelligent and highly civilized American or European. We legislate, quarantine and use all the methods known to expert medical men, when cholera, yellow fever or small-pox enters or threatens to enter, our country or State. Yet only a few States legally recognize tuberculosis as an infectious disease that annually destroys more lives than all of the three frightful diseases just mentioned.

"If we take the whole civilized world and compare with the tuberculous mortality all the accumulated deaths from war, famine, plague, cholera, yellow fever and small-pox, we find that the latter are comparatively insignificant. Yet tuberculosis like every other germ disease is absolutely preventable and is allowed to continue its career of death because of reprehensible ignorance and criminal indifference" (Law).

THE EXCITING OR ORIGINATING CAUSE OF TUBERCULOSIS.

Since Koch's discovery of the bacillus tuberculosis, the study of this disease has been thorough and systematic. It is now a well established fact that tuberculosis can not exist without the presence of the living tubercle bacillus. This microbe or germ is a one-celled plant, having the shape of a very delicate rod, about 1-2500 of an inch long and about 1-10 as broad as long. This rod is usually almost straight but may be slightly curved. It may appear alone, in pairs, or in irregular groups or masses. It absorbs coloring matters (stains) very slowly; but when once stained it holds the stain with great tenacity. It will hold certain stains when all or nearly all other germs become discolorized.

This enables the pathologist to distinguish it amid myriads of other germs. The bacillus tuberculosis is a plant parasite that lives in the animal body, but it may be cultivated on artificial culture media, such as: agar agar or bouillon containing 5 per cent. of glycerine, and blood serum. It develops best at 100 to 102 degrees Fah. This germ may also live and retain its vitality outside of the animal body for an indefinite time; its length of life out of the body will depend upon heat, light, moisture and the material in which it exists. Koch and other observers have found that in many instances the tubercle bacillus has retained its vitality for nine or ten months in the sputa or expectorations of tuberculous persons. However, it is very probable that this germ does not grow or multiply outside of the animal body.

Many authorities (Baumgarten, etc.,) claim that the gastric juice will not destroy the tubercle bacillus. If infected sputa be kept at a temperature of 158° Fah. for ten minutes the tubercle bacilli are destroyed. The germ in the same material is destroyed in 20 hours if 3 per cent. of carbolic acid is added; the germ perishes in five minutes in iodoform-ether; it dies in ten minutes in a mercuric chloride solution (1 to 1,000). According to Koch the tubercle bacillus perishes in a few hours in direct sunlight, and in five to seven days in diffuse daylight. This germ may remain virulent in ordinary living rooms from two to ten months, varying with the light, heat and the frequency of disinfection or cleansing of the room. An absolute heat of 158 degrees Fah. for fifteen minutes in meat and other tuberculous masses, will kill the germs. Boiling for one-half hour is always fatal to the tubercle bacilli. In springs, wells and all forms of surface water, at ordinary temperature, the tubercle bacilli may maintain their virulency indefinitely. Non-sterilized water from rivers and surface wells may be contaminated; likewise public drinking troughs. Freezing will not destroy the tubercle bacillus. Fermentation and decomposition of organic materials, in which tubercle bacilli are present, will not always destroy them. Common salt liberally applied to meats is fatal to the germ in one month; but in large masses of meat, the salt may not permeate the mass evenly and many bacilli may thus escape the destructive action of the salt.

In truth, there are probably many conditions outside of the animal body in which the tubercle bacillus may live and retain its virulency that are yet unknown to pathologists. However, it is certain that poorly ventilated and dark living rooms, public halls, school rooms and churches are places where the infected sputa may be slowly dried, thus preserving its infective power indefinitely. Hence, the dust from such rooms may carry the virulent germs into the air passages, and into the alimentary canal with the food. In fact the greatest number of cases of tuberculosis in the human family are contracted by breathing tuberculous dust in living rooms, churches, school rooms and public places. The next greatest number of cases of tuberculosis are contracted by eating tuberculous food.

ACCESSORY OR PREDISPOSING CAUSES OF TUBERCULOSIS.

Predisposing causes consist of influences or factors that reduce the animal vigor and the resisting power of the leucocytes and tissues of the animal body, and of conditions which favor the introduction of the germs into the body.

(1). Heredity produces a tendency in the cell structure of the body favorable to the development of the germ and depressing more or less the body vitality or vigor. The offspring of tuberculous parents readily contracts tuberculosis, because the protecting liquids and cells of the body can not prevent the invasion of the tubercle bacilli. In rare instances the bacilli pass into the embryo or unborn fœtus. Some authorities claim that the germ may pass from a tuberculous sire in the semen, or it may be in the ovum from the dam, or pass from the mother to the fœtus by way of the fœtal membranes.

Evidently the continued breeding of tuberculous animals produces a weak family; and weakness of body, whether of tuberculosis origin or not, predisposes the offspring to tuberculosis.

(2). The modern method of breeding the cow as a milk-producing machine is developing a constitutional weakness in many individuals of the milk-producing families. Furthermore, experience has proven that a cow which is kept in a small stall without exercise will give more milk with a given quantity of food, than one which is given plenty of exercise in a lot or field, with the same quantity of food. Of course, such close confinement reduces the vigor of the cow and predisposes her to tuberculosis. This doctrine of close, warm, continual confinement is occasionally preached and practiced by dairymen and sometimes it is taught by instructors in agricultural colleges. Dairy cows as well as beef cattle should have exercise in open air. Exercise and fresh air will not prevent all cases of tuberculosis, but they certainly help to prevent the contraction or spreading of tuberculosis.

(3). *Ventilation and Light.*—Poorly ventilated and dark stalls are, in many respects, worse than continual out-door exposure. Light is one of nature's best disinfectants, and moving air carries away foul gases and brings fresh, pure air. The drainage of stalls should be so arranged that they may be kept dry and clean.

(4). Climate, in a degree, influences the propagation and development of tuberculosis. A moist and variable climate favors the development and transmission of tuberculosis. Dry and rarified air with a uniform temperature tends to decrease its ravages.

(5). *Food and Feeding*—Too heavy or forced feeding may weaken the animal as well as a deficiency in the quantity of food. The proper quantity and the best quality of food should be given. Food should not only be nutritious and digestible, but should also be given at regular intervals in proper quantities. Too much food overtaxes the digestive organs and decreases the vitality of the animal, and eventually produces acute or chronic indigestion.

(6). *Faulty Breeding*—In-and-in breeding or the mating of closely related individuals is always to be regarded as unsafe. It may bring out the weak or the bad points which may predominate over those that were strong and good in the sire and dam. Breeders who have developed distinct breeds recognize the fact that continued in-and-in breeding is very liable to produce an outcrop of tuberculosis.

Early and frequent breeding produce a decrease in bodily vigor and should be avoided.

Intensive breeding, or the pairing of animals from two great milking strains, may result in an offspring that is weak, poorly developed and predisposed to tuberculosis.

Animals with thin flat chests and long legs are predisposed to tuberculosis by conformation and should not be used for breeding purposes.

Animals having tuberculosis should never be bred.

(7). Disease, exposure to cold and rain and any influence which depresses the vitality or physical vigor of an animal, predisposes it to tuberculosis.

It should not be understood that any or all of these predisposing or preparing causes will produce tuberculosis without the presence of the bacillus tuberculosis. Neither should it be taken as self-evident that the absence of any or all of these predisposing causes will always prevent the spread of tuberculosis or the contraction of it. Dr. Niles of Iowa reports the appearance of tuberculosis in a herd that had been kept in the best out-door conditions.

TUBERCULOSIS AMONG THE VARIOUS SPECIES OF DOMESTIC ANIMALS AND IN MAN.

There appears to be a constant relation between the prevalence of this disease in man and in domestic animals. In a state or locality where tuberculosis is very common in the human family, it is also very frequently observed among the more susceptible of domestic animals. Cattle and swine are more susceptible to the disease than the other domestic animals; however, sheep, horses, dogs and cats occasionally become infected. Many of the wild animals when caged succumb to this disease. Caged monkeys, lions, tigers, deer, elk, kangaroos, antelope and birds have been known to die of tuberculosis. Rats and mice are susceptible and instances have been recorded where they have contracted tuberculosis in houses that were inhabited by tuberlous persons. Guinea pigs and rabbits are very susceptible.

ITS PREVALENCE IN CATTLE.

In Europe.—According to Arloing 0.5 per cent. of the cattle of France are tuberculous; in Paris, 6 per cent.; in Baden, Germany, 0.2 per cent.; in the province of Bavaria, 0.225 per cent.; in Belgium, 0.4 per cent.; in Holland, 20 per cent.; in Leipsic 20 per cent.; in Edinburgh 26 per cent.

The above per centages (from Law's bulletin) shows how tuberculosis in cattle varies in the thickly populated cities and countries of Europe. It will be observed that the cattle of the cities are more frequently tuberculous than the cattle of the country[1]. In some local herds of Europe 75 per cent. have been found to be tuberculous. According to the records in the slaughter houses of Germany cows are more frequently tuberculous than oxen or calves. In fact,

1. It is interesting to note in this connection the following valuable table prepared by Dr. Lagnaeu, showing the gradual increase of tuberculosis when the smaller cities are compared with the larger. These tables were made from the records of 662 cities in France:

95	cities with less than	5,000		inhabitants	1.81
332	cities of between	5,000 and	10,000	inhabitants	2.16
127	" "	10,000 and	20,000	"	2.71
50	" "	20,000 and	30,000	"	2.88
46	" "	30,000 and	100,000	"	3.05
11	" "	100,000 and	430,000	"	3.65
Paris	with 2,224,704			inhabitants	4.91

The above table shows the number of persons who die annually from tuberculosis of the lungs (consumption) to every 1,000 inhabitants in cities of different population. The table does not take into comparison any of the other forms of tuberculosis.

almost, one-half of the cases of tuberculosis in cattle are found in cows. This is due to the fact that the cow comes in closer contact with man and has less freedom, less pure air and receives more infected food than calves or oxen.

In the Copenhagen slaughter houses from 1891 to 1893 inclusive, the following records were made:

Inspected	132,294 oxen and cows,	23,305 or 17.7 %	were tuberculous.	
"	8,292 swine,	1,272 or 15.3 %	"	"
"	185,765 calves,	369 or 0.2 %	"	"
"	337,014 sheep,	1 or 1.0003 %	"	"

At the Berlin public slaughter house during 1892, the following records were made:

Inspected	142,874 oxen and cows,	21,603 or 15.1 %	were tuberculous.	
"	518,073 swine,	7,055 or 1.55 %	"	"
"	108,348 calves,	125 or 0.11 %	"	"
"	355,949 sheep,	15 or 0.004 %	"	"

In America.—The extent of tuberculosis in the United States is not definitely known. So far only one State has commenced a systematic attempt at eradicating bovine tuberculosis. Massachusetts is now working upon a large scale and during the present year has tested over 25,000 cattle for tuberculosis. In this work the diagnostic agent has been Tuberculin.

Outside of Massachusetts the tests for tuberculosis have been confined to local herds. In New York State, Law has found some herds with 98 per cent. of the animals tuberculous; while in other herds he found only 5 per cent. tuberculous. To be sure some dairy herds in country districts were found entirely free from tubuculosis.

Reports of tests in Minnesota, Wisconsin, Illinois and Iowa show that many of the herds in the favored country regions of the north-west are infected. In fact, so far as tuberculin tests have been made in every part of the United States no state has been found entirely free of this bovine pest. However, there is no doubt that the older and more densely populated states and cities are more extensively and seriously infected. A few tests have been made in Virginia, Texas, North Carolina and Alabama, and these are sufficient to determine the fact that we have tuberculosis among our cattle.

The following reply to a letter of inquiry sent out by the department explains itself:

MOBILE, ALA., JUNE 28, 1895.

DR. C. A. CARY, Auburn, Ala.,

MY DEAR SIR:—In reply to your favor of the 25th inst., I beg to inform you that tuberculosis is prevalent among cattle here. I consider the extent alarming enough although I have no idea what the per centage is. Human tuberculosis is also quite prevalent, which is not to be wondered at, since prominent dairy herds are infected. * * * *

Yours fraternally,

L. VAN ES, V. S.

The following letter from the Board of Health of the city of Mobile gives their views and present position:

MOBILE, ALA., JULY 16, 1895.

DR. C. A. CARY, Auburn, Ala.,

DEAR SIR—In reply to your favor of the 5th inst., I beg to say: No officer of this board inspects the dairy herds supplying this city with milk. If tuberculosis exists among these herds, knowledge of it is not possessed by this board. No power is possessed to make the tuberculin test, to determine the presence or absence of tuberculosis. At present we could not use the tuberculin if furnished free. It is the intention of the Board of Health to try to have the requisite laws enacted as insure a thorough inspection of milk, and if successful we may have occasion to correspond with you on the subject of tuberculosis.

Yours truly,

JAS. A. ABRAHAMS, M. D., H. O.

Dr. French, of Birmingham, Alabama, has found, by physical and post mortem examinations, tuberculosis in four different dairy herds in and around Birmingham.

By physical and post mortem examination the writer has found tuberculosis in three dairy herds in Alabama.

It is hoped that within another year the writer may have many records of tests, made with tuberculin, that will give more definite and extensive knowledge concerning the prevalence of bovine tuberculosis in Alabama.

HUMAN AND BOVINE TUBERCULOSIS CAUSED BY THE SAME GERM.

The tubercle bacilli found in man are identical in all respects with those that are found in cattle and all other animals with one possible exception—the chicken. At present it is questionable whether tuberculosis in man is identical with tuberculosis in chickens. Koch has found considerable variation in the bacilli from the two different sources. Any of the domestic animals except fowls, when inoculated with living tubercle bacilli from man contract tuberculosis Dogs and cats have become tuberculous by eating the sputa from tuberculous persons. Guinea pigs when forced to inhale air ladened with fine particles of dried tuberculous sputa, or when inoculated with the same material become tuberculous.

Numerous instances are recorded where tuberculous material from cattle has infected other animals.

Pearson, Bollinger, Ernst, Peters, Schroeder and others have produced tuberculosis in guinea pigs, by feeding them milk from tuberculous cows.

At the Experiment Station in Vermont a number of the dairy cows were found by the tuberculin test to have tuberculosis. A litter of five pigs, from healthy parents, had been fed milk from this dairy herd. The five pigs at the time of slaughter were found tuberculous. In every instance where pigs have been fed, any length of time, upon milk containing tubercle bacilli, they have contracted tuberculosis.

Since the discovery of the bacillus tuberculosis, the transmissibility or the contagious and infectious character of tuberculosis has been proven by numerous accidental or natural and artificial cases of transmission. A few typical cases will be given illustrating the transmissibility from man to animal, from animals to man, from man to man and from animal to animal.

(1) The writer knew a family, of which nearly every member died of tuberculosis. This family's herd of milch cows nearly all died of tuberculosis. The disease first appeared in the family; later in the herd of cattle.

(2) Three Grecian physicians injected tuberculous sputa into the thigh of a fisherman whose death from another disease was inevitable. His lungs previous to the inoculation were sound and his family was free from any taint of tuberculosis. In three weeks his lungs exhibited symptons of disease and at death (38 days after the inoculation) seventeen tubercles were found in his right lung, two in his left and two in his liver.

(3) Tappiener was trying to produce tuberculosis in dogs by forcing them to breathe air, artificially infected with tubercle bacilli. His servant, disbelieving in the danger, persisted in going into the infected inhalation rooms. In fourteen weeks he died from acute tuberculosis; and at the post mortem exhibited the same pathological lesions as those found in the dogs.

(4) A servant, in removing a glass sputum cup broke it and punctured her finger with a splinter of glass. In the course of time it became necessary to amputate that finger, when it was found to be filled with small tubercles.

(5) Dr. Stang, of Amorbach, reports a case, in his practice, of a five year old boy, after an illness of a few weeks, dying of acute miliary tuberculosis. Previous to his sickness he was healthy and well developed, and entirely free from any hereditary tendency to tuberculosis. A short time previous to his death the family cow was killed and found to have a severe case of pulmonary tuberculosis.

(6) Dr. Demme, of Berne, reports that four infants, in the Child's Hospital, died of intestinal and mesenteric tuberculosis. They were free from tuberculous taint, but had been fed on unsterilized milk from tuberculous cows.

(7) Hills and Rich state that a grandson of Henry Ward Beecher died from tuberculous meningitis. The child had no hereditary predisposition. The physician suspected the cows, from which the boy was supplied with milk. The tuberculin test and the post mortem examination showed that the two cows were tuberculous.

(8) Dr. Gage, city physician of Lowell, Mass., reports the case of an infant dying of tubercular meningitis. It had no tuberculous ancestry and had never been fed on anything but unsterilized milk from one cow. This cow's milk was examined microscopically and found to contain tubercle bacilli. Guinea pigs inoculated with the milk died of tuberculosis. A second child of the same family, fed on the same cow's milk was also developing tuberculosis. At that time (1890) the cow could not be condemned and destroyed. Hence, a year later Dr. Gage found this cow furnishing infected milk to the public.

(9) Dr. Treon states that the indians of the northwest eat the uncooked livers, entrails, tallow and other parts of the poor cattle furnished them by the agents of the government. These carcasses are eaten fresh or dried and are rarely, if ever cooked. In many tribes the mortality from tuberculosis is 50 per cent. of all the deaths. At Crow Creek agency 50 out of 1200 indians die annually from tuberculosis. Another authority states that the food of the indians is the primary cause of disease among them, and when the supply of fresh beef is most abundant the death rate from consumption is the greatest.

(10) Dr. E. O. Shakespeare, of Philadelphia, a noted specialist in bacteriology and pathology, says: "It has been found that in infants and young children in some large cities the mortality from some form of tuberculosis is far greater than is generally believed, amounting, in some localities to one-fifth of the deaths in the young. The significant fact in this connection is that it is most frequently some part of the digestive tract that first become affected."

(11) From the report of the English Royal Commission of 1895, the following extract is taken: "There is reason to believe that tuberculous matter, when present in meat sold to the public, is more commonly due to the contamination of the surface of the meat with material derived from other diseased parts than the meat itself. The same matter is found in the milk of course when the udder has become invaded by tuberculous disease, and seldom or never when the udder is not diseased. Tuberculous matter in milk is exceptionally active in its operation upon animals fed either with the milk or with dairy produce derived from it. No doubt the largest part of tuberculosis which man obtains through his food is by means of milk containing tuberculous matter."

(12) The statement is frequently made by medical men and others that since the freedom of the negroes there has been a remarkable increase in the amount of tuberculosis among them. This is said to be due to the bad sanitary condition of their homes; their crowding together in filthy, unclean beds and rooms; the indiscriminate mix-

ing of the tuberculous with the healthy; eating infectious meats and milk; the great degree of looseness in social intercourse; and last, but not least, the constant "giving" and "re-giving" of tuberculous individuals in marriage.

HOW TUBERCLE BACILLI ENTER TISSUES AND ORGANS.

(1). Infection by way of the air passages and the lungs.—This is the most common method of infection. The dried sputa and dried infectious materials that float in the air are liable to be carried into the air passages and lungs. Living rooms, churches, school rooms and public halls where persons expectorate indiscriminately are not infrequently filled with air infected with tubercle bacilli. The dust-ladened air of dairy barns, where infected cattle are kept, is also infected with tubercle bacilli. The dust from handkerchiefs, clothing, beds, bed-clothing of tuberculous persons is nearly always very infectious. The reason that all animals and all men do not become infected is because the germ is a very slow growing organism, and in most instances dies before it gains admission into the tissues of a new host. Furthermore, all animals or all men are not susceptible at all times. Full vigor, great bodily vitality and good health are the strongest fortifications against the entrance of any disease-producing germ into the body.

(2). Infection by way of the Digestive Apparatus.—This mode of infection is a result of carrying the tubercle bacilli into the alimentary canal along with the food, and from there into other parts of the body by way of the lymphatics, blood vessels and possibly by the tissues. This method has been demonstrated experimentally by feeding tuberculous material to pigs, calves, cats, dogs and guinea pigs. Moreover, there have been numerous clinical observations recorded where infants, children and even grown persons have become tuberculous by consuming tuberculous milk or other infected food. Infants, children and young animals (calves and pigs) are more frequently infected by drinking tuberculous milk than in any other way. Whenever the intestines, the mesentery or any of the abdominal organs are the first and chief seats of tuberculosis, it is evident that infection occurred by way of the alimentary canal. Occasionally the family milch cow becomes tuberculous by eating the waste slops and other materials which come from the house or rooms where tuberculous persons live. The alimentary canal may become the secondary seat of the disease by the animal or person coughing up the infectious material from the lungs to the pharynx or mouth and then swallowing it.

(3). Infection by direct inoculation.—If a terbuculous animal drops infected sputa or saliva upon a freshly abraded surface of a healthy animal infection might occur. Or a diseased animal might lick the freshly abraded surface of another and thus infection could take place. However, infection by this method is extremely rare.

(4). Intra-Ulterine Infection.—The bacilli may pass by way of the uterus and fœtal membranes, or by way of the blood vessels, from the mother to the fœtus. The fœtus or unborn embryo, by tuberculous semen from the sire, or a tuberculous ovum from the dam, may become infected. Recorded cases of infection by this method are extremely rare.

(5). It is also asserted that when the genital organs of either sire or dam are infected, the tuberculous one may transmit the bacilli to the other during copulation.

THE ACTION OF TUBERCLE BACILLI IN THE TISSUES.

After the bacilli gain admission (by any method of infection) to the tissues, they multiply at the point of lodgement and there produce the tubercle. .A young tubercle is composed of a collection of cells forming a small grayish nodule and the fresh state presenting the appearance of mother of pearl. Two or more tubercles lying near one another in the lungs, liver, spleen or kidney may unite or become confluent as they continue to develop. Later in the development of the tubercle the central mass becomes "cheesy"—forming a large, soft, yellow, pus-like mass that is sometimes called a yellow tubercle. The growth of the tubercle advances by the multiplying tubercle bacilli invading the tissues around the tubercle. As a rule extension of the disease from the primary focus takes place by way of the lymphatic vessels and glands—the lymph carrying the germs. In old and severe cases, where a large amount of tissue has been destroyed by the invading germs, the tubercle bacilli may be carried from the primary tubercle to other parts of the body by the current of blood in the blood vessels.

LOCATION OF THE TUBERCLES AS DETERMINED BY POST-MORTEM EXAMINATIONS.

No tissue or part of the body is exempt from the ravages of this disease. Some tissues and organs, by virtue of their structure, use and location, are more exposed to the action of tubercle bacilli, and consequently are more frequently the place of lodgement and growth of these germs than other parts of the body. Other organs appear to possess, by location and function, a comparative immunity and are rarely the seat of tubercles. The most frequently attacked tissues and organs will be given in regular order.

(a) The lungs are most frequently the location of tubercles. When the individual has tuberculosis of the lungs he is said to have consumption or pulmonary tuberculosis. When the lung tissue is first invaded it may be filled with small, hard nodules, which are called miliary tubercles. In exceptional cases these miliary tubercles do not increase in size. As a rule, they increase in size until those near one another unite and form large, soft, yellow, cheesy masses. Unusually a fibrous capsule develops around this mass to protect surrounding tissue and prevent its eruption into the bronchial tubes. Occasionally this yellow tuberculous mass erupts into the bronchial tubes; is coughed up and discharged into the outer world by expectoration. No one part of the lungs is more liable to be involved than the others, and the various stages in the development of tubercles may be seen in one tuberculous lung. The Bureau of Animal industry states that their records show that the large caudal lobes of the lungs were most frequently tuberculous. The bronchial lymphatic glands that lie along the bronchi, and the mediastinal lymphatics that lie along the surface of the thoracic portion of the œsophagus are usually involved when the lungs are tuberculous.

(b). The pleura or serous membrane, lining the chest or lung cavity and reflected over the lungs, is involved next in frequency to the lungs. This membrane, when tuberculous, is covered or filled with numerous, small pearly tubercles, called by the butchers "grapes." The tubercle bacilli, as a rule, reach the pleura from the lungs, and occasionally the germs come from the abdominal organs by way of the diaphragm.

(c). The mesenteric glands or small lymph glands of the mesentery are nearly always infected when infection takes place by way of the digestive tract. When tuberculous, these glands are enlarged and they may contain cheesy masses if the disease is of long standing. Or there may be minute miliary tubercles in the mesentary. Tubercles may appear in the peritoneum, the membrane lining the abdominal cavity. Sometimes Peyers patches in the small intestines may become tuberculous and occasionally tuberculous ulcers or tubercles may develop in the stomach, and other parts of the alimentary canal.

(d). The liver is not as frequently involved as the mesentery. It is very probable that the bacilli gain admission to the liver by way of the portal circulation from the intestinal tract. In the liver the tubercles may be small grayish bodies or large, yellow cheesy masses.

(e). The spleen and kidneys are rarely involved. As a rule, they are tuberculous when the disease becomes generalized or involves many organs and is widely distributed in the body.

(f). The uterus or womb is very rarely tuberculous. When involved its walls are greatly thickened and the mucous membrane is covered with ulcers and tubercles are numerous in tisues of its walls.

(g). The udder may be tuberculous in comparatively rare instances. When tuberculous, the udder becomes swollen, hard and knotty. The tubercles are located in the mucous membrane which lines the milk cavities and canals. Abscesses of the udder are rarely tuberculous.

It is possible to have a tuberculous abscess in the udder when the lesions are very severe and extensive. Occasionally the lymphatic glands in front and back of the udder may become enlarged and tuberculous.

(h). The bones are more frequently the seat of tuberculosis in swine than in cattle. The spongy centres of the bodies of the vertebræ of swine may exhibit yellow tubercles after the carcass has been cut into right and left halves. The articulations and bones of the limbs in cattle are sometimes involved in tuberculous alteration. The articulations are quite frequently involved in tuberculous calves.

(i). The pharyngeal (throat) glands are more frequently tuberculous than the udder or bones. These glands lie just back of the pharynix (throat); and when enlarged may sometimes be observed before the death of the animal. At first these glands are slightly enlarged and hard but later, as the disease advances, they become large and soft, owing to the extensive breaking down of tissue and the formation of large cheesy masses. In some cases the post pharyngeal glands are the only ones that are sufficiently involved by tuberculous changes as to be visible to the naked eye upon post mortem examination.

(j). The lymphatic glands at the base of the ear, the lymphatic glands on the inside of the lower jaw, the inguinal lymphatics on either side of the scrotum in the male, and on either side of the udder in the female, the lymphatic glands above and in front of the stifle and those in front of the shoulder blade may be the seat of tuberculous nodules or tubercles.

(k). The brain and spinal cord and the covering membranes of each occasionally become tuberculous.

(l). In extremely rare instances tubercles develop between the muscles. The muscle tissue proper does not present favorable canditions for the development of tubercles.

SYMPTOMS OR SIGNS OF TUBERCULOSIS AS OBSERVED IN LIVING CATTLE.

Tuberculosis may be acute or chronic; the former is rare; the latter is common and lasts for months or years. The physical signs or symptoms in the living animal are extremely variable—depending upon the location, extent and severity of the disease.

If the lungs and air passages are involved there may be, in the early stages, a harsh, dry, rough cough. Violent exertion, excitement, eating dry food or drinking cold water may cause the animal to cough. Sometimes the animal coughs at the beginning of exercise or upon rising after having lain down for some time. Striking the animal over the ribs a sharp rap with the knuckles may arouse the cough. Striking the chest with the knuckles may reveal regions or spots where the sound is muffled or dull instead of being resonant as in health. If the ear be applied to the chest, it may detect a weak, highly pitched whistling sound, made by the air rushing through some partially obstructed bronchial tube. Or, the ear may hear a sound that resembles bubbles of air passing through a thick liquid; this would indicate the presence of a liquid in the bronchial tubes. These last two tests are difficult and the trained expert is often mistaken; because there is such a limited area on the sides of the chest that can be thus inspected and because, in many instances, the area of lung tissue involved may be very small and deeply seated. A physical examination of the lungs in the living animal is satisfactory only in the advanced stages of the disease where the tuberculous animal is poor and the diseased part of the lung is very large. As the disease advances the cough may become more and more aggravated; a discharge from the nose may appear; the hair becomes rough and dry, and is not shed regularly; the skin becomes scurfy and clings closely to underlying tissues. In aggravated cases the animal may become greatly emaciated; yet, in some cases, the animal will remain in good flesh when the lungs are extensively tuberculous.

Respirations may be labored or accelerated according to the advancement and intensity of the disease. The pulse and temperature at times will rise above the normal; but will remain normal most of the time.

If the pleura is involved, the ear applied to the chest may detect friction sounds which are most distinct near the end of inspiration.

In tuberculosis of the stomach, intestines or mesentery, digestion is deranged and irregular. Young animals whose chief food is milk may have tuberculosis of the bowels or mesentery; this is manifest by indigestion, bloating and persistent diarrhœa; it may lead to general tuberculosis, involving the lungs and many other parts of the body. In older animals the appetite is capricious, digestion is impaired; the animal may bloat slightly after meals; have attacks of indigestion, and finally persistent and uncontrollable diarrhœa will appear. In some cases constipation will alternate with periods of diarrhœa or "scouring."

Tuberculosis of the peritoneum is difficult to determine in the living animal.

Tuberculosis of the uterus and ovaries is usually accompanied by sterility and long and frequent periods of heat (nymphomania).

When the udder is tuberculous it is confined usually to one quarter; yet it may involve each quarter. The diseased quarter is hard, insensitive to pressure and does not yield much milk. In rare instances the tuberculous udder may contain an abscess. Sometimes the cheesy or yellow tubercles erupt into the milk cavities and canals; thus the bacilli become mixed with the milk. Infrequently the submaxillary glands enlarge, soften, erupt and discharge a cheesy yellowish matter. This might be mistaken for actinomycosis.

The surface lymphatic glands at the base of the ear, in front of the shoulder, in front and behind the udder, in the groins, in front of, and above, the stifle, may be detected at first as hard nodular swellings; in the later stages as large soft swellings.

Bones and articulations are at first swollen and hard. Bones may later become soft, and if close to the skin, may be opened for an abscess.

When the brain, the spinal cord and their coverings are tuberculous the animal shows more or less signs of paralysis or mental derangement. In a brief time general stupidity, paralysis or convulsions may occur.

DIAGNOSIS.

How to Recognize Tuberculosis.

The physical signs or symptoms peviously mentioned may enable the veterinarian to recognize tuberculosis in well marked cases, but there are many dangerous and badly infected cases that can not be recognized by the veterinarian if he bases his diagnosis upon physical signs alone. The United States Veterinary Medical Association at their last meeting declared that tuberculosis in cattle could not, in many cases, be determined by physical examination alone. Besides the symptoms given we have the following aids to assist in making a more accurate diagnosis:

(1). Microscopical examination of the nasal discharge, of the saliva, of the milk and of the tubercles that erupt on the surface or that may be surgically removed from the skin or superficial tissues of the body.

(2). Inoculating susceptible animals with any of the liquids or materials mentioned in (1).

(3). The Tuberculin Test.

The first two of these methods are very tedious and difficult, and in many instances entirely without definite results.

The tubercle bacilli are rarely found in the milk in sufficient numbers to admit of their detection by the use of the microscope. It is only in very severe cases that the tubercle bacilli can readily be detected in the milk. Some claim that the udder or milk glands must be tuberculous before bacilli are in quantities sufficient for easy and accurate microscopic detection. Inoculating susceptible animals (guinea pigs, rabbits, etc.,) with the milk would require twenty to thirty days for the disease to develop, and the small quantity of milk used for the inoculation might not contain tubercle bacilli. The nasal discharge and the saliva of cattle do not contain tubercle bacilli unless there be erupting tubercles in the lungs or somewhere along the air passages; furthermore, the tuberculous material, coughed up from the lungs, may be swallowed when it reaches the pharynx (throat). In all cases where the lungs and air passages are not tuberculous the nasal discharge and saliva contain no tubercle bacilli. Hence, microscopical examinations, or inoculations with these materials will be of value only in a limited number of cases.

Feeding the milk of a tuberculous cow to a pig or calf may develop tuberculosis in the latter in three to six months.

Tuberculin Test.

The Tuberculin Test comes the nearest being a perfect diagnostic agent for determining the presence or absence of tuberculosis among cattle. Tuberculin is a material that was discovered by Dr. Koch; it is a condensed filtrate that is made from sterilized bouillon cultures of tubercle bacilli. In 1890, Koch gave tuberculin to the medical world as a prospective remedy for tuberculosis. For two or three years it was extensively used as a curative agent, but it gradually grew into disuse because it did not meet with the success that was anticipated. During this extensive use of tuberculin in the human family, physicians observed that it uniformly produced a fever or an elevation of the temperature in a certain number of hours after its administration to tuberculous persons. This fact led veterinarians to try it as a diagnostic agent in detecting tuberculosis in cattle.

If a sufficient quantity of tuberculin be injected beneath the skin of a tuberculous animal, its temperature will rise one and one-half to four or more degrees Fah. above the normal in eight to eighteen hours after the injection. This rise of temperature is known as the "reaction" in the tuberculin test. Before injecting an animal its normal temperature must be determined. To obtain the normal take the temperature of the animals to be tested every two hours beginning at 6 a. m. and continuing until 6, 8 or 10 p. m. When time is important and many cases are to be tested, the temperature may be taken every three hours during the day. In no case where the temperature runs to or above 102 degrees Fah. from morning till evening should the animal be injected; since it already has fever and the characteristic reaction will not always appear. It should be remembered that the normal temperature, as a rule, reaches its maximum in the evening and only in very rare instances in the morning.

After getting the temperatures during the day, at 6, 8 or 10 p. m. the animals may be injected with tuberculin. If the tuberculin, made by the Bureau of Animal Industry, is used, 2 c. c. (one-half fluid drachm) is hypodermically injected into each animal weighing 1,000 lbs.; for bulls and animals weighing over 1,000 lbs. 3 c. c. is injected into each; for yearlings and small two-year olds use one and one-half c. c.; for calves 1 c. c. may be used. If Koch's or Pasteur's tuberculin is used, .25 c. c. is injected into each animal weighing 1,000 lbs.; this must first be diluted with a one per cent. solution of carbolic acid to a strength of ten per cent. This may be conveniently done by pouring 5 c. c. of Koch's or Pastuer's tuberculin into a perfectly clean glass vessel and adding thereto 19 drachms of a one per cent. solution of carbolic acid. (In making the one per cent. carbolic acid solution always use boiled distilled or filtered water.) Each drachm of this solution will then contain a dose for an animal weighing 1,000 lbs.; 1½ drachms for a bull or larger animal; ¾ of a drachm for 1 and 2 year olds and ½ drachm for calves.

The hypodermic syringe should be thoroughly disinfected and have a capacity of one to two drachms. Inject the tuberculin under the skin on the side of the neck or over the shoulder.

The morning following the injection begin to take the temperatures at 6 o'clock and continue at regular periods of every two or three hours until six or eight in the evening.

It is important that a good thermometer be used and that it be held in the rectum, at least five minutes. The six inch Hicks'thermometer is very well adapted to this test. An eight inch thermometer would be better.

If within eight to eighteen hours after the injection of the tuberculin, the temperature rises $1\frac{1}{2}$ or more degrees, Fah., above the normal, for two or more successive readings the reaction is characteristic and the animal is tuberculous. But if the temperature rises at one reading, drops to the normal at the next two readings, then rises at the next reading, this reaction ("double curve") is not characteristic—not positive that the animal is tuberculous. Such an animal should be re-tested in three to six months.

The animals should be kept in their stalls under the same conditions each day during the test; the same quantity of water and food should be given at the same time each day; abrubt changes of temperature in the barn should be avoided. The temperature of cows in heat or in the advanced stages of pregnancy are usually above the normal and they should not be tested at such times. Animals that have been greatly exhausted by excitement or by shipment on cars or boats should be kept isolated in a quiet place for, at least, one week before they are tested.

All animals that give slight or indefinite reactions should be isolated for three to six months and then retested. Sometimes the reaction is accompanied by an acceleration of pulse and respirations and may be followed by a brief attack of diarrhœa and a slight decrease in the flow of milk. But as a rule there are no bad results following the reaction.

THE ACCURACY OF THE TUBERCULIN TEST.

Out of 4,068 animals tested in various parts of the United States by different persons and by the various kinds or forms of tuberculin, 1,137 reacted and 1,118 exhibitted undoubted tuberculous lesions upon post mortem examination; in 19 of these that reacted, the naked eye failed to find any visible tubercular lesions; the microscope was not used and possibly the post mortem examinations were not as thorough and complete as they might have been. Admitting that the 19 cases were not tuberculous this would be less than one error in 500 tests. In Massachusetts, the cattle commissioners have tested over 25,000 cattle and they have found the tuberculin test to fail in one out of every 400 cases tested. No diagnostic method can show a better record, and no other method can detect 75 per cent. of the cases of tuberculosis in 25,000 cattle.

Last year the Inter-National Congress of Veterinarians adopted the following committee report:

"The committee are agreed that tuberculin is a very valuable assistant in the discovery of tuberculosis. The occasional failures for which it is responsible are without practical significance." (Nocard, Bang and Hess.)

The Massachusetts Board of Cattle Commissioners have tested more animals than the United States government and all the other States. They testify as follows:

"First. That tuberculin is a reliable agent for determining tuberculosis in cattle.

"Second. That tuberclin, properly prepared and carefully handled, can have no injurious effects upon healthy cattle.

"Third. That it is the only known means whereby a positive diagnosis can be made in the early stages of the disease."

PREVENTATIVE MEASURES THAT MAY BE ADOPTED BY THE STOCK-OWNER.

The following is taken from Dr. Law's Bulletin:

"If he will the stockowner can extirpate this disease from his herd and thereafter keep the herd from such contamination. The following are the main precautions necessary to this end:

1st. Board up the partitions of the stalls at the front so that no two cows can feed from the same manger nor lick each other.

2d. Keep each animal strictly by its own stall and manger.

3d. When any animal is suspected do not let it use a drinking trough or bucket in common with other animals.

4th. Avoid old milch cows and unthrifty ones or keep them secluded from the rest of the herd.

5th. The following conformation usually indicates a weakness of constitution and a susceptibility to tuberculosis: Head narrow between the horns, sunken eyes, thin and narrow ewe neck, chest small and lacking in both depth and breadth, hollow flanks and tendency to pot belly, a general lack of muscle so that the limbs seem loosely attached to the body, in breeds that show a variety of colors, animals of the lighter shades of brown and yellow. If, however, such animals are of high value for the dairy and can be kept free from infection, they need not be rejected. The finest conformations of short horns, Devons, Holsteins, black or red polled furnish no protection in the presence of the germ.

6th. Don't purchase from a herd in which tuberculosis has appeared, or in which cattle have died or been killed within a year or two. Resort first to tuberculin.

7th. Don't take a cow with a husky or rattling cough; wheezing, hurried breathing; discharge from the nose; fœtid breath; hard bunches under the skin; diseased udder; swollen bones or joints; unthrifty or a tendency to scour or bloat.

8th. Don't purchase from city suburban or swill stables.

9th. Don't add newly purchased cattle to your herd until you have tested them with tuberculin, especially if they are the product of in breeding.

10th. Don't admit strange cattle to house, field or yard with your own; keep them apart until tested with tuberculin.

11th. In case of disease or unthriftiness in your herd put the animal apart and have it examined by a skillful veterinarian.

12th. In case one animal in the herd shows tuberculosis, test the whole herd with tuberculin.

13th. Test in the same manner all animals on the farm (swine, goats, sheep, horses, rabbits, cats, dogs, fowls), that co-habit with the cattle.

14th. Kill all tuberculous animals and boil, burn, dissolve with acids, or bury deeply in a place to which no animals have access.

15th. Disinfect premises thoroughly, also all products of diseased animals and all articles used by them.

16th. Let no consumptive person attend on cattle or other live stock or prepare their food.

17th. Vermin (rats, mice, sparrows) in a building, where tuberculous animals have been, should be exterminated."

HOW TO DISINFECT.

(1). Remove all loose materials from the mangers and stalls and burn such as are of no value.

(2). Thoroughly cleanse the stalls. If the floor be dirt remove at least three inches of it and replace it with fresh dirt after the disinfection.

(3). When the walls, floors, ceilings, etc., become dry, spray them with a corrosive sublimate solution (1 to 1,000), a two per cent. carbolic acid solution, or a two per cent. creolin solution. A fruit tree spray is best for this purpose.

(4). Close the windows and doors and fumigate the barn by burning two or three pounds of sulphur in kettles containing hot coals.

(5). After fumigation open the windows and doors and flood the barn with sunlight and air. It is the dry air and sunlight that disinfects pastures and other outdoor places.

DUTIES OF THE CITIES AND THE STATE.

What should our larger cities and the State do toward exterminating tuberculosis among domestic animals and prevent its extension in the human family?

The cities should pass ordinances requiring all the dairy herds that supply dairy products to the inhabitants of their respective cities to be tested with tuberculin twice annually, and forbid the use of tuberculous cows in such herds. All tuberculous animals should be destroyed and deeply buried or cremated.

The cities should also require that all animals killed for local consumption be tested with tuberculin. Furthermore, each city should have a city meat and milk inspector, whose duty shall be to test the dairy herds and all beef cattle with tuberculin and inspect all carcasses at the slaughter houses and market places.

The inspector should be a graduate veterinarian who has had special instruction in milk and meat inspection. This work could be done under the supervision of the City Board of Health.

The State laws necessary for the control and eradication of tuberculosis among domestic animals and to decrease human mortaliy from tuberculosis, are briefly suggested as follows:

1st. Alabama should provide for a State Veterinarian and several local assistant State Veterinarians. Said veterinarians should investigate all contagious and infectious diseases among domestic animals; inspect or superintend the inspection of all dairy herds and all animals slaughtered for human food not inspected by city or government inspectors. The State Veterinarian could be an *ex officio* member of the State Board of Health, or work under the supervision of that Board. Said veterinarians should receive pay for time spent in actual service for the State.

2d. Public Slaughter Houses should be established and all animals should be slaughtered at these places.

3d. The State should provide means for carrying on this work, and, also, to pay a small indemnity for animals condemned by the State.

This could be done by levying a small special tax upon all the domestic animals of the State. The protection given to both animals and man and the increase in value of the animals would more than compensate the owner of stock for the small tax.

The following are some of the suggestions made by City and State Boards of Health in various parts of the United States for the prevention and eradication of tuberculosis in the human family:

(1) Sterilize all milk, especially that given to infants and children. (See Bulletin 53).

(2) Thoroughly cook all meats before eating them.

(3) Completely sterilize all drinking water.

(4) Never employ consumptive (tuberculous) persons as cooks, house servants, or to milk or care for dairy cattle or to clerk in stores or handle eatables of any kind. Such persons better work in the open fields.

(5) Never visit improperly kept quarters or living rooms of consumptives, and in no case allow children to play with consumptives or visit their rooms.

(6) Consumptive persons should not teach school.

(7) Children or any one having consumption should not attend public schools or public gatherings in closed rooms.

(8) Consumptives should not marry.

(9) A person having consumption should occupy a room by himself; keep it as clean as possible; never use carpets or rugs; never expectorate upon the floor; always expectorate into cuspidors containing a solution of corrosive sublimate, 7 grains to one pint of water, or upon cloths that can be immediately burned.

(10) Consumptives should never kiss any one—especially children or babies. In fact, many physicians regard mouth to mouth kissing as filthy and as occasionally dangerous, because many diseases are thus communicated from the diseased to the healthy.

(11) Buildings, rooms, sleeping cars, berths and beds occupied by consumptives should be completely disinfected before being occupied by healthy persons.

(12) "Do not fail to wash thoroughly the eating utensils of a person who has consumption as soon after eating as possible, using boiling water for the purpose."

(13) A consumptive's unwashed clothing should never be kept, or washed with similar clothing of other persons. Such clothing should be boiled for at least one hour, or otherwise disinfected before being washed or during the process of washing.

(14) "The bowel discharges of consumptive persons with diarrhœa should be caught in a vessel containing corrosive sublimate seven grains to water one pint."

(15) "Do not fail to consult the family physician regarding the social relations of persons suspected of having consumption."

(16) Tuberculous parents can not be too careful lest they transmit the tubercle bacilli to their children. It is best to give sterilized cow's milk to infants having tuberculous mothers.

(17) Physicians and dentists having consumption should not practice or follow their respective professions.

(18.) Dogs and cats should not be permitted in rooms where consumptives live. If so kept, they should not be allowed to play with children or pass into other rooms or houses. Pets suspected of having consumption should be destroyed.

(19.) The State, counties or cities should provide houses for indigent tuberculous persons or public hospitals where consumptives could be isolated and treated.

The above preventative suggestions may seem to be extreme, but some of them are enforced in some of the largest cities in the United States. As soon as the people become aware of the necessity of State, city and government control of tuberculosis in all forms and conditions it is probable that many of these measures and others more severe will be enforced.

It is to be hoped that opportunity will be given this department to test dairy herds in various parts of this State. In fact, we will test a limited number of herds of cattle and attempt to furnish tuberculin free to those who will secure the services of a graduate veterinarian to make the test. Any one desiring further information upon this subject will please address the Station Veterinarian.

BULLETIN No. 68. JANUARY, 1896.

ALABAMA

Agricultural Experiment Station

OF THE

AGRICULTURAL AND MECHANICAL COLLEGE,

AUBURN.

PIG FEEDING EXPERIMENTS.

C. A. CARY, Veterinarian.

MONTGOMERY, ALA.:
THE BROWN PRINTING COMPANY, PRINTERS.
1896.

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☞ The Bulletins of this Station will be sent free to any citizen of the State on application to the Agricultural Experiment Station, Auburn, Alabama.

PIG FEEDING EXPERIMENTS.

BY C. A. CARY.

These feeding tests were made for the purpose of securing a ration—of which cotton seed or cotton seed meal should form one of the principal ingredients—that would not kill pigs and yet be a profitable food. At the same time it was our aim to attempt to determine the reason why cotton seed or cotton seed meal kills pigs; this part of the experiment was not fully carried out, because no pigs were killed by the feeding tests.

These tests must be considered as preliminary; because their number and the repetition of the same tests are insufficient to make fixed or definite feeding laws. In order to obtain definite conclusions, repeated and various tests must be made, and in connection therewith chemical analyses of the ration as fed and of the indigestible parts of the ration must be made.

In these tests we were controlled by limited means and difficulties in obtaining the foods desired at the time when needed. However, it was our intention to use such foods as were in season and most available to the farmer.

FIRST EXPERIMENT. (See table No. I.)

In calculating the cost of the rations in the tests, made from April 28th to August 11, 1894, the following prices were used: Corn, 60 cents per bushel; cow peas, 60 cents per bushel; sweet potatoes, 50 cents per bushel; green oats, green rye and green sorghum, each at 25 cents per cwt.; wheat bran and cotton seed meal at $20 per ton; cotton seed at 12½ cents per bush. Since I could find no digestible per-

FIRST EXPERIMENT. TABLE NO. I.

No. of Pig.	Daily Ration Fed to each Pig.	Weight April 28.	Weight May 5.	Weight May 12.	Weight May 19.	Weight May 26.	Weight June 2.	Weight June 9.	Weight June 16.	Weight June 23.	Weight June 30.	Weight July 7.	Weight July 14.	Weight July 21.	Weight July 28.	Weight Aug. 4.	Weight Aug. 11.	Total gain.	Cost of each lb. of gain.	Nutritive Ratio.
I.	Ground Corn..........1⅓ lbs. Ground Cow Peas.....1⅔ " Sweet Potatoes.....1.2-10 "	112	128	130	131	134	143	149	154	155½	159	165½	172	169	174	183½	185	73	6.1-6ct	1:4.2
II.	Ground Corn..........1⅓ lbs. Ground Cow Peas.....1⅔ " Sweet Potatoes......2.1-10 "	49	57	59½	61¼	66	73	79	82	90	95½	99	104½	101½	112	118	120	71	6⅓	1:4.6
III.	Ground Corn.........1.1-5 lbs. Ground Cow Peas.... 1½ " Green Oats..........1.4-5 "	57¼	62	65	66½	70	75	81½	82	88	92	95¼	95½	97	101	108	109	51¾	7⅓	
IV.	Cow Peas.............1.4-5 lbs. Green Oats..........1.4-5 " Sweet Potatoes......1.4-5 "	42	47	53	53	52	60	67½	67	71	75½	75½	78	79	83½	88	89	47	8.7-12	
V.	Crushed Cotton Seed 1.1-5 lbs. Ground Cow Peas....1.1-5 " Green Oats.........2.1-10 "	41	51¼	50¾	55	56½	61	66½	67	68½	71½	71½	72	75	77½	80	82	41	6.3-5	
VI.	Crushed Cotton Seed 1.2-5 lbs. Ground Cow Peas....1.2-5 " Sweet Potatoes.....2.1-10 "	52	59	62	61½	65	71½	78	77	82	80	85	87½	86	93	92	91	39	7	1:4.2
VII.	Cotton Seed Meal....3-10 lbs. Wheat Bran .... 1½ " Green Oats..........3.3-5 "	44	47	49	48	50½	49	53½	55	54	51½	54½	56	57½	59	58	57	13	23⅝	
VIII.	Cotton Seed Meal.....3-5 lbs. Ground Corn.........1.1-5 " Green Oats..............3 "	57½	66¼	69	70	66	73	77½	78	78	80½	78	81	77½	73	68	67	9½	18.11-12	

centages of sweet potatoes I used those of Irish potatoes in calculating the nutritive ratio in all rations where sweet potatoes were used.

Pig No. I., during the entire feeding period of 105 days, received daily, 1 1-3 lbs. of ground corn; 1 2-3 lbs. of ground cow peas, and 2 1-10 lbs. of sweet potatoes. The nutritive ratio based on the pig weighing 125 lbs. is 1:4.2. The pig gained 73 lbs. at a cost of 6 4-5 cents per lb. It required 7 1-3 lbs. of the ration mixture (just as fed) to make 1 lb. of gain. This ration is too small in quantity; 2 lbs. of corn, 2½ lbs. of cow peas and 3 lbs. of sweet potatoes would make a ration in proportion to the size of the pig.

Pig No. II., from April 28th to August 11th (105 days), received daily 1 1-3 lbs. ground corn; 1 2-3 lbs. of ground cow peas and 2 1-10 lbs. of sweet potatoes. With the average weight of the pig at 84 lbs. the nutritive ratio is 1:4.6. The pig gained 71 lbs. in 105 days at a cost of 7 cents per lb. It required 7½ lbs. of the ration mixture (just as fed) to make 1 lb. of gain. This ration is the same as that for pig No. I.; but this pig being smaller makes the ration slightly less in quantity than that which is required.

Pig No. III., from April 28th to June 2d (35 days), received daily 1 1-5 lbs. of ground corn; 1½ lbs. of ground cow peas; 1 4-5 lbs. of green oats. With the average weight of the pig at 65 lbs., the nutritive ratio is 1:4.7. The cost of 1 lb. of gain is 6 cents. It required 8 2-3 lbs. of the ration mixture to make one pound of gain. The pig gained 17¾ lbs. in 35 days.

Pig No. III., from June 2d to Aug. 11th (70 days), was fed daily 1 3-5 lbs. of ground corn; 1 3-5 of ground cow peas, and 2 2-5 lbs. of green sorghum. With the average weight of the pig at 90 lbs. the nutritive ratio is 1:5.1. The pig gained 34 lbs. at a cost of 8 2-3 cents per lb,, or 11 2-3 lbs. of the ration mixture.

Pig No. IV., from April 28th to June 2d (35 days), received daily 1 4-5 lbs. of cow peas; 1 4-5 lbs. of green oats, and 1 4-5 lbs. of green sorghum. The average weight of the pig at 50 lbs. makes the nutritive ratio 1:3.6. The pig gained 18 lbs. at a cost of 6 1-3 cents per lb., or 10 2-3 pounds of the ration mixture.

Pig No. IV., from June 2 to August 11 (70 days), was fed daily 2 2-5 lbs. of cow peas; 2 4-5 lbs. of green sorghum, and 2 2-5 lbs. of sweet potatoes. The pig gained 29 lbs. at a cost of 10 5-6 cents per lb. or 18 lbs. of the ration mixture. With the average weight of the pig at 75 lbs. the nutritive ratio is 1:3.6.

Pig. No. V., from April 28 to June 2 (35 days), received daily 1 1-5 lbs. of crushed cotton seed; 1 1-5 lbs. of ground cow peas, and 2 1-10 lbs. of green oats. With the pig weighing 50 lbs. the nutritive ratio is 1:3.9. The pig gained 20 lbs. at a cost of 4 1-5 cents per lb. or 7 4-5 lbs. of the ration mixture.

Pig No. V., from June 2 to August 11 (70 days), received daily 2 lbs. of crushed cotton seed; 1 1-5 lbs. of ground cow peas, and 2 1-5 lbs. of green sorghum. The average weight of the pig at 70 lbs. makes the nutritive ratio 1:5. The pig gained 21 lbs. at a cost of 9 cents per lb. or 20 lbs. of the ration mixture.

Pig No. VI., from April 28 to August 11, received daily 1 2-5 lbs. of crushed cotton seed; 1 2-5 lbs. ground cow peas, and 2 1-10 lbs. of sweet potatoes. With the average weight of the pig at 70 lbs. the nutritive ratio is 1:4.2. The pig gained 49 lbs. at a cost of 7 cents per lb. or 10½ lbs. of the ration mixture.

Pig No. VII., from April 28 to June 2, was fed daily 3-10 lbs. of cotton seed meal, 1½ lbs. of wheat bran, and 3 3-5 lbs. of green oats. The average weight of the pig at 46 lbs. makes the nutritive ratio 1:4. The pig gained 5 lbs. at a cost of 21 cents per lb. or 38 lbs. of the ration mixture. On May 30 this pig refused to eat, and was apparently sick.

From June 2 to August 11, Pig No. VII. received daily 3-10 lbs. of cotton seed meal; 1½ lbs. of wheat bran, and 3 3-5 lbs. of green sorghum. The average weight of the pig at 50 lbs. makes the nutritive ratio 1:4.5. The pig gained

8 lbs. at a cost of 26¼ cents per pound or 47¼ lbs. of the ration mixture. On August 4 this pig almost entirely refused to eat and grew worse until August 11, when the test closed and the pig was turned out to pasture and fed corn; upon this ration it made an average fat hog in 4 months.

Pig No. VIII., from April 28 to June 2, received daily 3-5 lb. of cotton seed meal; 1 1-5 lbs. of ground corn and 3 lbs. green oats. The average weight of the pig at 50 lbs. makes the nutritive ratio 1:4.7. In 35 days the pig gained 15½ lbs. at a cost of 6 1-6 cents per lb., or 10 4-5 lbs. of the ration mixture. On May 30 this pig refused to eat, but gradually improved until it manifested no signs of illness.

Pig No. VIII., from June 2 to Aug. 11, received daily 3-5 lb. of cotton seed meal; 1 1-5 lbs. of ground corn and 3 lbs. of green sorghum. The average weight of the pig at 70 lbs. makes the nutritive ratio 1:4.5. In 70 days the pig lost 6 lbs. This ration should have contained 1 lb. of cotton seed meal, 2½ lbs. of corn and 4 lbs. green sorghum. On July 28 and August 4 this pig refused food. It was evidently sick. It gradually grew worse until August 11 when the experiment was closed. Very probably it would have died had it not been turned out and given other food. This pig soon recovered after being turned into a pasture and fed corn. In fact, it became a fine "porker" in 4 months after the close of the experiment.

SECOND EXPERIMENT. (See Table No. II.)

In determining the cost of the food in the rations used in the feeding tests, made from March 30 to June 29, 1895, the same prices were used as for the test in 1894.

The green rye gave out on April 27, and it was our intention to follow the green rye with green oats or green sorghum; but owing to unavoidable conditions those foods could not be secured.

Pig No. I., from March 30 to June 29, was fed daily 3½ lbs. of corn. In 91 days the pig gained 25 lbs. at a cost of 13 3-5

SECOND EXPERIMENT. TABLE NO. II.

No. of Pig.	Daily Ration Fed to each Pig.	Weight March 30.	Weight April 1.	Weight April 6.	Weight April 13.	Weight April 20.	Weight April 27.	Weight May 4.	Weight May 11.	Weight May 18.	Weight May 25.	Weight June 1.	Weight June 8.	Weight June 15.	Weight June 22.	Weight June 29.	Total gain.	Cost of each lb. of gain.	Nutritive Ratio.
I.	Corn.................3½ lbs.	67½	60	60	68	70	71	75	78	79	81	81½	83	87	90	92½	25	13.3-5	1:10.3
II.	Ground Corn..........2½ lbs Crushed Cotton Seed..3½ "	47	46	45½	47	45	46½	50	51	53	53½	53½	54½	56	58	58½	11½	32	1:8
III.	Ground Corn..........2½ lbs. Crushed Cotton Seed..3½ "	60	60	60	60	55	55½	64	63	65	66	67	69	71	81	83	23	16	1:7.8
IV.	Ground Cow Peas.....2½ lbs. Crushed Cotton Seed..4 "	78	73	71½	75	79½	86	96	96	97	97	97½	101	103	106	107½	29½	12½	1:4.4
V.	Crushed Cotton Seed..4½ lbs.	71	68½	70½	65	62	60	55	53	51	51	51½	53	55	56½	58	lost 13		1:6.7
VI.	Crushed Cotton Seed..3½ lbs. Green Rye...........3½ "	70	69½	68	63	63	63½	70	69	67	67½	67½	69	71	73	76	6	7¾	
VII.	Crushed Cotton Seed....3 lbs. Ground Cow Peas.......3 " Green Rye........... 3½ "	65½	64	70	72	72	73	81	81	82	83½	83	83½	84	87	88½	23	14½	
VIII.	Crushed Cotton Seed....3 lbs. Ground Cow Peas.......3 " Green Rye...........3½ "			47½	53	51	51½	60	61	61	61½	62	63½	65	66		19½	19⅓	
IX.	Crushed Cotton Seed....3 lbs. Ground Corn ....3 " Green Rye............3½ "	58	55½	61	62	64	65	68	70	70	71	71	73	73½	75	77	19	38⅓	
X.	Wheat Bran ....3 lbs. Green Rye.............4 "	60	66½	71	71	69	70	73	74	73	73½	73	74	76	77	79	19	19.2-5	

cents per lb., or $12\frac{3}{4}$ lbs. of corn. The nutritive ratio is 1:10.3. This pig was of common stock.

Pig II., from March 30 to June 29, received daily $2\frac{1}{2}$ lbs. of ground corn, and and $3\frac{1}{2}$ lbs. of crushed cotton seed. In 91 days it gained $11\frac{1}{2}$ lbs. at a cost of 32 cents per lb. or 47 lbs. of the ration mixture. With the average weight of the pig at 52 lbs., the nutritive ratio is 1:8. This ration contains too much cotton seed. Corn $3\frac{1}{2}$ lbs. and cotton seed $1\frac{1}{2}$ lbs. would make a better ration. This pig was from common stock. It was turned into a pasture at the close of the test and in the fall was fed corn. About Jan. 1, 1896, it weighed 216 lbs.

Pig No. III., from March 30 to June 29, received daily $2\frac{1}{2}$ lbs. of ground corn and $3\frac{1}{2}$ lbs. of crushed cotton seed. With the average weight of the pig at 70 lbs., the nutritive ratio is 1: 7.8. The pig gained 23 lbs. at a cost of 11 cents per lb., or $23\frac{2}{3}$ lbs. of the ration mixture. The gain is better than that of pig No. II.; yet there is too much cotton seed in the ration. This pig was turned into a pasture at the close of the test and in the fall it was fed corn. It was of common stock, and weighed about Jan. 1, 1896, 164 lbs.

Pig No. IV., from March 30 to June 29, received daily $2\frac{1}{2}$ lbs, of ground cow-peas and 4 lbs. of crushed cotton seed. The average weight of the pig at 93 lbs. makes the nutritive ratio 1:4.4. In 91 days the pig gained $29\frac{1}{2}$ lbs. at a cost of $12\frac{1}{2}$ cents per lb. or 20 lbs. of the ration mixture. Ground cow-peas 3 lbs. and crushed cotton seed 2 lbs. would be a better ration for a pig of the same weight. This pig was afterwards fed as No. III., and weighed about Jan. 1, 1896, 170 lbs.

Pig No. V., from March 30 to June 29, received daily $4\frac{1}{2}$ lbs. of crushed cotton seed. The nutritive ratio is 1:6.7. In 91 days the pig lost 13 lbs. This pig apparently ate enough to prevent starvation. Yet it grew in frame work (bone, etc.), and when turned out to pasture and given corn, after the close of the test, made a hog that weighed 153 lbs. about January 1st, 1896.

Pig No. VI., from March 30 to April 27, received daily $3\frac{1}{2}$ lbs. of crushed cotton seed and $3\frac{1}{2}$ lbs. of green rye. The average weight of the pig at 67 lbs. makes the nutritive ratio 1:6.7. In 28 days the pig lost 6 lbs. Crushed cotton seed 2 lbs. and green rye 5 lbs. would have been a better ration for this pig.

Pig No. VI, from April 27 to June 29, received daily $3\frac{1}{2}$ lbs. of crushed cotton seed. The nutritive ratio is 1:6.7. The pig gained $13\frac{1}{2}$ lbs. at a cost of 5.9 cents per lb., or $13\frac{2}{3}$ lbs. of crushed cotton seed. The pig did not eat all the ration at any time. It ate sufficient to maintain life and increase the size of the frame work of the body. It was not in the best of health all the time, but never exhibited signs of serious illness. After the close of the feeding test this pig was treated as pig No. III. It weighed 220 lbs. January 1, 1896. It was of common stock.

Pig No. VII, from March 30 to April 27, received daily 3 lbs. of crushed cotton seed; 3 lbs. of ground cow peas, and $3\frac{1}{2}$ lbs. of green rye. With the average weight of the pig at 70 lbs., the nutritive ratio is 1:3.8. The pig gained $7\frac{1}{2}$ lbs. at a cost of 18 4-5 cents per lb., or 35 lbs. of the ration mixture. Crushed cotton seed $1\frac{1}{2}$ lbs.; ground cow peas 2 lbs., and green rye 4 lbs. would make a better ration.

Pig No. VII, from April 27 to June 29, received daily 3 lbs. of crushed cotton seed and 3 lbs. of ground cow peas. With the average weight of the pig at 80 lbs., the nutritive ratio is 1:3.7. The pig gained $15\frac{1}{2}$ lbs., at a cost of $14\frac{1}{2}$ cents per lb., or $20\frac{1}{2}$ lbs., of the ration mixture. With the same after treatment as No. III, the pig weighed 170 lbs. January 1, 1896. This was an Essex pig.

Pig No. VIII, from April 6 to April 27, received 3 lbs. of crushed cotton seed; 3 lbs. of ground cow peas, and $3\frac{1}{2}$ lbs. of green rye. With the average weight of the pig at 50 lbs. the nutritive ratio is 1:3.9. In 21 days the pig gained 4 lbs. at a cost of 25 3-5 cents per lb., or 49.9 lbs. of the ration mixture. Cotton seed 1 lb.; cow peas 2 lbs., and green rye 5 lbs. would make a better ration.

Pig No. VIII, from April 27 to June 22, received daily 3 lbs. of crushed cotton seed and 3 lbs. of ground cow peas. With the average weight at 58 lbs., the nutritive ratio is 1:3.6. The pig gained 15½ lbs. at a cost of 13 1-6 cents per lb. or 17¾ lbs. of the ration mixture. Cotton seed 1 lb. and cow peas 2 lbs. would make a better ration. On June 22 this pig accidentally escaped from the pen and was killed by being chased too long in the heat of the day.

Pig No. IX, from March 30 to April 27, received daily 3 lbs. of crushed cotton seed; 3 lbs. of ground corn; 3½ lbs. of green rye. With the average weight of the pig at 60 lbs. the nutritive ratio is 1:7.4. The pig gained 7 lbs. at a cost of 20 2-7 cents per lb. or 38 lbs. of the ration mixture. Crushed cotton seed 1 lb.; ground corn 2 lbs., and green rye 5 lbs. would have been a better ration.

Pig No. IX, from April 27 to June 29, received 3 lbs. of crushed cotton seed and 3 lbs. of ground corn. With the average weight of the pig at 70 lbs., the nutritive ratio is 1:8.3. The pig gained 12 lbs. at a cost of 23 cents per lb., or 31½ lbs. of the ration mixture. Corn 3 lbs. and cotton seed 1 lb.; or corn 3 lbs. and cotton seed 2 lbs. would have been better. This Essex pig was treated afterwards as No. III and weighed 186, January 1, 1896.

Pig No. X, from March 30 to April 27 (28 days), received daily 3 lbs. of wheat bran and 4 lbs. of green rye. With the average weight of the pig at 65 lbs., the nutritive ratio is 1:4.7. The pig gained 10 lbs. at a cost of 11 1-10 cents per lb., or 19 3-5 lbs. of the ration mixture.

Pig No. X, from April 27 to June 29, received daily 3 lbs. of wheat bran which has a nutritive ratio of 1:4.2. The pig gained 9 lbs. at a cost of 21 cents per lb., or 21 lbs. of the ration mixture. Bran and rye are apparently better and less expensive than bran alone. This Essex pig with the same after treatment as No. III, weighed 203, January 14, 1895.

THIRD EXPERIMENT. (See Table III.)

In determining the cost of the rations in these tests, cotton seed was rated at 12½ cents per bushel, separated milk at 5 cents per gallon and whole milk at 20 cents per gallon. It was our aim to make the entire test with separated milk and cotton seed, but owing to unavoidable circumstances whole milk was substituted for separated milk. It is very evident that whole milk at 20 cents per gallon can not be fed to pigs with profit.

At two periods during the test these pigs were slightly affected, but at no time were they seriously ill.

Pig No. I, from July 15 to September 2, received daily 6 lbs. of separated milk and 3½ lbs. of crushed cotton seed. With the average weight of the pig at 108 lbs., the nutritive ratio is 1:5.1. The pig gained 11½ lbs. at a cost of 21⅔ cents per lb. On August 15 this pig did not eat cotton seed and was evidently somewhat sick.

Pig No. I, from September 2 to October 21 (49 days), received daily 6 lbs. of whole milk and 3½ lbs. of crushed cotton seed. With the average weight of the pig at 126 lbs., the nutritive ratio is 1:6. The pig gained 19 lbs. at a cost 41 1-3 cents per lb. On September 19 this pig failed to eat the cotton seed and was slightly ill.

Pig No. II, from July 15 to September 2, received daily 6 lbs. of separated milk and 3½ lbs. of crushed cotton seed. With the average weight of the pig at 90 lbs., the nutritive ratio is 1:5.8. The pig gained 12½ lbs. in 49 days at a cost of 20 cents per lb. On August 15 this pig ate very little cotton seed.

Pig No. II, from September 2 to October 21, received daily 6 lbs. of whole milk and 3½ lbs. of crushed cotton seed. With the average weight of the pig at 100 lbs., the nutritive ratio is 1:5.7. The pig gained 8 lbs. in 49 days at a cost of 98 cents per lb. On September 19th, this pig refused to eat cotton seed.

THIRD EXPERIMENT. TABLE NO. III.

No. of Pig.	Daily Ration Fed to each Pig.	Weight July 15.	Weight July 22.	Weight July 29.	Weight Aug. 5.	Weight Aug. 12.	Weight Aug. 19.	Weight Aug. 26.	Weight Sept. 2.	Weight Sept. 9.	Weight Sept. 16.	Weight Sept, 23.	Weight Sept. 30.	Weight Oct. 7.	Weight Oct. 14.	Weight Oct. 21.	Total gain.	Cost of 1 lb. of gain.	Nutritive Ratio.
I.	Crushed Cotton Seed. . 3½ lbs. "Separated" Milk. . . . . . . 6 "	102	104	108	111	114	114½	116	113½	114	117½	123	129	136½	132	132½	30½	31½	
II.	Crushed Cotton Seed. . 3½ lbs. Separated Milk. . . . . 6 lbs.	84	84	87½	91	94	94½	96	96½	95	98	103	102½	105	103	104½	20½	59	

Tests at Other Stations.

According to feeding tests made by Curtis at the Texas Experiment Station, raw cotton seed, roasted cotton seed or boiled cotton seed will kill pigs in about six weeks after beginning to feed them. After two years of duplicate tests Curtis states that cotton seed is an unprofitable hog food, because hogs will not eat it. (See Bulletin No. 21, Texas Station.)

The Kansas Station gives the following results: "Cotton seed meal proved poisonous to pigs even though fed in small quantities. A mixture of one-fourth cotton seed meal was as disastrous as equal parts of these feeds. The pigs died in from three to eight weeks after being put on this feed, the larger ones holding out the longest. *Post mortem* examinations revealed in all cases severe inflammation and congestion of the intestines, lungs and heart. But cotton seed meal produces very rapid gains in both pigs and large hogs, and if the feed is changed before symptons of disease appear, hogs can be fed cotton seed meal for a short time with the best results, and this experiment would indicate without subsequent deleterious effects." (See Bulletin 53, Kansas Station.)

Why cotton seed or *cotton seed meal kills pigs* and *hogs* is not definitely known. At present the opinion most prevalent is that it is a result of the condition of the cotton seed or cotton seed meal. It is certain that cotton seed can undergo decomposition—possibly from various forms of germs. These germs when taken into the alimentary canal for some time, may, invade the tissues and produce the severe inflammation of the intestines and the peritoneum. This process may be explained in another way. The germs by their action on the cotton seed or the tissues may develop a poisonous product (ptomaine) which causes the inflammation and death. In either case it is the condition of the cotton seed or cotton seed meal that causes the death. Some one may ask: How is it with the roasted or boiled cotton seed where the germs are destroyed by the heat? The heat may not destroy the poisonous product, and in many instances the cotton seed is left in the pen and troughs of the pen long enough to begin to decompose before they are eaten. I am of the opinion that boiled or roasted cotton seed will not kill pigs if the seed are not allowed to begin to decompose in the pen before they are eaten. In other words the pen should be cleaned out as soon as the pig stops eating, after each time of feeding. Some have asserted that the lint on the cotton seed formed concretions or impactions in some part of the alimentary canal. I have never observed this and have only heard it asserted by persons whose ability to judge of such conditions was questionable.

Furthermore, some believe that the pig, when fed on nothing but cotton seed or cotton seed meal, starves to death. This may occur, but it failed to take place in the limited number of tests we have made.

From the tests that have been made here, it is very probable that combining crushed cotton seed with a liberal quantity of green rye, green oats, green sorghum, sweet potatoes or turnips, it can be fed to pigs and hogs without great danger, providing the cotton seed is not mouldy or decomposing or allowed to partially decay in the pen. It is also probable that crushed cotton seed can be combined with skimmed or separated milk.

Furthermore, it is quite evident that, after a pig reaches the weight of 50 lbs. cotton seed or cotton seed meal in combination with corn, or cow-peas, can be made a profitable pig ration up to the time of the premonitory symptoms of disease. As a rule this period varies between three and six weeks. The premonitory signs of disease, are weakness, staggering, fever, loss of appetite and few, if any, movements. When these symptoms appear, the pig should be turned into a pasture or the food should be changed to bran slops and corn or other healthy foods.

The details of these experiments were carried out by Mr. T. U. Culver, Superintendent of the Station Farm. Much credit is due him for the results obtained.

BULLETIN No. 69. FEBRUARY, 1896.

ALABAMA

Agricultural Experiment Station

OF THE

AGRICULTURAL AND MECHANICAL COLLEGE,

AUBURN.

TREATMENT OF SOME FUNGOUS DISEASES.

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MONTGOMERY, ALA.:
THE BROWN PRINTING COMPANY, PRINTERS.
1896.

☞ The Bulletins of this Station will be sent free to any citizen of the State on application to the Agricultural Experiment Station, Auburn, Alabama.

TREATMENT OF SOME FUNGOUS DISEASES

—BY—

L. M. UNDERWOOD AND F. S. EARLE.

Much has been written in recent years on plant diseases and their treatment. A division of the Department of Agriculture at Washington has been created for the special purpose of studying them, and the entire staff of ten or twelve trained botanists devote their whole time to the work. The various State Experiment Stations are nearly all working in the same field, and publications from these various sources are rapidly accumulating. It is the purpose of the following pages to present in compact and convenient form to the farmers and fruit growers of Alabama a statement of our present knowledge concerning some of the more common and destructive diseases of our more important crops. It is in no sense a contribution to scientific literature, but a compilation intended as a ready reference for practical farmers. Bulletin No. 45 issued from this station, serves a somewhat similar purpose for injurious insects, but so far this station has published no general directions for the treatment of plant diseases caused by fungi. Only the more important diseases, and those likely to prove troublesome in this State will be discussed under the crops which they affect. It is first desirable to give a brief discussion of the nature of fungi, and their relations to other plants, since many hold very erroneous ideas regarding them.

THE NATURE OF FUNGI.

Among the lower forms of vegetation none that are relatively so conspicuous and common are popularly so little understood as the fungi. This arises from the fact that the group contains a vast number of kinds that, so far as form and habit are concerned, are utterly diverse from each other. It is not easy for instance to see any striking resemblance between an ordinary mushroom or toadstool, and the rust that grows on our grain, or the smut that disfigures our corn. There is little outward resemblance between the giant puff-ball, and the leaf spot of cotton or strawberry, yet all these forms come under the same designation as fungi.

A second source of popular confusion has arisen from the more or less one-sided way in which the subject has been treated by popular or even scientific writers. Certain forms of fungi injurious to cultivated plants have been written about, and naturally their ravages have been made prominent. In this way the farmer has often been led to believe that all fungi are enemies to be combatted with Bordeaux mixture, and all sorts of spraying machines. A comprehensive view of the group is rarely presented, and it is desirable in this as in every other subject that we form some definite notion of the subject in its general relations in order that our ideas may not be one-sided or distorted.

The group of plants known collectively as fungi—for fungi are just as truly plants as any other form of vegetation—are associated together and distinguished from other low forms of vegetation by a simple physiological character, which can be easily recognized, notwithstanding the fact that it is a negative one. This characteristic is the inability to live on mineral or inorganic matter. Ordinary green plants, high or low, have the power to take the gaseous constituents of the atmosphere, together with water and certain mineral salts found in the soil, and through the agency of sunlight transform them into starch, sugars, and other more highly organized forms of food stuffs. This they are enabled to do by virtue of the possession of a green substance, that which gives the color to ordinary vegetation. This substance is called *chlorophyll* (literally leaf-green). It is this function possessed by green plants that serves to distinguish them from all other living things. The fungi having no chlorophyll in their composition, are unable to perform this function, and hence must depend for their food supply on some form of matter already organized. Some live on decaying matter, and are known as saprophytes: such are the toadstools and puffballs that grow about muck piles, or decaying stumps, or buried roots, and the bracket-fungi on dead or fallen tree trunks; such also are the moulds that grow on bread, preserved fruits, and other forms of food; such also is the microscopic yeast plant that causes alcoholic fermentation, and is used alike in the manufacture of bread and beer; such are many of the still more minute bacteria that are the cause of decay and putrefaction. Other fungi secure their food from the living tissues of plants and animals, and are called parasitic fungi; a few even are parasitic on other fungi.

Fungi are unable to organize inorganic food, because they contain no chlorophyll. Whatever may be their color, they may be characterized as not green.* The more ordinary color of fungi is white, but black, brown, blue, yellow and various shades of red are not uncommon.

Since it happens that not all parasitic plants are fungi, we should limit the definition of the group still further by the statement that fungi reproduce their kind by microscopic spores, and never by seeds.

Spores Different from Seeds.

As the distinction between seed and spore is not well understood, it may be well to contrast them. If we cut open the seed of a squash, apple or bean, we will find that the in-

*Certain apparent exceptions to this rule are familiar in the ordinary green mould, the green fungus of decaying wood which stains fallen timber, and a few others. In all these cases the green color is due to other substances than chlorophyll, and in fact the shade of green presented is different from the familiar green of ordinary vegetation.

terior consists of two halves, connected at one point by a short sprout-like body. Between these two halves, especially in seeds that have commenced to swell, we can see even with the unaided eye, the young shoot that is destined to become the new plant. These two halves of the seed contain a rich supply of nourishment, and as the seed sprouts, they become the first leaves of the young plant, and supply its food until it has developed its roots and is able to obtain nourishment from the soil. This structure which forms the entire contents of the hull in the cases mentioned, is called an embryo, as it is really nothing but a young plant. It is the possession of this embryo that distinguishes a seed as such. In other seeds like the morning glory and the persimmon, the embryo instead of filling the entire hull, lies embedded in a mass of nutritive substance. This embryo can be seen beautifully in the seed of a persimmon that has been split flatwise after a little soaking. A seed then is a reproductive body of sufficient size to be easily seen, possessing a complex structure, and containing an embryo which on sprouting becomes a young seedling.

Now how does a spore differ from a seed? In the first place a spore is so small that it cannot usually be seen singly with the unaided eye. If we press a puff-ball, a small cloud of dust-like particles issues from it. Every particle of this dust-like matter is a spore and the mass of them issuing from the ball becomes visible because of the immense numbers. These spores are so small that it would take about 5,000 of them laid side by side to make a line an inch long, and a puff-ball an inch in diameter would contain many millions of them. And yet each of these spores, consisting of a mere skin containing a minute drop of a glairy fluid, is capable, if placed under suitable conditions of heat and moisture, of germinating into a new fungus like the one that produced the spore in the first place. Another instance of spores that are visible in the mass is seen in the ordinary smut of corn or oats. The black smutted heads of oats are made up when mature of a mass of black dust that easily soils the fingers. Each particle of this black smut is a spore and each one that reaches a suitable place for sprouting is able to smut a head of grain the following year. Still other spores can be seen in the rusty or black lines that appear on the stems of various small grains. These lines are simply the masses of spores of the parasitic fungus breaking through the surface of their host plant in order to spread the rust to other plants or to hold the fungus over the winter to attack the young grain of the following season.

A spore then is a reproductive body that has the same office as a seed, but differs from it in its microscopic size and simple structure. When the spore germinates it pushes out a minute germ tube which becomes what we call a *hypha.* The spores of fungi have a definite form when viewed through a microscope. Some have characteristic shapes so that the particular group to which they belong can be easily recognized. In others the shape is less characteristic, but the form of spore produced by any one species is as constant for that species as the shape of the seed produced by any of the higher plants.

Definition of a Fungus.

A Fungus then is (1) A plant that has as definite a life history and mode of growth as a cotton plant, an oak or any other form of vegetation. (2) Is devoid of chlorophyll or the ordinary green color of vegetation. (3) Possesses a simple structure, and (4) Reproduces itself by means of spores.

In structure, fungi vary as widely as do the higher forms of vegetation. Some of the simplest, like the yeast-plant, consist of a minute drop of semi-fluid substance (*protoplasm*) surrounded by a delicate covering known as the cell wall, the whole not over one three-thousandth of an inch in diameter. More complex forms like the moulds, form delicate thread-like structures (*hyphæ*) which frequently interlace into a tangled, matted or more or less felty mass (*mycelium*). Some of the larger forms are gelatinous, some are fleshy, some leathery, corky or even firm and woody, but in each case this structure is developed by some modification of the simple interlacing mycelium. There are none of the highly developed forms of tissues seen in higher plants, the structure of fungi being always simple.

Not all fungi are injurious, many are harmless, some are beneficial and even a necessity to our existence. Of the larger fleshy forms a considerable number are valuable food plants as nutritious as fish, oysters or beef, and there is no reason why they should not form as common an article of food among us as they do in the countries of Europe. The fact that we import large quantities of mushrooms from Europe which could be easily produced in this country and of a much better quality than the imported article is suggestive of one of the undeveloped resources of industry and cultivation that is lying dormant in our midst. It is, however, the parasitic forms of fungi, that at present concern us most.

Classes of Parasitic Fungi.

Parasitic fungi may be conveniently classified in three groups:

(1) Internal free parasites floating or swimming in the cell sap of plants and absorbing their vitality. Such a parasite is the one that produces pear blight and such are the parasites that assist in producing the various rots of different garden vegetables.

(2) External fixed parasites, forming a cobwebby growth of mycelium on the surface of leaves or fruits and drawing nourishment from the plant by means of suckers. Such are the powdery mildew of the grape and those of a similar nature found on many other plants.

(3) Internal fixed parasites, growing entirely within their host-plant, sapping its nourishment, and only appearing at the surface when ready to reproduce by means of spores. This group includes by far the greater number of species of parasitic fungi that infest cultivated plants and include the rusts, smuts, downy mildew of the grape, black rot, the ripe rot of apples and other fruits, etc., etc.

Other Causes of Plant Diseases.

Not all the diseases of plants are produced by parasitic fungi. Some diseases are physiological, due to drainage, the character of the nutrition or the lack of it, and to many other causes not well understood. Other diseases are caused by insects of various kinds or by the ravages of other and often more minute forms of animal life.

In order to treat a disease succesfully we must know its cause and if it is due to a parasitic organism we must know its life-history, its mode of entrance to its host and its method and time of reproducing itself, in order that we may attack it at its weakest point, prevent its entrance to the host, and prevent its spread by its many methods of reproduction.

Not all diseases that are called by the same general name are produced by the same cause. For instance the term "rust" as applied in the State of Alabama to a disease of cotton has nothing in common with the rust that appears on the cereals. In fact the term "cotton rust" is a loose general term that really means about as much as "cotton disease" for it is indiscriminately applied to several distinct diseases, some of which are physiological and some of which are caused by various parasitic fungi. Again the term *blight* has a very loose popular usage and has been the source of much confusion. There is no such thing as a general blight affecting various plants. The blight of the pear and apple is due to a very definite organism, concerning which much is already known. The blights of other plants, notably various garden vegetables, is due to other entirely different organisms whose character is far from being well known.

Root galls, or swellings on the roots of plants, are due to various causes and must be made a separate study before the cause can be determined in any given case. In the grape they may be due to the work of various insects, or produced by minute thread worms (*nematodes*); in many garden vegetables and field crops they may be due entirely to the latter cause; in the cabbage and other members of the mustard family they are due to an internal plant parasite of a low order that produces the disease known as "club foot," which externally often resembles the deformities produced by the nematodes. In several leguminous plants root galls are produced by an internal parasite, but in this case instead of forming a disease, the parasite is rather beneficial than otherwise as it serves to assist the host in collecting nitrogen. In still other cases the causes of root galls are entirely unknown.

Sufficient has been said to indicate that too careful a study of the conditions and causes of plant diseases can not be made, and that we should be careful in too much hasty generalization. In order to furnish the farmers of Alabama some information of the most common fungous diseases that are likely to be met with in the State, and to furnish simple directions for treating them as approved by practice here and elsewhere, we give, after a few formulas for preparing fungicides, a classified list of fungous diseases, giving symptoms where not well known and method and time of treatment.

FORMULAS FOR FUNGICIDES.

As a rule fungicides are applied as a preventive rather than a cure. Since it has been found that the spores of fungi will not germinaie in the presence of salts of copper, various preparations have been applied which involve the salts of that metal in solution. The following will be found the most efficient for general use, but modifications will be noted for special cases later:

SULPHATE OF COPPER.

Formed by dissolving two pounds of copper sulphate (bluestone) in fifty gallons of water. In dissolving the bluestone it should be placed in a small piece of gunny sack and suspended near the top of the barrel as it will dissolve too slowly otherwise. This can only be used on vines or trees before the buds have commenced to swell.

Bordeaux Mixture.

As commonly applied, it is formed of six pounds of copper sulphate (bluestone) and four to six pounds of quick lime dissolved in fifty gallons of water. The bluestone should be dissolved as in the preceding formula. The mixture must be thoroughly stirred while using.

Ammoniacal Carbonate of Copper.

This is made by dissolving four ounces of carbonate of copper in two quarts of ammonia and adding the solution to fifty gallons of water.

Copper Acetate.

Dissolve four ounces of copper acetate in fifty gallons of water.

Combination of Insecticides and Fungicides.

Four ounces of Paris green or London purple may be added to fifty gallons of Bordeaux mixture when it is desirable to spray for both fungi and insect pests.

Method of Application.

A large number of forms of spraying apparatus are on the market and the amount of work of this kind to be done and the kind of plants to be sprayed will determine the character of the apparatus to be used. A nozzle that produces a fine mist-like spray is always desirable and in some cases a necessity.

DISEASES OF CULTIVATED PLANTS.

CORN.

Fortunately this great staple suffers from comparatively few fungous diseases. The only one to be mentioned here is the smut (*Ustilago maydis*). The appearance of this disease is too well known to need description. The unsightly pustular masses filled with black powder are only the fruiting portion of the fungus. They usually occur on the ears but are occasionally seen on the tassels or on the leaves. Under the microscope each particle of the black smutty powder is found to be a minute brown ball-like spore covered with little spines. The mycelium or vegetative portion of the fungus grows entirely within the corn plant. It consists of delicate colorless threads which penetrate the tissues of the corn plant and draw its nourishment from it. They cannot be seen without the use of a microscope.

Corn smut is widely distributed. Probably no field can be found entirely free from it. Farmers are so accustomed to seeing it that but little thought is given to the loss it causes. It is true that in individual cases this is not great; it does not sweep through a field destroying an entire crop as is the case with some diseases, but the aggregate loss it occasions is quite large; cattle are sometimes killed by pasturing in badly smutted stalk fields.

The smuts of the small grains can now be quite successfully controlled by treating the seed. So far no treatment has been found that is of the least use for corn smut. It is sometimes recommended to go through the fields and remove the diseased stalks as soon as they can be detected before the spores ripen. If this should be done persistently by all the farmers in a neighborhood, it would doubtless materially reduce the loss from the disease in subsequent crops. At present no other remedy can be suggested.

OATS.

OAT SMUT.—Like corn smut this is a widely occurring disease. It is caused by a similar fungus (*Ustilago avenae*). The spore masses are much smaller than in corn smut, and the single spores are slightly smaller and smoother. The smutted heads of course go through the thresher with the rest, so that the dusty smut spores are well mixed with the grain. When such smutty seed is planted the following spring, the smut spore germinates just as the oats are sprouting, and its delicate germ tube is able to pierce the soft tissue of the young oat sprout. The mycelium of the fungus now grows with the growing oat plant, and it makes no outward sign until the heads are formed, when instead of oats they are found to contain only the worthless smut spores. Fortunately the fungus cannot damage the oat plant after it has had time to harden. Many careful experiments show that infection only takes place through the freshly sprouting seed. For this reason any treatment that will thoroughly disinfect the seed by killing the smut spores adhering to it, will effectually protect the crop. The importance of treatment will be apparent when we know that the average loss in untreated fields is over ten per cent. of the entire crop. Treating the seed with copper sulphate (blue stone), has long been known as a preventitive of smut. It is still often recommended for wheat, but for oats either of the two following treatments are preferred.*

Potassium sulphide treatment.—Dissolve one and one-half pounds of potassium sulphide (liver of sulphur) in 25 gallons of water in a barrel. Add three bushels of seed oats, stir thoroughly at intervals to insure thorough wetting of all the grain, and allow to stand for twenty-four hours. Strain off the liquid and spread the oats to dry. The solution will answer for three lots of seed. Of course a tank should be used for treating large quantities.

Hot water treatment.—Provide two kettles, tubs or barrels holding at least twenty gallons each. Fill one with hot water at 110 to 120 degrees, the other with scalding water at 132 to 133 degrees. Have plenty of boiling water and cold water at hand with which to maintain these temperatures. Put one-half bushel of oats in a coarse loosely woven gunny sack. Plunge it in the vessel of warm water and lift it up and down several times to

*For a full discussion of this subject, see "The grain smuts; their causes and prevention," by W. T. Swingle, in the Yearbook of the Department of Agriculture for 1894.

thoroughly wet and warm the grain. Allow it to drain a moment, and then transfer it to the hot water. Let it remain in the hot water for ten minutes, agitating freely, then remove and spread the grain to dry. The success of the treatment will depend entirely on keeping the hot water as nearly as possible at 133 degrees. If the temperature rises above 135 degrees, it may injure the seed, and if it falls below 130 degrees, some of the smut spores will not be killed. The wet seed should be spread out two or three inches deep, and be shoveled over frequently until quite dry. This is not necessary if it is to be sown immediately by hand.

An important consideration in favor of these two treatments of seed oats, is that the seed germinates quicker, and the yield is considerably increased aside from the gain in preventing smut. The copper sulphate treatment retards germination and does not increase the yield.

OAT RUST.—This disease is produced by *Puccinia coronata*,* quite a different fungus from those causing smut. The mycelium in this case also consists of colorless threads buried within the oat tissues, but instead of extending throughout the plant as with the smut, they are confined to rather small areas beneath the spots covered by the reddish or rust-colored powder from which the disease takes its name. This reddish powder consists of the spores of the fungus. Under the microscope they are seen to be three or four times as large as the smut spores. They are oval in shape, and of a light yellow color. They germinate quickly under proper conditions of heat and moisture, and their germ tubes are able to penetrate the oat leaves, where they soon develop new spots of rust. The disease is thus enabled to spread very rapidly when weather conditions are favorable. This disease does not attack the grain itself, as does the smut. If only a little is present, the injury is slight, but when abundant, it de-

**Puccinia graminis* and *P. rubigo-vera* also occur on oats, but the above remarks will apply equally well to these species.

stroys so much of the leaf surface, and appropriates so much of the nutriment of the plant, that the grain is light and poor in quality, and often greatly deficient in quantity.

A little later in the season a second kind of spore is developed on the rust mycelium. These form short black lines on the leaves and stems. They are called winter spores, because their office is to carry the fungus through the winter. They are long and narrow, and are divided by a cross partition into two cells. They are darker colored, and the cell wall is thicker than in the red or summer spores. This fungus is a good example of the true rusts (*Uredineae*). They form a large group and include some of our most troublesome diseases. As a rule they do not yield readily to treatment. No practical remedy has been found for the oat rust. Some varieties of oats, however, suffer less from the disease than others. In this State it is usually only the resistant or so called "rust proof" varieties that are planted. Something moreover can be done by methods of planting and fertilizing, to help the oat plant to resist the rust. On some soils oats will rust less when plowed in, thus covering the seed more deeply, and producing a deeper rooting habit than when merely brushed and harrowed in after the land is plowed. Excessive applications of nitrogenous fertilizers like stable manure or cottonseed meal that cause a soft, succulent growth, are more apt to favor rust than where the mineral elements, phosphates and potash, predominate in the fertilizer, and the growth is harder and less rapid.

Other serious diseases of oats occur, but they will not be considered here.

COTTON.

The diseases of cotton have been studied by the officers of this station, and have been discussed in Bulletins 21, 27, 36, 41 and 55. In Bulletin 41, Professor Atkinson described all the cotton diseases that had been observed by him, and the reader is referred to that bulletin for a detailed discussion of them. The diseases enumerated, are briefly as follows:

1. Yellow leaf blight or mosaic disease. A physiological trouble due to poor nutrition. It can often be prevented by applications of kainite.

2. Frenching. Caused by a fungus (*Fusisporium vasinfectum*).

3. Damping off or sore-shin. Caused by the mycelium of an unknown sterile fungus. This affects the young seedlings.

4. Anthracnose. Caused by *Colletotrichum Gossypii*, usually affecting the bolls.

5. Shedding of bolls. A serious trouble, usually entirely physiological and not due to either insects or fungi.

6. Angular spot of cotton. An obscure disease of the leaves, probably caused by bacteria.

7. Areolate mildew of cotton. Caused by a fungus (*Ramularia areolata*) which produces a white mildew on the leaves.

8. Cotton leaf blight. Caused by the early or Cercospora stage of a fungus (*Sphaerella gossypina*).

9. Root gall of cotton. Caused by the nematode (*Heterodera radicicola*). The same nematode affects many other garden and field crops and orchard trees.

Unfortunately no remedies can be suggested at present for most of these diseases. They are doubtless largely induced or at least aggravated by the common practice of cropping the land year after year in cotton. When cotton shall be made to take its place in a carefully considered rotation of crops great benefit will follow in its comparative freedom from disease as well as in the preservation of soil fertility and the avoidance of over production.

POTATOES.

Potato Blight.—The much dreaded Northern potato rot or blight (*Phytophthora infestans*) probably does not occur in this State. It certainly is not a common disease here.

We have, however, a Southern potato blight that is often very destructive. It manifests itself by the sudden wilting of the tops about the time the young potatoes are forming or perhaps after they are nearly grown. On cutting open the freshly wilted stems a spot will be found near the surface of the ground where the substance of the stalk looks clear and watery much as in the "water core" of certain apples. This watery portion is found to be swarming with bacteria and there is little question but that they are the direct cause of the disease. At first the young potatoes will still be quite sound but the disease soon reaches them through the stem and causes them to rot. When seemingly sound potatoes from a diseased vine are cut open a brown line can often be traced under the skin showing that the disease has already reached them. Such potatoes will not keep but will rot quickly, and if stored with others the rot soon spreads throughout the mass, causing great loss. This disease seems to live in the soil from one crop to the next, so that it is unsafe to plant potatoes the following year on land where the disease has appeared. The same, or at least a very similar disease attacks tomatoes, egg plants and peppers, so that these crops should not follow blighted potatoes.

No remedy is known except to avoid planting on infected land and to practice rotation of crops.

Potato Scab.—The black roughened or sunken patches often seen on potato tubers are caused by an obscure fungus (*Oospora scabies*). The same fungus attacks beets. It seems to be able to live as a saprophyte on the vegetable matter in rich soils, so that when the soil is once infected by planting scabby seed it is unsafe to plant it again in potatoes for some years. No known treatment will prevent the scab on such land. On clean land, treating the seed with corrosive sublimate will entirely prevent the disease even if scabby seed is used. Of course clean seed should always be used when possible. For this treatment dissolve two and one-half ounces of corrosive sublimate in two gallons of hot water in a tub or barrel. After standing until all is dissolved add thirteen gallons of cold water. Soak the seed potatoes in this solution for an hour and a half, then dry, cut and plant as usual. The treated potatoes should of course all be *planted* and not used for other purposes as they are poisoned by the treatment. When scabby potatoes are fed to stock it is unsafe to use the manure for fertilizing potatoes as the scab fungus propagates in the manure and is thus taken to the field. On this account chemical fertilizers are usually preferred by potato growers.

LEAF-SPOT OF POTATOES OR MACROSPORIUM DISEASE.—Potato foliage is often observed to be covered by rounded brown or arid spots. At first these spots are marked by concentric rings or zones of a darker color, but at length the dried portion of the leaf often breaks out and falls away. This spotting may begin soon after the plants are up. If there is but little of it no great damage is done, but when abundant it destroys so much of the leaf surface that the nutrition of the plant is deranged and the tubers are few and small. In extreme cases the leaves fall and the plant dies prematurely without forming tubers at all. It is a wide spread disease and frequently occasions much damage. Fortunately it can be quite effectually controlled by careful spraying with Bordeaux mixture. The first spraying should be given soon after the plants are up and should be repeated three or four times, at intervals of ten days or two weeks. It must be remembered that this treatment, like most others, is preventive not curative. The Bordeaux mixture serves to protect the foliage from attack; it does not cure the spots already formed, hence the importance of beginning the treatment early. To be successful we must keep ahead of the disease. Fortunately the labor of spraying will not be lost even if the disease does not appear, for in some way, not understood, the Bordeaux mixture seems to slightly increase the yield besides preventing the disease.

If potato beetles appear, Paris green may be mixed with the Bordeaux mixture as indicated elsewhere, and both enemies can be combatted by the one application.

TOMATOES.

SOUTHERN TOMATO BLIGHT.—This is similar to the Southern potato blight if not identical with it and like it is of bacterial origin.* It also attacks egg plants and peppers. It first appears about the time the fruit is beginning to form, and is characterized by the sudden wilting and dying of plants that are apparently vigorous. In some localities its ravages have been so great as to cause the abandonment of the tomato as a market crop. The disease will remain in the soil from one year to the next, and will increase rapidly if tomatoes are planted continously on the same land. Some experiments conducted in Mississippi indicate the probable usefulness of heavy applications of lime and kainite to the soil, as well as the spraying of the stems with Bordeaux mixture, but these experiments are not conclusive, and no treatment can be positively recommended, except to avoid planting on infected land. Even then the disease sometimes appears when tomatoes are planted on entirely new land quite remote from other tomatoes. The source of the contagion has not been accounted for in such cases.

TOMATO LEAF-SPOT OR MACROSPORIUM DISEASE.—This is the same as the potato disease of the same name, and yields to the same treatment. It frequently occasions heavy losses.

TOMATO LEAF BLIGHT.—This is caused by a fungus (*Cladosporium fulvum*) that forms a velvety olive brown coating on the under side of the leaves causing them to fall prematurely. It is a common pest when tomatoes are grown in greenhouses in winter, and is sometimes troublesome in the open air at the South. Spraying for the macrosporium will check this disease also.

TOMATO BLACK-ROT OR BLOSSOM-END ROT.—This widely occurring and destructive disease is not yet well under-

*A blight somewhat similar in its effects occurs in Florida that is caused by the growth of the mycelium of some fungus. It has not so far been detected in this State.

stood. At least two fungi (*Macrosporium Tomato and Fusarium Lycopersici*) are usually associated with it, but in just what connection cannot be positively stated. It is usually first seen as a discolored spot on the blossom end of the tomato fruit, soon after it has formed. This increases rapidly in size, becomes sunken, and is at length covered with the dusty spores of the associated fungi. It is liable to cause very serious damage, not unfrequently destroying over half the crop. The early clusters usually suffer worst, but its attacks are quite erratic, seeming to depend on the weather and on the general condition of the plant. It is invariably bad during seasons of protracted drouth; at such times a good rain will often check its ravages. Again during very wet weather there may be a destructive outbreak. Excessive manuring sometimes seems to favor the disease, while half starved plants growing in some poor spot may also be badly affected. In fact anything that checks or unduly stimulates the normal healthy growth of the plant, seems to favor the disease.

Spraying with Bordeaux mixture is often recommended for this disease, but the results of experiments so far reported are somewhat contradictory, and it cannot be definitely stated how successful such treatment will prove to be. Much will probably depend on the thoroughness and frequency with which the applications are made. Since the Bordeaux is known to be useful in combatting the Macrosporium disease, and is possibly useful in preventing the blight, it should certainly be applied with the hope that it will be of use in preventing the rot also. For one or two applications while the fruits are small, it is advisable to add one-fourth of a pound of Paris green to each barrel of the Bordeaux, with the hope of killing some of the young boll worms that feed on the surface a few hours after they are hatched, and before they bore into the fruit. The ravages of this insect will cause it to contest with the black rot for first place among the enemies of the tomato grower.

Other destructive rots of the green tomato occur, one probably of bacterial origin, but they have been little studied, and no remedies can be suggested.

WATERMELONS.

Melon Wilt or Melon Blight.—This disease is attracting increasing attention throughout the South. In most melon growing districts it is being found impossible to plant the land to melons year after year, without suffering great loss from it. It usually only appears after the vines have run out so as to nearly cover the ground, when they will suddenly wilt and die. The symptons are so much like those of the potato and tomato blights, that some connection between them has been suggested. This, however, is not the case. The melon blight is not bacterial, but is caused by the growth of an internal fungus that plugs up the ducts of the stems and causes the sudden wilting by shutting off the water supplied by the roots. This has been demonstrated by Dr. Erwin F. Smith of the Department of Agriculture, who is making an exhaustive study of this disease. Where the soil becomes infected, it is necessary to abandon the culture of melons for several years. No remedy has been found. A rotation of crops is suggested as a proper preventive measure. In fact the more we study plant diseases, the more important the question of crop rotation becomes.

Melon Anthracnose or Black-rot.—This disease occurs abundantly throughout the South, and causes considerable loss to melon growers. It is probably identical with the melon anthracnose caused by *Colletotrichum lagenarium*, discussed in the fifth annual report of the Delaware experiment station. It has been little studied, and no remedy can be suggested.

SWEET POTATOES.

This is an important crop for the South but its diseases have not been studied much here. In Bulletin No. 76 of the

New Jersey Experiment Station, Dr. Halsted describes nine fungous diseases of the sweet potato. It is probable that many of them also occur in this state. Some of them only attack the stored potatoes, others attack the foliage, while still others live on the vine through the summer and cause a destructive rot of the stored potatoes in winter. The Black-rot (*Ceratocystis fimbriata*) is of this class and is perhaps the worst of sweet potato diseases. It first appears on the potatoes as dry sunken dark-colored spots. If any such diseased potatoes are bedded in the spring, the fungus will attack the draws or shoots forming black spots on the stems. Such draws are said to have "black-shank" and if planted will certainly produce diseased potatoes in the fall. This may not show much when dug but it will develop later and the the rot will spread to neighboring sound potatoes in the bin. This shows the necessity for bedding none but perfectly sound potatoes. This disease seems to be able to live over for some time in the soil so when it is detected it is unwise to replant the same land to sweet potatoes for a year or two at least.

Much of the loss in the stored sweet potatoes from the other rots can be avoided by greater care in digging and handling. Cut and bruised sweet potatoes never keep well and when freshly dug they are very easily injured. The common practice of picking them up in sacks after digging always bruises them badly. Smooth shallow boxes holding half a bushel to a bushel should be provided for this purpose and they should be emptied carefully so as to avoid letting the potatoes fall any distance. In fact they should be handled as carefully as eggs in order to keep well. If they are stored in bins or cellars it is important to clean these out thoroughly and disinfect by burning sulphur and whitewashing before storing another crop. Some very favorable results are reported from dusting the potatoes as they are stored with a powder prepared by slaking lime with water in which copper sulphate has been dissolved.

PEACHES AND PLUMS.

These important stone fruits may be considered together since they are mostly subject to the same diseases. Peach yellows so destructive to orchards in many other regions does not occur here; nor has the closely related peach rosette been reported from this state though it occurs abundantly in middle Georgia and may be expected here at any time. Fortunately it has not proved as serious a disease as was feared a few years ago.

PEACH AND PLUM ROT.—This is easily the worst disease of stone fruits. Its appearance on the half grown and ripening fruit is well known but the fungus causing it (*Monilia fructigena*) also attacks the blossoms and very young fruits causing them to blast and fall. At other times it attacks the rapidly growing young wood and causes a destructive twig blight. It lives over winter in such diseased wood and also in the dried or mummied fruits so often seen hanging on the tree in the spring.

Some varieties are more subject to the rot than others but none a are exempt. Its growth is largely influenced by the weather, being greatly aggravated by hot damp or showery days, and in seasons where such weather is frequent, total loss of crops sometimes occurs. As the fruit approaches ripeness the trees should be examined frequently and any rotting specimens should be removed. This is important as the disease spreads very rapidly from the rotting to the sound fruit. Thinning the young fruit so that they hang separately on the limbs is of great use in preventing the spread of the rot as it allows them to dry more quickly. This practice adds so much to the size, quality and market value of the fruit that it should certainly be practiced by all. Another important precaution is to remove all mummied fruits from the orchard before blooming time. Fruit rots worse on rich land or where an excessively luxuriant growth has been caused by heavy applications of nitrogenous manures. Such lands and fertilizers should be avoided for stone fruits. They thrive best on high well drained, rather thin lands but on such soils will be greatly benefited by moderate applications of the phosphates and potash.

The advisability of spraying with fungicides to combat peach and plum rot is perhaps still an open question. Some experimenters, particularly Professor Chester of the Delaware Experiment Station, report very encouraging results, but the foliage especially of the peach, is very liable to injury from such applications and they must be made with great care. The disease is so important that extensive experiments are justified in attempting to control it, but only the best pumps and Vermorel nozzles giving a fine mist-like spray should be used in making the applications. Professor Chester * recommends the following treatment:—

1st. During the winter gather and burn all mummied fruit.

2nd. In winter or early spring (before the buds start) spray with a solution of copper sulphate using one pound to 25 gallons of water.

3rd. When fruit buds begin to swell spray with Bordeaux mixture made with six pounds of copper sulphate and at least six pounds of quick lime to the barrel.

4th. Spray again with Bordeaux mixture just before the blossoms open.

5th. As soon as the blossoms fall, spray again with the Bordeaux mixture, to which is added three ounces of Paris green per barrel. This is on account of the curculio which attacks the young fruit. The Paris green should be rubbed to a smooth paste with a little water before adding to secure an even mixture.

6th. In ten days repeat the Bordeaux and Paris green

7th. When fruit begins to color, spray with copper acetate (four ounces to the barrel of water). This is recommended instead of the Bordeaux at this stage, since it does not adhere to the fruit nor disfigure it, and it is found to be equally effective.

*Delaware Experiment Station, Bulletin 29.

8th. Repeat the copper acetate after a week or ten days. The total cost of this treatment is estimated by Professor Chester at twelve cents per tree where everything is done economically, and in the experiments reported about three-fourths of the rot was prevented. He admits some dropping of the leaves as a result of the spraying, but thinks this injury more than balanced by the foliage hanging much later in the fall on the treated than on the untreated trees.

LEAF RUST.—This is caused by a fungus (*Puccinia pruni-spinosae*) closely related to the rusts of grain. It often develops abundantly on peach and plum leaves late in summer, causing them to fall prematurely. This and other leaf destroying fungi will probably be effectively controlled by the spraying suggested for the rot.

GUMMOSIS.—This is an obscure diseased condition that manifests itself by the occurrence of blisters or pockets filled with gum under the bark of the trunk and branches. It is not to be confounded with the copious flow of gum occasioned by injuries from borers or other mechanical causes. It is accompanied by a serious constitutional derangement of the tree, and frequently causes its death, but the nature of the disease is not known, and no remedy can be suggested.

APPLES, PEARS AND QUINCES.

These pomaceous fruits are subject to many of the same diseases, the most important of which is the—

BLIGHT.—This is a bacterial disease caused by the growth of a minute germ or microbe in the young, soft tissues of the tree. The diseased parts soon die, and the blackened persistent leaves can be seen hanging as a signal of distress in most Southern orchards. As the wood growth begins to harden, the disease becomes less active and usually dies out of its own accord. In such cases a distinct ring marks the union of the dead and living bark. In a few cases, however, the disease does not stop, but continues to grow slowly in the soft inner bark, and it is such spots of still living blight that serve to carry the contagion over winter. This is an important point in the life history of the disease that has been pointed out recently by M. B. Waite of the Department of Agriculture, who has devoted much time to the study of this disease. He has shown that from such spots of "hold over blight," the germs are carried to the flowers in the spring by bees and other insects. Here they multiply rapidly in the nectar secreted by the flowers, and are widely disseminated by the same insect agency, causing the sudden outbreak of "blossom blight," so familiar and so disastrous to Southern pear growers. The disease has attracted most attention on the pear, but it frequently occurs on the apple and the quince. The only known remedy has been to cut out and burn the diseased portions as soon as they can be detected. Mr. Waite's discovery of the way in which the disease passes the winter, indicates that it should be supplemented by a very careful examination of the trees during winter and early spring, to remove all spots of the "hold over blight," thus destroying the contagion as far as possible before it is carried to the open flowers, which are by far the most vulnerable part of the tree.

Another important point in combatting pear blight, is to so control the growth of the tree as to prevent a rank, sappy, over vigorous condition. It is in soft, rapidly growing tissues that the blight thrives best, and when it gains entrance to such trees, it is very hard to check its course. In a tree that is making only a moderate growth that matures and hardens early, the disease frequently dies out of itself without doing such serious injury. For this reason especially, as the trees reach bearing age, nitrogeneous fertilizers and excessive cultivation should be carefully avoided. A little seeming neglect is often the best possible treatment for a pear orchard. On good soil the ideal treatment of a pear orchard of bearing age would be to sow down to some low-growing legume like *Lespedeza* or white clover, and pasture with hogs, giving occasional top-dressings of kainite and acid phosphate.

APPLE LEAF RUST.—A yellow spotting of apple leaves, caused by the growth of a fungus forming cupshaped receptacles filled with yellow spores, often does considerable damage. Some varieties are much more affected than others. It seldom attacks pears or quinces. Another stage of the growth of the same fungus occurs on the red cedars, causing the large gall-like growths known as cedar apples. The advisability of destroying infested cedars in the neighborhood of apple orchards will at once suggest itself as a remedy against this disease.

PEAR AND QUINCE LEAF BLIGHT.—A very different fungus (*Entomosporium maculatum*) causes the dropping of pear and quince leaves in midsummer. It does not attack apples. Minute brown spots, usually with a reddish border, appear on the leaves, and when there are many of these spots the leaf turns yellow and falls. Some varieties of pears are so badly affected as to be as bare of leaves in June and July as they should be in December. Such trees can, of course, mature no fruit and the falling of the leaves prevents the forming of fruit buds for the next season's crop. The fungus also grows on the fruit, causing it to crack. It is often less severe in trees standing in sod than in cultivated ground. Pear seedlings in the nursery often suffer severely from this trouble and it prevents their becoming large enough to bud.

It is found to yield easily to treatment with Bordeaux mixture, and the spraying of nursery stock is now largely practiced with the best results. In the orchard the treatment to be recommended under the next heading will serve to control this disease also.

APPLE AND PEAR SCAB.—The species of *Fusicladium* causing this well known disease are supposed to be slightly different on apple and pear, but for practical purposes they may be considered as identical. The presence of the fungus prevents the fruit from reaching full size; it injures its keeping qualities, and by its unsightly appearance greatly reduces its market value. It also develops on the leaves and on the young twigs. An early spring growth of the fungus often causes the blasting of the flowers and the serious dropping of the young fruit.

The following combined treatment is recommended for preventing or materially lessening the amount of scab and leaf blights and of various summer rots, and at the same time to prevent the loss from wormy fruit and leaf eating insects.

1st. In winter or early spring, before the buds swell, spray with solution of copper sulphate.

2d. Just before the blossoms open spray with Bordeaux mixture.

3d. Just after the blossoms fall spray with Bordeaux, to each barrel of which four ounces of Paris green has been added.

4th. In ten days or two weeks repeat the Bordeaux and Paris green. Later sprayings of Bordeaux alone may be useful but are liable to mar the fruit.

The above treatment cannot be too strongly recommended to all apple and pear growers where scab and codling worms are abundant. On the Gulf coast these troubles have not yet appeared so that these sprayings are not required.

GRAPES.

BLACK ROT; DOWNY MILDEW; POWDERY MILDEW; ANTHRACNOSE.—These four well known grape diseases can all be largely prevented by the following treatment, which is earnestly recommended to all grape-growers:

1st. Before the buds swell spray with copper sulphate solution.

2d. When growth starts, and the largest leaves are perhaps an inch across, spray with Bordeaux mixture.

3d. Just before the flowers open spray again with Bordeaux.

4th. As soon as the flowers fall spray with Bordeaux.

5th. In ten days or two weeks, when the berries are the size of small peas, spray again with Bordeaux, taking care to direct the spray so that all the bunches will be fully covered. If the work has been carefully done this will usually serve to protect the crop quite perfectly. In very wet seasons one or two later sprayings may be advisable, but they should be made with the ammoniacal copper carbonate solution, as late spraying with Bordeaux stains the fruit unpleasantly.

The anthracnose is more difficult to fully control than the others and treatment is not always satisfactory. The black rot is also very persistent and in badly affected vineyards the greatest care and thoroughness in making the applications is required to control it. On a small scale pinning paper bags over the clusters as soon as the fruit is set furnishes very complete protection from the rot and such bagged grapes ripen more evenly and are finer in flavor than those unprotected. If the vineyard is infested with the green saw-fly larva or by any of the leaf-eating beetles, four ounces of Paris green may be added to the barrel of Bordeaux at any of the sprayings.

Bitter Rot.—This disease seems to be largely confined to the South. In some localities here it is far more troublesome than the black rot. It attacks the berries just as they are ripening giving them a blistered or sun-scalded appearance. Later they are covered with the fruiting pustules of the fungus (*Melanconium*) which resemble somewhat closely those of the black rot, but the berry remains plump and turgid and does not shrivel and become hard as in the latter disease. The bitter rot also attacks the stems of the fruit clusters and it is here that it does its greatest damage for the diseased stems instead of "curing" and becoming soft and pliant when picked so as to pack nicely and carry well, becomes hard and brittle. The berries fall off easily and such shattered bunches are quite unsaleable in market.

The early spraying with Bordeaux does not prevent this disease. Something can be done towards controlling it by training the vines so that the fruit will hang in the shade of the leaves, for such sheltered fruit is less often diseased than that hanging exposed to the sun and dew. On this account some form of horizontal trellis is much to be preferred to the ordinary vertical trellis or to training to stakes.

ROOT ROT.—This disease can be detected by the presence of a white mould-like growth under the bark on the roots and crown. It is quite prevalent at the South often doing serious harm. A recent examination of the Station vineyard shows that out of 584 vines all but 83 show evident signs of this disease and many died during the late summer and fall. It seems evident that this is the cause of the death of so many of the vines on the station grounds as reported in previous bulletins. This disease has been little studied in this country and no remedy for it can be proposed at present. It seems to be identical with the disease known as *pourridie* in France. This has been shown to be caused by the growth of any one of three or more different fungi and is usually fatal in from two to three years.

Here some varieties are evidently much more resistant that others and some facts go to show that vines may live many years while more or less affected by it. The character of the soil probably has much to do with the prevalence of the disease.

***

Correspondence regarding the appearance and extent of any diseases of plants cultivated in the State of Alabama is requested by this Experiment Station. When writing regarding plant diseases accompany the correspondence with specimens of the affected plants or portions of plants. It is desirable also to give as full data as possible regarding the nature and extent of the disease. Address all correspondence on this head to The Biological Department, Alabama Experiment Station, Auburn, Alabama.

BULLETIN No. 70. MARCH, 1896.

ALABAMA

Agricultural Experiment Station

OF THE

AGRICULTURAL AND MECHANICAL COLLEGE,

AUBURN.

THE FLORA OF ALABAMA.

PART V.

P. H. MELL.

MONTGOMERY, ALA.:
THE BROWN PRINTING COMPANY, PRINTERS,
1896.

☞The Bulletins of this Station will be sent free to any citizen of the State on application to the Agricultural Experiment Station, Auburn, Alabama.

LIST OF PUBLICATIONS

—OF THE—

ALABAMA AGRICULTURAL EXPERIMENT STATION.

1. Bulletins Nos. 1–10, 1883–1885.
2. Bulletins Nos. 1–9, 1885–1887. "Second series."
3. Bulletins Nos. 1–8 for 1887.
4. Bulletins Nos. 1–5 for 1888.

The above Bulletins were issued in the early formative period of the Experiment Station partly in conjunction with the Commissioner of Agriculture, whose office was then located at Auburn.

5. Bulletins Nos. 1-69 of the current series. These represent the regular bulletins of the station since the foundation under the Hatch fund.

6. Annual Reports of the Agricultural Experiment Station, 1–8, 1888–1895.

By recent action of the Station Council the above bulletins have been arranged into volumes as follows:

Vol. I. To include all Bulletins issued in the first four series and before the foundation under the Hatch act.

Vol. II. To include Bulletins 1–21 of the current series, 1888-1890.

Vol. III. To include Bulletins Nos. 22–58 of the current series, 1891–1894.

Vol. IV. Commencing with No. 59 and now current.

Indices of these bulletins are in process of preparation and when completed will be sent to such as desire to bind their series of bulletins.

In addition to the early bulletins grouped under Vol. I, the following bulletins are out of print and cannot be furnished: Nos. 3, 4, 5, 7, 8, 35, 43, 44, 48, 54, 57, 60, 61, 63.

THE FLORA OF ALABAMA.

PART V.

LEGUMINOSÆ AND ROSACEÆ,

—BY—

P. H. MELL.

INTRODUCTION.

An authentic list of the plants growing wild in Alabama has long been demanded by botanists. No complete work on the subject has ever been printed. With the exception of Chapman's "Flora of the Southern United States," and Darby's "Botany of the Southern States," both of which are now out of date, there is no guide to the botanical explorer in regard to the location and habitat of the plants in this State. In the above works whenever Alabama is mentioned only general references are made, and but little definite information is given when speaking of the location of species.

During the past few years botanical science has undergone material change in the classification of genera, the assignment of authority in the naming of species, the weeding out of superfluous names and the adjustment of synonyms. It is not safe, therefore, to trust entirely to publications issued ten or twelve years since without first consulting the corrections recently made by the light of authoritative investigations. In this bulletin, and in others that will follow from time to time on the same subject, an effort has been made to bring the names of species up to date. No doubt mistakes will occur and the author will esteem it a great favor to have such errors pointed out so that corrections may be made in the publications to follow.

In the migration of plants species have been found in

Alabama within recent years which were supposed formerly to be confined to other sections of the country.

For these and other equally important reasons this publication is issued with the confident belief that it will be gladly welcomed by the students of Botany.

This work will be printed in Parts, each of which will be issued only when the material on hand will warrant the publication. Whenever new material is secured after the printing of the part a supplement will be prepared in such form as to render it comparatively easy to attach it as an appendix. These Parts may not be published in consecutive order, but this will be of no material disadvantage since the entire work, when completed, may be bound in one volume and the orders will then follow each other in accordance with Botanic sequence.

A study of the orders has convinced the author that the most convenient grouping is as follows:

PART I. Ranunculaceæ, Magnoliaceæ, Anonaceæ, Menispermaceæ, Berberidaceæ, Nymphæaceæ, Sarraceniaceæ, Papaveraceæ, Fumariaceæ.

Comprising 9 orders and 41 genera.

PART II. Cruciferæ, Capparidaceæ, Resedaceæ, Cistaceæ, Violaceæ.

Comprising 5 orders and 27 genera.

PART III. Caryophyllaceæ, Portulacaceæ, Clusiaceæ, Elatinaceæ, Hypericaceæ, Ternstræmiaceæ, (Camelliaceæ), Malvaceæ, Tiliaceæ, Byttneriaceæ, Linaceæ,

Comprising 10 orders and 47 genera.

PART IV. Olecaceæ, Aurantiaceæ, Cedrelaceæ, Geraniaceæ, (Oxalidaceæ and Balsaminaceæ), Zygophyllaceæ, Rutaceæ, Simarubaceæ, Burseraceæ, Ilicineæ (Aquifoliaceæ) Celastraceæ, Rhamnaceæ, Vitaceæ, Sapindaceæ, (Aceraceæ and Staphyleaceæ) Anacardiaceæ, Polygalaceæ, Krameriaceæ.

Comprising 16 orders and 43 genera.

PART V. Leguminosæ, Rosaceæ.

Comprising 2 orders and 57 genera.

PART VI. Calycanthaceæ, Myrtaceæ, Saxifragaceæ, (Parnassiaceæ and Grossulaceæ), Crassulaceæ, Droseraceæ, Hamamelideæ, Halorageæ (Callitrichaceæ), Melastomaceæ, Lythoraceæ.

Comprising 9 orders and 36 genera.

PART VII. Onagraceæ, Turneraceæ, Cucurbitaceæ, Cactaceæ, Ficoideæ.

Comprising 5 orders and 16 genera.

PART VIII. Umbelliferæ, Araliaceæ, Cornaceæ.

Comprising 3 orders and 31 genera.

PART IX. Caprifoliaceæ, Rubiaceæ, Valerianaceæ.

Comprising 3 orders and 32 genera.

PART X. Compositæ.

Comprising 1 order and 99 genera.

PART XI. Lobeliaceæ, Goodeniaceæ, Campanulaceæ, Ericaceæ, Diapensiaceæ, Plumbaginaceæ.

Comprising 6 orders and 26 genera.

PART XII. Primulaceæ, Sapotaceæ, Theophrastaceæ, Myrsinaceæ, Ebenaceæ, Styracaceæ, Cyrillaceæ, Oleaceæ, Apocynaceæ, Asclepiadaceæ, Logoniaceæ, Gentianaceæ.

Comprising 12 orders and 38 genera.

PART XIII. Polemoniaceæ, Hydrophyllaceæ, Borraginaceæ, Hydroleaceæ, Convolvulaceæ, Solanaceæ.

Comprising 6 orders and 30 genera.

PART XIV. Scrophulariaceæ, Orobanchaceæ, Lentibulariaceæ, Bignoniaceæ.

Comprising 4 orders and 32 genera.

PART XV. Pedaliaceæ, Acanthaceæ, Verbenaceæ, Labiatæ.

Comprising 4 orders and 40 genera.

PART XVI. Plantaginaceæ, Nyctaginaceæ, Illecebraceæ, Amarantaceæ, Chenopodiaceæ, Phytolaccaceæ, Polygonaceæ.

Comprising 7 orders and 30 genera.

PART XVII Podostemaceæ, Aristolochiaceæ, Piperaceæ, (Saururaceæ), Lauraceæ, Thymelæaceæ, Loranthaceæ, Santalaceæ, Euphorbiaceæ.

Comprising 8 orders and 25 genera.

PART XVIII. Urticaceæ (Moraceæ), Platanaceæ, Juglandaceæ, Myricaceæ, Cupuliferæ, Salacaceæ, Empetraceæ, Batidaceæ, Ceratophyllaceæ, Coniferæ, Cycadaceæ, Palmæ.

Comprising 12 orders and 31 genera.

PART XIX. Hydrochardiaceæ, Burmanniaceæ, Orchidaceæ, Cannaceæ, Bromeliaceæ, Hæmodoraceæ, Iridaceæ.

Comprising 7 orders and 33 genera.

PART XX. Amaryllidaceæ, Dioscoriaceæ, Roxburghiaceæ, Liliaceæ (Melonthaceæ), Pontederiaceæ, Xyridaceæ, Mayaceæ.

Comprising 7 orders and 33 genera.

PART XXI. Commelinaceæ, Juncaceæ, Typhaceæ, Araceæ, Lemnaceæ, Alismaceæ, Naidaceæ, Eriocauleæ.

Comprising 8 orders and 28 genera.

PART XXII. Cyperaceæ.

Comprising 1 order and 21 genera.

PART XXIII. Gramineæ.

Comprising 1 order and 65 genera.

The author acknowledges with pleasure, material assistance from Dr. Chas. Mohr, of Mobile, in locating many of the species mentioned in this bulletin.

ORDER 42. LEGUMINOSÆ. PULSE FAMILY.

1. **BAPTISIA,** Vent. *False indigo.* PERENNIAL HERBS.

C. leucantha, Torr. and Gray. *Smooth wild indigo.* Growing on river banks from March to April. Specimens found in Washington county, (Dr. Mohr). Also reported growing in Tennessee (Killebrew), and therefore may be found in north Alabama.

B. alba, R. Br. *White flowered indigo.* Growing in south and middle Alabama—Russell county (Dr. Neisler), Mobile (Dr. Mohr), Lee (Mell), April.

B. perfoliata, R. Br. Dry sandy soils near Auburn, Lee county, (Mell) and probably south. May

B. lanceolata, Ell. Dry pine barrens in south and west Alabama. Baldwin county, (Dr. Mohr.)

2. **CROTALARIA,** L. *Rattle box.* HERBS.

C. sagittalis, L. *Virginian rattle box.* Growing in south and middle Alabama in barren sandy soils. Specimens obtained in Lee (Mell), Russell (Dr. Neisler), Tuscaloosa, Cullman (Dr. Mohr), counties—June, July. Found also growing abundantly in Tennessee, (Killebrew) and therefore may be looked for in North Alabama.

C. ovalis, Push. Dry pine soil throughout lower middle and south Alabama—May, July—Specimens obtained in Russell (Dr. Neisler), Washington, Mobile, Baldwin, Monroe (Dr. Mohr), counties.

C. Purshii, DC. South Alabama—May, June—Mobile, Baldwin (Dr. Mohr) counties.

3. **LUPINUS,** Tourn. *Lupine.* HERBS.

L. perennis, L. *Wild lupine.* From middle to north Alabama—April May—Lee (Mell), Russell (Dr. Neisler), Cullman, Tuscaloosa (Dr. Mohr), counties. Mountains Tennessee (Killebrew).

L. perennis, *Var* GRACILIS, Mobile (Dr. Mohr.)

L. villosus, Willd. *Villous lupine.* South Alabama, Mobile, Baldwin (Dr. Mohr) counties. April.

L. diffusus, Nutt. South Alabama, Mobile, Baldwin (Dr. Mohr) counties—April, May.

4. **TRIFOLIUM**, Tourn. *Clover, Trefoil.* HERBS.

T. pratense, L. *Red clover.* Escaped from cultivation in middle and south Alabama—Lee (Mell), Mobile (Dr. Mohr), counties. Also in Tennessee (Killebrew).

T. reflexum, L. *Buffalo clover.* From middle to north Alabama—Lee, Montgomery (Mell), Tuscaloosa, Autauga, Cullman, Winston (Dr. Mohr), counties—April, May.

T. repens, L. *White clover.* Generally throughout the State in sandy soils—Lee (Mell), Mobile, Baldwin (Dr. Mohr). Also in Tennessee (Killebrew). May.

T. Carolinianum, Michx. *Southern clover.* Middle and southern extending into north-west Alabama—Lee, Macon, Montgomery (Mell), Mobile, Baldwin, Tuscaloosa (Dr. Mohr), counties—March, April. Tennessee (Killebrew).

T. procumbens, L. *Low hop clover—Small yellow clover.* Middle and northern Alabama—in waste places—Lee (Mell), Madison, Tuscaloosa, Jackson (Dr. Mohr), counties.

5. **HOSACKIA**, Dougl. HERBS.

H. Purshiana, Benth. Introduced from Texas (Dr. Mohr).

6. **MELILOTUS**, Tourn. *Medick, Melilot, Sweet Clover.* HERBS.

M. officinalis, Willd. *Yellow clover.* An introduced species escaped from cultivation—Lee (Mell), and probably in other sections of middle Alabama.

M. alba, Lam. *White clover.* Throughout middle Alabama—Lee, Macon, Montgomery (Mell), Hale (Dr. Mohr), counties.

M. parciflora, Desf. Lower middle and south Alabama, Perry, Mobile counties (Dr. Mohr). Introduced.

7. **MEDICAGO**, Tourn. *Hop medick–Black medick.* HERBS.

M. lupulina, L. *Black medick—Nonesuch.* In waste places and in old fields in all parts of the State.—Lee, Russell, Dallas, Montgomery (Mell), Mobile, Baldwin, Monroe (Dr. Mohr) counties. Tennessee (Killebrew).

M. maculata, Willd. *Spotted medick.* Introduced into south Alabama with ballast, Mobile (Dr. Mohr), county.

M. denticulata, Willd. *Reticulated medick.* Introduced with ballast in Mobile (Dr. Mohr), county.

8. **PSORALEA**, L PERENNIAL HERBS.

P. melilotoides, Michx. Dry soils—May, June—Lee, Montgomery (Mell), Washington, Cullman, Monroe, Shelby, St. Clair, Calhoun (Dr. Mohr), Russell (Dr. Neisler), counties. Tennessee (Killebrew).

P. canescens, Michx. Dry sandy soils in south Alabama, probably extending into lower middle. Mobile (Dr. Mohr), county—April, May.

9. **AMORPHA**, L. *False indigo.* SHRUBS.

A. herbacea, Walt. Middle Alabama, Lee (Mell), Russell (Dr. Neisler) counties.

A. fruticosa, L. *False indigo—Lead plant.* Tall shrub sometimes arborescent along banks of streams.—May, June. Montgomery (Mell), Mobile, Baldwin, Hale (Dr. Mohr), counties. Tennessee (Killebrew).

10. **PETALOSTEMON**, Michx. *Prairie clover.* PERENNIAL HERBS.

P. gracilis, Nutt. Sandy soils in south Alabama, Mobile, Baldwin (Dr. Mohr), counties. August.

P. carneum, Michx. Dry sandy soils in lower middle and south Alabama—Henry (Dr. Mohr), Dallas (Mell), counties.

P. candidens, Michx. Montgomery (Dr. Mohr), county.

P. carymbosum, Michx. *Virginian lupnie—Silk, prairie clover.* Dry sandy soils in middle and south Alabama, Lee (Mell), Russell (Dr. Neisler), Mobile (Dr. Mohr) counties. It may also be found in north Alabama since Dr. Killebrew reports it as growing in Tennessee.

P. decumbens, Nutt. *Low prairie clover.* Northern portions of State. Franklin (Dr. Mohr), Jackson (Dr. E. A. Smith), counties.

P. violacens, Michx. Hale (Dr. Mohr), county.

11. **TEPHROSIA**, Pers. *Hoary pea.* PERENNIAL HERBS.

T. Virginiana, Pers. *Goats rue.* Common in all parts of the State—June, July.

T. spicata, Torr. and Gray. Dry Soils extending from north to south Alabama—June, July. Mobile, Baldwin, Monroe, Escambia, Clark, Washington (Dr. Mohr), Lee, Cullman (Mell), counties, extending into Tennessee (Killebrew).

T. hispidula, Pers. Dry sandy soils in south Alabama, June, July. Mobile (Dr. Mohr).

T. onobrychoides, Nutt. Pine barrens near Mobile (Dr. Mohr).

T. chrysophylla, Pursh. Sandy soils in south Alabama, Mobile, Baldwin (Dr. Mohr), counties.

T. ambigua, Curtis. Dry sandy soils in south Alabama, Mobile (Dr. Mohr).

12. **INDEGOFERA,** L. *Indigo.* HERBS OR SHRUBS.

I. Caroliniana, Walt. *Wild indigo.* Dry sandy soils in middle and southern Alabama—July, August. Lee, Montgomery (Mell), Russell (Dr. Neisler), Mobile (Dr. Mohr), counties.

13. **ROBINIA,** L. *Locust.* TREES OR SHRUBS.

R. pseudacacia, L. *Common locust, False acacia.* Common throughout middle and north Alabama—April, May. Wood valuable for lumber because of hardness and beautiful color.

14. **ACACIA,** Neck. MOSTLY TREES OR SHRUBS.

A. Farnesiana, Willd. *Opoponax.* Growing in waste places in the lower part of the State. Naturalized near Mobile (Dr. Mohr).

15. **WISTORIA,** Nutt. HARDY CLIMBERS.

W. frutescens, Poir. *Carolina kidney bean.* From Mobile westward and north in alluvial soils and along margins of swamps—Mobile, Baldwin, Monroe, Clark (Dr. Mohr) counties.

16. **ASTRAGALUS,** Tourn. *Milk vetch.* CHIEFLY HERBS.

A. Plattensis var Tennesseensis, Gray. Franklin (Dr. Mohr).

A. villosus, Michx. Dry sandy soils in middle and south Alabama—Lee (Mell), Russell (Dr. Neisler), Baldwin (Dr. Mohr) counties—extending into Tennessee (Killebrew).

17. **GLOTTIDIUM**, Des. ANNUAL.

G. Floridanum, DC. Damp soils in south Alabama. August—Mobile, Baldwin (Dr. Mohr).

18. **SESBANIA**, Pers. HERBS OR SHRUBS.

S. macrocarpa, Muhl. South Alabama—August, September—Mobile, Baldwin counties (Dr. Mohr).

19. **ÆSCHYNOMENE**, L. *Sensitive joint vetch.* HERBS OR SHRUBS.

Æ. hispida, Willd. Borders of swamps in south Alabama—August.

Æ. viscidula, Michx. South Alabama, in sandy soils—Mobile (Dr. Mohr).

20. **ZORNIA**, Gmel. PERENNIAL HERBS.

Z. tetraphylla, Michx. South and west Alabama, in dry sandy soils—June, August—Mobile, Baldwin (Dr. Mohr).

21. **DESMODIUM**, Des. *Tick, Trefoil.* PERENNIAL HERBS.

D. nudiflorum, DC. *Crowded leaved trefoil.* Rich soils in western Alabama—July, August.

D. acuminatum, DC. *Pointed Tick Trefoil.* Rich soils in shady places in nearly all portions of State—Lee, Macon, Montgomery (Mell), Russell (Dr. Neisler), Mobile, Cullman, Franklin (Dr. Mohr) counties—July, August.

D. pauciflorum, DC. *Few flowered tick trefoil.* From middle to north Alabama—August—Montgomery (Mell), Bibb (Dr. Mohr), extending into Tennessee (Killebrew); growing in rich woods soil.

D. rotendifolium, DC. *Round leaved tick trefoil.* In dry rocky woods soil from south to north Alabama—August—Lee, Montgomery (Mell), Russell (Dr. Neisler), Mobile, Baldwin, Autauga (Dr. Mohr) counties, extending into Tennessee (Killebrew).

D. glabellum, DC. (Resembles D. Marilandica and D. paniculatum)—Russell county (Dr. Neisler).

D. humifusum, Beck. Dry sandy soil in Russell (Dr. Neisler) and on Alpine mountain, Talladega (Dr. Mohr).

D. canescens, DC. Moist places in south, middle and north Alabama—July, August—Mobile, Talladega, Franklin (Dr. Mohr), Lee, Macon (Mell) counties.

D. cuspidatum, Torr. and Gray. *Sharp pointed tick trefoil.* Middle and north Alabama—Lee, Macon (Mell), Russell (Dr. Neisler), Calhoun (Dr. Mohr) counties, extending into Tennessee (Killebrew)—August.

D. lævigatum, DC. Middle and northeast Alabama—August—Russell (Dr. Neisler), Talladega (Dr. Mohr) counties.

D. viridiflorum, Beck. In dry rich soil in middle Alabama. Russell (Dr. Neisler), Lee (Mell), Montgomery (Dr. Mohr) counties.

D. Dillenii, Darl. In open woods from south Alabama to Tennessee. Mobile, Baldwin (Dr. Mohr), Lee (Mell), Tennessee (Killebrew)—August.

D. paniculatum, DC. *Smooth tick trefoil.* In shady places throughout Alabama—Mobile, Talladega (Dr. Mohr), Clay (Mell), extending into Tennessee (Killebrew)—August.

D. strictum, DC. *Stiff tick trefoil.* Pine barrens, from south to north Alabama—Mobile (Dr. Mohr), Russell (Dr. Neisler), Montgomery, Lee (Mell), extending into Tennessee (Killebrew)—July, September.

D. Canadense, DC. In north Alabama (Dr. Smith), extending into Tennessee (Killebrew).

D. rigidum, DC. Montgomery, Talladega, Calhoun (Dr. Mohr)—August.

D. ciliare, DC. Dry hills and sandy fields in most sections of the State—August—Mobile, Talladega (Dr. Mohr), Montgomery, Macon (Mell).

D. Marilandicum, Boott. Dry open woods soil in northeast Alabama—Talladega, Calhoun (Dr. Mohr), Clay, Randolph (Mell) counties. August.

D. lineatum, DC. South Alabama—August—Mobile, Baldwin (Dr. Mohr) counties.

D. tenuifolium, Torr. and Gray. Dry pine barren in south Alabama—July, August—Mobile, Baldwin, Monroe counties (Dr. Mohr).

22. **LESPEDEZA**, Michx. *Bush clover.* HERBS.

L. procumbens, Michx. (L. repens Bart.) *Creeping bush clover.* Extending throughout the State—August—Mobile, Cullman, Talladega, Morgan (Dr. Mohr), Lee, Macon, Clay (Mell), Russell (Dr. Neisler), found also in Tennessee (Killebrew).

L. polystachya, Michx. (L. hirta, Ell.) *Hairy bush clover.* Dry hill soils throughout most of the State—Mobile, Baldwin, Clark, Washington, Bibb, St. Clair, Calhoun (Dr. Mohr), Lee, Montgomery, Clay, Cullman (Mell), Russell (Dr. Neisler)—July, August.

L. violacea, Pers. *Purple bush clover.* Russell (Dr. Neisler)—July, September.

L. reticulata, Pers. (L. violacea var angustifolia T. and G.) Generally distributed throughout the State—Mobile, Calhoun, Talladega, Madison (Dr. Mohr), Clay, Lee (Mell).

L. Stuvei, Nutt. *Downy bush clover.* In portions of North Alabama (Dr. Smith).

L. Stuvei, var. **Intermedia**, Wat (L. violacea var. sessiliflora Man.) has about the same distribution as last.

L. capitata, Michx. *Round headed bush clover.* Dry sandy soils—Lee, Montgomery, Cullman (Mell), Russell (Dr. Neisler), Mobile, Clark, Washington, Autauga (Dr. Mohr) counties, extending into Tennessee—August.

L. striata, Hook and Arnott. An introduced species found in old fields throughout the State.

L. Nuttallii, Darl. Talladega (Dr. Mohr).

23. **STYLOSANTHES**, Sw. *Pencil flower.* LOW PERENNIAL HERBS.

S. elatior. Sandy soils, common everywhere—June, August.

24. **VICIA,** Tourn. *Vetch. Tare.* MOSTLY CLIMBING HERBS.

V. sativa, L. *Common vetch or tare.* An introduced species found in cultivated soil in south and middle Alabama—Lee (Mell), Mobile (Dr. Mohr).

V. hirsuta, Koch. Introduced in ballast near Mobile (Dr. Mohr))—April, May.

V. micrantha, Nutt. *Small flowered vetch.* Shady banks of streams in Wilcox county (Dr. Mohr)—April.

V. Caraliniana, Walt. *Carolina vetch.* Dry open woods soil in north Alabama—Cullman (Mell), Blount (Dr. Mohr)—April, May.

V. acutifolia, Ell. South Alabama—Mobile (Dr. Mohr,) March, May.

V. Ludoviciana, Nutt. Southwest Alabama—Mobile (Dr. Mohr).

25. **LATHYRUS,** Tourn. *Everlasting pea—Bitter Vetch.* PERENNIAL HERBS.

L. venosus, Muhl. Shady banks throughout upper east Alabama, probably extending west—Lee, Clay (Mell), Russell (Dr. Neisler), Cullman (Dr. Mohr) counties—June, July.

26. **Apios,** Boerh. *Ground nut—Wild Bean.* PERENNIAL HERB.

A. tuberosa, Mœnch. Growing near swamps from middle to northern Alabama—Lee, Macon (Mell), Russell (Dr. Neisler), Cullman, Winston, Madison (Dr. Mohr) counties, extending into Tennessee (Killebrew)—July, August.

27. **CENTROSEMA.** DC *Spurred butterfly pea.* TWINING PERENNIAL HERBS.

C. Virginianum, Benth. Dry sandy soil from Lee (Mell) and Russell (Dr. Neisler), Mobile, Baldwin (Dr. Mohr) counties. June, September.

28. **PHASEOLUS.** Tourn. *Kidney bean.* PROSTRATE OR TWINING HERBS.

P perennis, Walt. *Wild kidney bean.* In woods and along field margins from middle towards north Alabama. Lee, Tallapoosa, Clay (Mell), Russell (Dr. Neisler), Talladega (Dr. Mohr), extending into Tennessee (Killebrew).

29. **STROPHOSTYLES,** Ell. PROSTRATE OR TWINING HERBS.

S. angulosa, Ell. (P. diversifolius Pers and P. helvolus L). *Creeping kidney bean.* Sandy banks of streams from Mobile to Tennessee. June, September. Lee, Coosa (Mell), Baldwin, Mobile, Calhoun (Dr. Mohr), Russell (Dr. Neisler) counties, extending into Tennessee (Killebrew). June, September.

S peduncularis, Ell (P. helvolus, Man) sandy soils over the same territory as preceding. June, September.

30. **VIGNA.** Savi. TWINING HERBS.

V. glabra, Savi. Brackish marshes along coast. June, September. Mobile (Dr. Mohr).

31. **ERYTHRINA,** L. TREES, SHRUBS RARELY HERBS.

E. herbacea, *Coral plant.* Light sandy soils in lower middle and south Alabama—Macon (Mell), Russell (Dr. Neisler), Mobile, Clark, Monroe (Dr. Mohr) counties. April, May.

32. **CLITORIA,** L. *Butterfly pea.* PERENNIAL HERBS.

C. Mariana, L. Dry sandy soils. Lee, Macon (Mell), Russell (Dr. Neisler), Mobile, Baldwin, Monroe, Clark, Washington (Dr. Mohr) counties, extending into Tennessee (Killebrew). July, August.

33. **AMPHICARPÆA,** Ell. *Hog peanut.* PERENNIAL HERBS.

A. monoica, Nutt. Rich moist soils throughout south, middle and northwest Alabama. Lee, Montgomery (Mell), Russell (Dr. Neisler), Mobile, Tuscaloosa (Dr. Mohr) counties, extending into Tennessee (Killebrew). August, September.

34. **GALACTIA,** P. Br. *Milk pea.* PROSTRATE AND TWINING HERBS.

G. glabella. Michx. *Smooth milk pea.* Extending throughout middle and probably into north Alabama, growing in sandy soils. July, August. Lee (Mell), Russell (Dr. Neisler), Autauga (Dr. Mohr) counties. Reported also from Tennesse (Killebrew).

G. pilosa. Ell. (G. mollis, Gray). Generally distributed over the State. July, September. Lee (Mell), Russell (Dr. Neisler), Mobile, Baldwin, Cullman (Dr. Mohr) counties.

G. sessiliflora. Torr & Gray. South Alabama, Mobile (Dr. Mohr). June, August.

35. **DIOCLEA.** Kunth. (Dolichos, L). TWINING SHRUB.

D. Boykinii. Benth. Hale county (Dr. Mohr).

36. **RHYNCHOSIA,** Lour. TWINING OR TRAILING PERENNIAL HERBS.

R. tomentosa. Hook & Arn. (R. tomentosa var volubilis (T. & G.) Dry soils in rolling pine lands of Mobile, Monroe, Washington, Cullman counties (Dr. Mohr).

R. erecta. DC (R. tomentosa var erecta T. & G). Dry pine wood soils from middle Alabama south. Lee (Mell), Russell (Dr. Neisler), Mobile (Dr. Mohr) counties.

R. galactioides, Endl. Dry sandy soils in south Alabama. June. Mobile, Baldwin (Dr. Mohr).

R. minima, DC. Damp soils in extreme south Alabama. Mobile county (Dr. Mohr), July.

37. **CERCIS,** L. *Red bud—Judas tree.* TREES.

C. Canadensis, L. Generally distributed over the upper half of the State. Handsome tree with bright pink flowers early in February. Lee, Coosa, Clay, Tallapoosa, Talladega (Mell), Russell (Dr. Neisler), Cullman, Winston, Madison, Lauderdale, Morgan (Dr. Mohr) counties, extending into Tennessee (Killebrew).

38. **CASSIA,** Tourn. *Senna.* HERBS.

C. Marilandica, L. *Wild American senna.* Growing in the lower half of the State in rich soil—Mobile, Clark, Choctaw counties (Mohr)—August.

C. tora, L. (C. obtusifolia, L). *Wild senna.* Extending over the State from south to north, along the banks of streams, Tennessee (Killebrew), Russell and Muscogee, Ga. (Dr. Neisler), Mobile (Dr. Mohr), Lee (Mell).

C. occidentalis, L. Introduced species in portions of middle and south Alabama. Lee (Mell), Russell (Dr. Neisler), Mobile, (Dr. Mohr).

C. chamæcrista, L. *Partridge pea.* Common in dry, barren soils in most sections of the State. Tennessee (Killebrew), Cullman, Lauderdale, Mobile, Baldwin (Dr. Mohr), Lee, Montgomery, Wilcox (Mell), Russell (Dr. Neisler).

C. nictitans, L. *Wild sensitive plant.* Rather common over the State, in sandy soils. Montgomery, Lee (Mell), Russell (Dr. Neisler), Mobile, Cullman (Dr. Mohr).

39. **GLEDITSCHIA**, L. *Honey locust.* THORNY TREES.

G. triacanthus, L. *Three thorned acacia.* Common throughout the State.

40. **NEPTUNIA**, Lourn. PERENNIAL HERBS.

N. lutea, Benth. Damp sandy soils along the coast—Mobile (Dr. Mohr)—June.

41. **DESMANTHUS**, Willd. HERBS OR SHRUBS.

D. brachylobus, Benth. In alluvial soils along streams, Mobile, Montgomery (Dr. Mohr).

42. **SCHRANKIA**. Willd. *Sensitive briar.* PERENNIAL PROSTRATE HERBS.

S. uncinata. Willd. Sandy soil. Lee county (Mell) June, August.

S. angustata. T. & G. *Narrow leaved sensitive briar.* From south to north Alabama. Mobile, Clark, Washington, Munroe, Cullman (Dr. Mohr), Tennessee (Killebrew).

In addition to the species mentioned in the preceding list, the following may also exist in Alabama. The evidence in the possession of the author is not, however, positive enough to warrant their insertion in the list given:

Baptisia tinctoria, R. Br.—B. leucophæa, Nutt—B. microphylla, Nutt—Cladrastis tinctoria, Raf—Trifolium amphianthum, T. & G.—Medicago sativa L—Psoralea lupinellus, Michx—Indigofera letosepala, Nutt—Robinia viscosa Vent—R, hispida L—Astragalus plattensis, Nutt—A Canadensis, L—A. glaber, Michx—A. obcordatus Ell—Lespedeza angustifolia, Ell—Lathyrus pusillus, Ell—Rhynchosia reniformis DC.—Gleditschia aquatica Marsh—Mimosa strigillosa T. & G.

ORDER 43. **ROSACEÆ.** (ROSE FAMILY).

1. **CHRYSOBALANUS, L.** LOW SHRUBS.

O. oblongifolius. Michx. Dry Sandy soils in south Alabama. May, June. Mobile, Monroe, Baldwin, Washington, Escambia, Choctaw counties (Dr. Mohr).

2. **PRUNUS.** Tourn. *Plum, Cherry.*

P. Americana. Marsh. *Wild yellow or red plum* Lee, Tallapoosa, (Mell), Clark, Cullman, Winston, Lauderdale (Dr. Mohr) counties. March, April.

P. maritima. Wang. *Beach plum.* Sea coast. Mobile. (Dr. Mohr).

P. umbellata. Ell. *Southern bullace plum. Sloe. Wild plum.* Tallapoosa, Montgomery (Mell), Baldwin, Mobile, Wilcox (Dr. Mohr), Russell (Dr. Neisler). February, March.

P. Chicasa. Mich. *Chickasaw plum.* Old fields. Marsh extending nearly over entire State.

P. serotina. Ehr. *Wild black cherry.* April, May. Lee, Macon, Tallapoosa (Mell), Russell (Dr. Neisler), Mobile, Clark, Blount, Cullman, Madison (Dr. Mohr).

P. Caroliniana, Ait. *Mock orange.* Lee, Macon (Mell), Russell (Dr. Neisler), Mobile, Pike (Dr. Mohr), an introduced species escaped from hedges.

3. **NEVIUSIA.** Gray. SHRUB.

N. Alabamensis. Gray. Growing in only one place in the State, near Tuscaloosa. It was discovered in 1857 by

Rev. R. D. Nevius, an Episcopal clergyman. It is a handsome plant with many showy flowers.

4. **SPIRÆA**, L. *Meadow sweet.* SHRUBS OR PERENNIAL HERBS.

S. aruncus, L. *Goats beard.* Growing in the northeast portions of State. June. Coosa (Mell), Cullman (Dr. Mohr).

5. **PHYSOCARPUS**, Maxim. *Nine bark.* SHRUBS.

P. opulifolius, Maxim. Tallapoosa, Coosa (Mell), Lauderdale (Dr. Mohr). April, May.

6. **GILLENIA**, Mœnch. *Indian physic.* PERENNIAL HERBS.

G. trifoliata, Mœnch. *Bowman's root.* Cullman, Madison, Autauga (Dr. Mohr). June.

G. stipulacea, Nutt. *American ipecac.* Mountains of Alabama. Coosa (Mell), Cullman (Dr. Mohr). June.

7. **RUBUS**, Tourn. *Bramble briar.* PERENNIAL HERBS.

R. occidentalis. L. *Black raspberry, thimbleberry.* Winston county (Dr. Mohr). May.

R. villosus, Ait. *Common or high blackberry.* Common everywhere.

R. hispidus, L. *Running swamp blackberry.* Along the flank of Lookout Mountain, DeKalb county (Dr. Mohr). May, June.

R. cuneifolius, Pursh. *Sand blackberry.* Lee, Montgomery (Mell), Monroe, Clark, Escambia, Tuscaloosa (Dr. Mohr).

R. trivialis, Michx. *Low bush blackberry.* Common in sandy soil everywhere. April.

8. **GEUM**, L. *Avens.* PERENNIAL HERBS.

G. album, Gmel. Borders of woods. Montgomery (Mell), Autauga, Tuscaloosa, Lauderdale, Cullman, Madison (Dr. Mohr). April, May.

9. **FRAGARIA**, Tourn. *Strawberry.* PERENNIAL HERBS.

F. Virginiana, Mill. *Wild strawberry.* Rich woods.

Lee, Macon, Russell (Mell), Lawrence, Franklin (Dr. Mohr).

F. Indica, L. Introduced in south Alabama—Baldwin, Mobile, Choctaw counties (Dr. Mohr).

10. **POTENTILLA,** L. *Cinque-foil, Five-finger barren strawberry.* HERBS OR SHRUBS.

P. Canadensis, L. Lee, Coosa, Montgomery (Mell), Tuscaloosa, Lawrence, Cullman (Dr. Mohr). July, August.

11. **AGRIMONIA,** Tourn. *Agrimony.* PERENNIAL HERBS.

A. Eupatoria, L. *Common agrimony,* (or A. striata Michx). Growing in Russell (Dr. Neisler), Tuscaloosa, Autauga, Cullman (Dr. Mohr). August.

A. parviflora, Ait. *Small flowered agrimony.* Tuscaloosa (Dr. Mohr), Coosa (Dr. Smith), Clay, Tallapoosa, Talladega (Mell). August.

A. incisa, T. & G. Dry open woods in south Alabama, Baldwin, Mobile (Dr. Mohr), Coffee (Mell). August.

12. **ROSA,** Tourn. *Rose.* PRICKLY SHRUBS.

R. setigera, Michx. *Climbing or prairie rose.* Morgan county (Dr. Mohr). June. Chapman reports this species growing in Florida along swamps. It should therefore be also found in south Alabama.

R. Carolina, L. *Swamp rose.* Madison, Franklin (Dr. Mohr). June.

R. humilis, Marshall. *Dwarf wild rose.* Talladega, St. Clair, Madison (Dr. Mohr), Lee, Coosa, Randolph (Mell), Russell (Dr. Neisler). May, June.

R. canina, L. *Dog rose.* Introduced near Mobile and naturalized (Dr. Mohr).

R. bracteata, Wend. Naturalized near Mobile (Dr. Mohr).

R. rubiginosa, L. *Sweet briar Eglantine.* Tuscaloosa county (Dr. Mohr).

R. lævigata, Michx. *Cherokee rose.* Found in many sections of middle and south Alabama.

13. **PYRUS**, L. *Pear, apple.* TREES OR SHRUBS.

P. coronaria, L. *American crab apple.* April. Lee, Tallapoosa (Mell), Russell (Dr. Neisler).

P. angustifolia, Ait. Lee, Montgomery, Macon (Mell), Mobile, Baldwin, Clark, Choctaw, Cullman, Jefferson, Tuscaloosa (Dr. Mohr) counties. April.

P. arbutifolia, L f. *Red choke berry.* Lee (Mell), Russell and Muscogee, Ga. (Dr. Neisler). Growing in damp soils on borders of swamps.

P. arbutifolia, var. **erythrocarpa** Chap. *Choke berry.* Mobile, Baldwin, Cullman (Dr. Mohr) Tallapoosa, Clay (Mell).

14. **CRATÆGUS**, L. *Hawthorn, whitethorn.* THORNY TREES OR SHRUBS.

C. spathulata, Michx. *Spathula shaped leaved thorn.* Tallapoosa, Clay, Macon, Talladega (Mell), Choctaw, Autauga, Cullman, Morgan, Montgomery (Dr. Mohr) counties. April.

C. viridis, L. (C. arborescens, Ell). Mobile, Clark, Choctaw, Baldwin, Dallas, Hale, Wilcox counties (Dr. Mohr). March, April.

C. apiifolia, Michx. *Parsley leaved thorn.* Lee, Montgomery, Tallapoosa (Mell), Russell (Dr. Neisler), Baldwin, Mobile, Wilcox, Dallas, Tuscaloosa (Dr. Mohr). River swamps. March, April.

C. coccinea, L. Coosa, Clay, Talladega, Randolph (Mell), Montgomery, Tuscaloosa, Franklin, Madison (Dr. Mohr) counties. Open woods. April, May.

C. coccinea var **mollis**, T. & G. Clark, Cullman (Dr. Mohr) counties.

C. crus-galli, L. *Cockspur thorn, white thorn.* Montgomery, Macon, Tallapoosa (Mell), Cullman, Morgan, Franklin, Madison (Dr. Mohr). April, May.

C. æstivalis, T. & G. South Alabama. Mobile (Dr. Mohr). March, April.

C. flava, Ait. *Summer haw, yellow haw.* Clark (Mell), Baldwin, Monroe (Dr. Mohr) counties. May.

C. glandulosa, Michx. *Glandular thorn.* Mobile (Dr. Mohr).

C. parvifolia. Ait. *Dwarf thorn. Small-leaved thorn.* Sandy soil, Macon, Tallapoosa, Montgomery (Mell), Mobile, Clark, Cullman (Dr. Mohr). April—May.

15. **AMELANCHIER**, Medic. *June-berry.*

A. Canadensis T. & G. *Shadflower—Service-berry.* Quite common in nearly all sections of the State. February—March.

The following species of Rosaceæ have been also reported to the author as growing wild in the State, but the evidence is not strong enough to include them in the above list.

Prunus Virginiana L—Cratægus tomentosa L—Cratægus punctata, Jacq.

The following species mentioned in this bulletin are considered valuable for agricultural and commercial uses.

Forage plants: Crotalaria sagittalis, Trifolium pratense, T. repens, T. reflexum, T. procumbens, Melilotus officinalis, M. alba, Medicago lupulina, Astragalus plattensis var Tennesseensis, Desmodium nudiflorum, D. pauciflorum, D. cuspidatum, D. paniculatum, D. Canadense, Lespedeza procumbens, L. violacea, L. Stuvei, L. polystachya, L. capitata, L. striata, Vicia sativa, V. Caroliniana, V. micrantha, Lathyrus venosus, Apios tuberosa (root bears tubes which are eatable; hogs are fond of them). Centrosema Virginianum, Strophostyles angulosa, Galactia glabella, G. pilosa (excellent forage for cows). Desmanthus brachylobus.

Ornamental plants: Amorpha fruticosa—leaves large, of a pleasant green color and beautifully pinnated. Flowers purple and singular in structure. Wistaria frutescens, Erythrina herbacea, Cercis Canadensis, Prunus Caroliniana, Neviusia Alabamensis, Spiræa aruncus, Physocarpus opulifolius, Rosa setigera, R. lævigata, Cratægus spathulata.

Lumber and Cabinet Work: Robinia pseudacasia, Cercis Canadensis, pruna serotina.

Medicinal and Commercial: Indegofera Caroliniana (indigo), Cercis Canadensis (dye wool of fine nankeen color), Cassia Marilandica (senna from leaves and pod), Prunus serotina (bark for tonic, &c.), Agrimonia eupatoria (with bismuth dyes wool beautiful color—a powerful astringent.)

Fruit plants: Prunus Americana, P. maritima, P. chicasa, Rubus occidentalis, R. villosus, R. cuneifolius, Fragaria Virginiana, F. Indica, Pyrus coronaria, Cratægus coccinea, C. flava, C. glandulosa.

Hedge plants: Prunus Caroliniana, Cratægus apiifolia, C. crus-galli.

BULLETIN No. 71. APRIL, 1896.

ALABAMA

Agricultural Experiment Station

OF THE

AGRICULTURAL AND MECHANICAL COLLEGE,

AUBURN.

EXPERIMENTS WITH FOREIGN COTTON.

P. H. MELL.

MONTGOMERY, ALA.:
THE BROWN PRINTING COMPANY, PRINTERS.
1896.

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☞The Bulletins of this Station will be sent free to any citizen of the State on application to the Agricultural Experiment Station, Auburn, Alabama.

EXPERIMENTS WITH FOREIGN COTTON.

BY

P. H. MELL.

Within recent years much attention has been attracted to foreign cottons, especially those of India and Egypt, because of the yearly increased importation of the staple into this country. It is claimed by a few experts that the fibre, in some respects, is superior to the ordinary "upland" varieties grown in the South, and that there is danger of the importation increasing to such an extent as to seriously injure the trade in American cottons. The Indian cotton is generally noted for its rich creamy color, its ready adaptability for certain dyes and the property the thread has of swelling in the process of bleaching, so that the cloth made of it becomes more substantial than that manufactured from the coarser grades of American cottons. These foreign staples are also used in the United States for mixing with the low grade American fibres to improve their color and the quality of the cloth.

Several of the Experiment Stations in the South have cultivated some of the varieties of the cotton from India and Egypt in order to compare their properties with our native forms, but, so far as the knowledge of the writer goes, there have been no regular systematic experiments conducted in any state extending over a period of several years, except at the Alabama Station. Of course nothing definite can be determined about any foreign plant until it has become acclimated by several years careful cultivation. The experiments at Auburn have been planned to accomplish first this result.

The first step taken in these investigations was, therefore, to acclimate the plants; secondly, to secure the best results possible in health of plant, maturity of fibre and the yield of lint that the conditions of the soil and climate would permit; and thirdly, to so blend the best properties of the foreign cotton with those of the superior grades of American varieties as to produce an exceptionably fine cotton plant.

This bulletin contains the results secured through the first and second steps, and the data are much more gratifying than the author anticipated. During the season ot 1895 several hundred crosses were made between the best American cottons and these foreign species and the seeds were carefully gathered and assorted for cultivation during the coming season. From the present outlook some very interesting facts will be secured from these experiments. It is the intention of the writer to issue a bulletin after this crop is gathered to discuss the results secured by the third step in the plan outlined above.

In conducting these experiments the following so-called varieties were secured from India, Egypt and Mexico, and most of them were first planted in 1894. (Three of the varieties, however, viz: Mit Afifi, Bamieh and Mannoah were first planted in 1893):

Bajwara,	Mirzapore,
Bamieh,	Mit Afifi,
*Bani,	"Mexican resists drought,"
*Bombay,	"Mexican,"
Broach,	"Mexican,"
*Bourbon,	*"Nagpur jari,
‡Creula,	Narma,
Deshi,	Nadam,
Ghoghari,	Nimari bani,
*Guchard,	*Painaa,
Herbucco,	‡Roji,
Indrepur,	Surat Kupas,
*Jari,	*"Tree cotton" (Mexico,)
Jakko,	"Upland Georgian" (Mexico,)
Mannoah,	*Wagaria Wadhwan.

*These failed to germinate.

‡Requires two years for maturing balls.

As an indication of the importance of continued and careful experiments with these cottons before final conclusions are drawn the following extracts are taken from bulletin No. 65 issued by this Station June, 1895. The Department sent out to the cooperative seed test experimenters some of these foreign cotton seeds before they were acclimated at this station and the reported results of one season's cultivation are thus given :

Franklin County.—"Bamieh, Egypt. Yield 600 lbs per acre; quality good; growth vigorous and large, but bolls are too small for a desirable cotton."

Perry County.—"India Cotton No. 1. Quality poor; growth large stalks; yield very poor; staple short, and is inferior to any of our native varieties."

Madison County.—"Afifi, Egyptian. Lint, cream colored, medium length and very fine and silky. Appears to be hardy as to cold; was not injured by spring frosts when other varieties were damaged. Grows from six to ten feet high. Yield about 300 lbs per acre.

Bibb County.—"Egyptian cotton. Yield per acre very poor; quality inferior; lint short and yellow."

Tallapoosa County.—"Egyptian cotton. Yield about 600 lbs per acre. Lint very long and strong. Another variety is worthless on account of the smallness of bolls and being so few on the stalk."

Pickens County.—"Egyptian cotton. Yield per acre about 200 lbs. Quality of product, fine strong fibre, dingy color. Stalk large, bolls small, does not pay for cultivating."

[The expression "fine strong fibre" seems to contradict this hasty conclusion.]

Morgan County.—"Egyptian cotton. Yield about 200 lbs per acre. Lint very fine and weak. Stalks from 3 to 6 feet high, very few limbs and bolls."

Chilton County.—"Egyptian cotton. Yield about one-third bale per acre. Lint short, bolls scattering, very large growth."

Etowah County.—"Egyptian cotton. Complete failure."

Hale County.—"Egyptian cotton. Yield per acre 1,200 lbs. Quality good."

Blount County.—"Egyptian cotton. Yield about 400 lbs seed cotton per acre. The quality of the lint was very fine and yellow. The growth tall, limbs long, bolls very small and scattering."

Pike County.—"Egyptian cotton. Yield about 300 lbs per acre. Growth rapid, stalks from 6 to 10 feet high."

Lauderdale County.—"Egyptian cotton. Yield about 250 lbs per acre. Quality of product good. Growth vigorous, 3 to 5 feet high. Yield poor on account of maturing so late. Afifi. Yield practically nothing. Growth extremely vigorous, from 6 to 10 feet high."

The statements made by these experimenters appear quite contradictory for the reason that three important factors are overlooked. 1. The term "Egyptian Cotton" is too indefinite. The list given on page 300 will show that there are several species growing in Egypt as prominently distinct from each other as exists between the so-called "Peerless" and the sea Island species. 2. The soil in one county differs materially from that in another—particularly is this true when the counties are separated by the length of the state. 3. The seeds sent out from Auburn were those direct from Egypt and India, and therefore not acclimated.

The following items in reference to the derivation of the local names of these cottons may be of interest:

Broach, Baroach or *Bharuch,* is a comprehensive term and is used to indicate the finer grades of cotton. It is the name of a district in India.

Manuah, Mannoah or *Jettooee,* in its native clime yields one-eighth of clean cotton, but it is cultivated with other crops. It requires nearly a year to mature.

Miduopore or *Mirzapore* is the largest cotton mart in India.

Nadam is an inferior grade of cotton and is grown in the district of the same name in India not for exportation, although it is used for adulterating the best grades which are sent to other countries. It is a triennial and poor bearer, and the fibre is cleaned with difficulty.

Narma or *Nurma,* sometimes also called *Deo-Kupas,* is a fine silky cotton. It is the name of a section in India. The plant bears ten to twelve years in its native country. The fibre is more than one inch long and is used for the manufacture of the finest linens. It is cultivated near the temples for making the robes of priests.

Surat Kupas is named after an important seaport town through which most of the cotton from one district is shipped. This term is often used in a general sense for cotton coming from *Surat, Broach,* and *Berar* districts. *Kupas* signifies clean cotton, or ginned.

Wagaria, Wagriah or *Wadhwan* is also the name of a district in India and represents an annual cotton growing to the height of 2 or 3 feet with a single tapering stem. The bolls do not open wide, but remain closed except a crack at the apex. There is considerable trouble necessary to force them open and extract the fibre. The bolls are gathered from the plants and afterwards opened by children. This cotton is suitable for the manufacture of only the coarser grades of cloth.

The other names mentioned in the list are local rather than descriptive.

Prior to 1810 the Indian and Egyptian cottons were coarse and of an inferior quality. But since that year a systematic effort was made by the English Government to improve the character of the plant by blending it with the American upland and sea Island varieties with remarkable success. The war between the states from 1861 to 1865 greatly encouraged the cultivation of cotton in these foreign countries. Commissioner Young in his report of the cotton exhibit at the Paris Exposition in 1878, says: "From this exhibition I learned that the cotton of all or nearly all of the Indian provinces has been greatly improved by the introduction of American seed. It was in Dharwar that our

American planters obtained the greatest success, and I am told that the entire crop in this province is now from seed originally American."

BOTANICAL CLASSIFICATION.

A careful examination of the foreign cottons under consideration would classify them as follows :

1. *Gossypium herbaceum* var *microcarpum* Tod: Broach, Ghoghari.
2. *G. Wightianum* Tod: Nadam, Deshi, Jakko, Roji, Nimari bani.
3. *G. roseum* var *albiflorum.* Tod : Indrepur, Ghoghari, Surat Kupas, Mirzapore, Roji.
4. *G. hirsutum* var *album* Tod: Indrepur, Herbucco, Surat Kupas, Mirzapore.
5. *G. maritimum* Tod: Jakko, Manuah, Mit Afifi.
6. *G. maritimum* var *polycarpum* Tod: Bamieh.
7. *G. Brazililiense* Macf: Guchard, Creulo.

The seed, when delivered at Auburn in 1893 and 1894, were badly mixed, rendering it difficult in most instances, to determine which plant represented the local name given on the package. It will thus be noted that in the above seven species and varieties the same local name has been repeated. After gathering the first year's crop the seeds were carefully assorted, however, and the classification made as above stated.

A detailed description of these species is given in accordance with "Relazione sulla Cultura dei Cotoni—Monografia del Genere Gossypium" by Agostino Todaro.

1. *Gosypium herbaceum*, var *microcarpum* Tod. Stem erect, covered with long soft hair ; branches spreading, slightly pyramidal ; leaves 3–5 lobed, rarely 7 lobed, lobes rotundate obtuse, apex minutely mucronate ; stipules linear lanceolate, acuminate very short ; peduncle erect and nearly equal to half of peteole ; bracts ovat - cordate, with sharp cut teeth, general outline of bract leaf rotundate, bases united ; coralla longer than the bracts, obovate, unequally wedge shaped, yellow, marked at base with purple spots, after flowering the outside surface turns reddish ; bolls small ovate, hardly

subrotundate, apex deeply hollowed out, 4-5 celled, cells 6-7 seeded; seeds ovate, short mucronate at hilum, covered with thick closely adhering fibre, in some cases white ash-gray, short, in other cases rather long and white.

Broach—Ghoghari.

2. *Gossypium Wightianum* Tod. Stem erect and covered with soft hairs; branches spreading, slightly ascending, leaves rather rotundate, obscurely obcordate, 3-5 lobed, lobes ovate, obtuse with bases drawn together or wrinkled, the depressions between two lobes obtuse with small dentiformed lobes now and then interjected, stipules semiovate, somewhat sickle shaped, otherwise linear lanceolate, all acuminate; peduncles erect during the blooming period but recurved during fruiting; bracts ovate, very small, base united, cordate, acute, small serrated; corolla longer than bracts, obovate, unequally shaped, yellow, base spotted dark purple but after flower opens, petals turn red; bolls very small, ovate, 8-seeded; seeds small ovate-subrotundate, densely covered with fibre; fibre short and closely adhering and white.

Nadam, Deshi—Jakko—Roji—Nimari barie.

3. *Gossypium martimum*, Tod. Glabrous, stem erect, branched, tall; branches graceful, spreading, subpyramidal ascending, and later recurving; leaves rotundate-ovate, sub-cordate, 3-5 lobed, sometimes intermingled with other entire leaves, lobes ovate, ovate-lanceolate, or lanceolate-oblong, depressions between lobes subrotundate; single peduncle above the axis of leaf and stem, an inch long during flowering period, but afterwards elongating; bracts broadly ovate, cordate, adhering at middle of base with calyx, but not coalescing among themselvs, deeply cut into lobes, lobes near base slightly broader, lanceolote, terminating with an elongated point; corolla longer than bracts, petals yellow, or pale sulphur color, not entirely expanded during flowering period; lower part of style free from stamens and equal in length to anther-bearing column. Style somewhat three parted; boll ovate-conical, acute, three to four celled, 6-9 seeded; seeds beaked at hilum, black, smooth and covered with long silky fibre.

Jakko, Manuah, Mit Afifi.

4. *Gossypium maritimum* var *poly carpum* Tod. Stem erect, simple; 1-3 peduncles in the axis of each leaf; few if any branches.

Bamieh.

5. *Gossypium roseum* var *albiflorum* Tod. Stem erect, branches slender, spreading profusely, pyramidal, slightly ascending; leaves palmate parted, cordate, marginally fringed with hairs, segments 5-7, lanceolate acute, base somewhat narrowed, depression rotundate,

two lower segments containing little interjected lobes; stipule near peduncle semiovate, dentate, the other linear-lanceolate, somewhat curved like a scythe, both acute and covered with downy hairs bracts rotundate covered with long weak hairs throughout its entire length, ovate, cordate, deeply dentate from apex to middle, in the lower portions much less dentate, half united; flowers bell shaped and corolla is about equal in length to the bracts. Short bract-like petals of corolla in the act of flowing approximately convolute in the tube, obovate, base coalescing to each other almost contracted into a claw, apex rotundate, dirty white, and purple spotted from the base nearly to the middle; calyx base contracted unequally dentate; naked anther column pubescent beneath, the remaining portion of style tube anther-bearing; boll very small ovate-acuminate, reddish, three celled, cells 5-6 seeded; seeds clothed with thick fibre, in some instances ash gray, very short and strongly adherent, while in other cases the fibre is short and rather reddish.

Ghoghari--Indrepur-Mirzapore--Surat Kupas--Rogi.

6. *Gossypium hirsutum* var *album*, Tod. Stem erect, branches spreading, slightly ascending, pyramidal, hairy; leaves ovate rotundate cordate, 3-5 lobed, those found at end of branches are at times acute and entire, lobes truncate-semiovate, subtriangular, acute or acuminate, the middle lobes larger and longer, at fold acute plicate; stipules ovate lanceolate, unequalateral, sharp rigid pointed, the other portion lanceolate acuminate; bracts large ovate, acuminate, in the upper portion deeply cut into many narrow lobes, in the lower part simply dentate, the clefts are elongate linear produced at the apex into an attenuated point; corolla large, longer than bracts, during flowering period considerably expanded, petals pale sulphur color, afterwards rolling up and turning red; style long, exserted; boll large, walnut shaped, generally four celled, apex rotundate terminating abruptly into a short point; seeds ovate covered with short white fibre firmly adherent.

Indrepur--Herbucco--Surat Kupas--Mirzapore.

7. *Gossypium Brazililience* Macf. Stem strongly, shrubby, erect, branched; leaves very deeply cordate, 5-7 lobes, widely radiate, spread out below the base nearly the length of the petiole; bracts ovate-rotundate, longer than the convoluted corolla, deeply cut into narrow lobes; boll ovate, acuminate, shorter than bracts, cells 7-9 seeded, seeds closely adherent, wrapped up in long fibre.

Guchard--Creulo.

The following table shows the results of microscopic examination of the foreign cottons. Three of the best varieties of the American cottons are also given for the purposes of comparison.

Local Names of Cotton.	Length of fibre. Millimeters*.	Diameter of fibre. Millimeters*.	Maturity of fibre.	Condition of twist of fibre.	Rupture Strain of Fibre Expressed in Grammes*. Several trials to rupture a single strand.	Average.
Bajwara	32.0	0.024, 0.032	Medium	Fair	5.140, 5.875, 10.460	7.158
Bamieh	42.0	0.024, 0.040	Excellent	Excellent	16.700, 22 733.	18.717
Broach	30.0	0.028, 0.032	Fair	Fair	5.810, 6.840, 15.600	9.413
Deshi	29.0	0.024	Irregular	Good	7.475, 8.775, 15.350	10.533
"Georgia Upland," India	36.0	0.032	Excellent	Excellent	13.600, 14.535	14.068
Ghoghari	30.0	0.032	Fair	Fair	12.200, 14.460.	13.330
Herbucco	30.0	0.032	Irregular	Fair	5.320, 9.830, 6.315, 12.575	8.610
Indrepur	38.5	0.032	Good	Good	4.110, 8.885, 9.335	7 443
Jakko	40.0	0.028, 0.032	Good	Good	14.260, 16 380	15.320
Mannoah	31.5	0.032	Good	Good	10.200, 12.750, 18.750	13.933
Mirzapur	38.4	0.032	Medium	Poor	6.250, 7.920	7.085
Mit afifi	38.0	0.032, 0.048	Excellent	Excellent	12.610, 10.335	11.472
Mexican	27.0	0.024, 0.048	Medium	Fair	2.925, 4.100, 6.705	6.865
Mexican	28.0	0.016, 0.048	Good	Good	9.250, 11.075	10.163
Narma	23.0	0.016, 0.032	Good	Good	9.585, 15.585	12.585
Nadam	33.0	0.032, 0.048	Fair	Good	7.120, 9.780	8.450
Nimari bani	27.0	0.016, 0.032	Fair	Fair	10.055, 11.668	10.862
Surat Kupas	28.0	0.032	Fair	Good	6.750, 12.375	9.562
Cherry Cluster	22.4	0.019, 0.027	Excellent	Excellent	9.348, 17.608, 19.345	15.434
Cook, W. A	38.7	0.020	Good	Good		7.590
Peerless	18.5	0.016 0.024	Fair	Medium	5.811, 10.276, 14.022	10.055

* 1 Gramme is equivalent to 15.43 grains; 1 Millimeter is 0.039 of an inch.

Robt. A. Conley.

BULLETIN No. 72. JULY, 1896.

ALABAMA

Agricultural Experiment Station

OF THE

AGRICULTURAL AND MECHANICAL COLLEGE,

AUBURN.

A Study of Skin Tumors of Horses and Mules in Alabama.

S. L. COLEMAN.

MONTGOMERY, ALA.:
THE BROWN PRINTING COMPANY, PRINTERS.
1896.

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A STUDY OF THE SKIN TUMORS OF HORSES AND MULES IN ALABAMA.*

—BY—

S. L. COLEMAN.

It is my endeavor to give the results of my investigations of the common skin tumors which are so frequently found upon horses and mules that are brought to the free clinics for treatment.

I have made no new discoveries as to the origin and cause of these tumors, nor do I desire to advance any new theories as to their origin; but, by the advice of Dr. Cary who has kindly furnished me with the material for the study, I have attempted (by collecting several of these tumors from different animals, and studying them individually and collectively with special reference to their history and their macroscopical and microscopical appearances) to place them under their proper classification. In the first place, as their name indicates, they are tumors; that is, they are neoplasms or pathological growths of an embryonal character, developing without inflammation. This variety of tumor is almost painless; it is, of course, not entirely devoid of sensation; it may be more sensative than normal skin; yet, when compared with most sacomas and carcinomas, it may be called painless. These neoplastic growths are tumor-like in their origin; that is, they originate without any apparent cause—somewhat spontaneously. We do not know why or how they orig-

* Mr. S. L. Coleman was a post-graduate (1895-96) in the A. and M. College at Auburn, Ala., and worked up this bulletin as a thesis for a post-graduate degree while studying histology, pathology and bacteriology in the Veterinary Department.—C. A. C.

inate; but their history proves them to be non-hereditary. So far as we can learn by the aid of the microscope, they are not caused by parasites, and they are not of a nervous origin. However, there is some slight indication that they may be of a mechanical or inflammatory origin; but admitting this, it would not give us all the causal factors; since there must have been some unknown favorable condition of the system to produce the morbid growth that follows the mechanical irritation. These tumors are very frequently found upon regions of the body which, on account of their location, are little liable to irritation. For instance, in several cases which were brought to the college free clinic, these tumors were found upon the ears, the breast, the inside of the legs and on the sides of the neck—places little liable to irritation; hence, could not be so produced except by uncommon accidental mechanical irritation. It is true that after the tumors have begun to grow, mechanical irritation will augment their development, cause them to grow more rapidly and larger.

These tumors are composed of multiplying or proliferating cells; the growth or enlargement is not due simply to an increase in the size of the individual tumor cells, but to a multiplication and enlargement of the cells.

These tumors are vascular; are supplied with neutrient blood by branches from the vessels of the subcutaneous connective tissue, in which they are generally found imbedded.

The shape of these tumors depends upon their location; as a rule, they approximate a spherical form. If they are crowded or pressed by a limb or by another tumor, they will assume a shape corresponding to the pressure to which they are subjected; hence, they may be oval, pear shaped, or somewhat flattened, but when they occur on a free surface they generally approximate a sperical form.

According to one classification, tumors are divided into three groups:

1. The Simple or Histoid tumors which are composed

almost entirely of the tissues of which the body is composed, generally of some form of connective tissue; such as neuroglia, bone, cartilage, white fibrous tissue, or adipose tissue.

2. The Sarcomatous tumors are composed largely of embryonic tissues, which may, in some cases, reach a partial development, but the growth of the tissues always stops before reaching the highest stage of development.

3. Carcinomas or Cancerous tumors are those in which any of the elementary tissues of the body may be present, but these tissues are present usually in an erratic manner.

Since the morbid skin growths have been classified as tumors, the question arises, to which of the above three groups do the skin tumors belong?

Some writers classify similar tumors under the head of fibromas (fibrous tumors); others take a stand half way between the first and second groups and call them sarcofibromas. Evidently, it is rather difficult to distinguish between a young or embryonal fibroma and a spindle-celled sarcoma. A spindle-celled sarcoma is composed of young or embryonal fibrous connective tissue cells; the embryonal or young fibroma contains young fibrous connective tissue cells very like those found in a spindle-celled sarcoma. However, after the fibroma has reached a greater degree of maturity, it is comparatively easy to distinguish it from a sarcoma.

In none of the cases, which I have studied with the microscope, have I found anything characteristic of the sarcoma; but in every case, as I hope to show by the accompanying plates, I have found them to be distinctly fibromatous, fibrous tumors.

The fibromas are divided into the hard and soft variety.

The soft fibroma is nothing more or less than young connective tissue; the tumor contains more cells than fibres, and its cellular elements are not so highly developed as in the hard fibroma. The soft fibroma bears a greater similarity to the sarcoma than the hard fibroma.

A careful study of the microscopical sections (illustrated by the accompanying plates) proves, beyond question, that these tumors are distinctly fibromas; some of them approach more nearly the soft variety, while others are evidently hard fibromas.

The seat of the fibroma is in the mucous, the muscular or the subcutaneous connective tissue. All of the tumors or fibromas, studied by me were found in the subcutaneous connective tissue. But the sarcoma is also found in this same locality, so that we find nothing peculiar about the seat of these skin tumors to preclude the possibility of their being sarcomas.

Macroscopical Characteristics.—As before mentioned, these skin tumors vary in size and shape. Some of the young tumors are less than one-fourth of an inch in diameter, while others may be three or more inches in diameter. They are all somewhat spherical in form, but their shape is determined largely by the pressure of the surrounding tissues.

As a rule, more than one of these tumors appear on an animal at one time. In all cases that I have observed and investigated there were several tumors found on the same animal. In one instance, there were more than fifty tumors cut from one mule. However, it is not always the case that these tumors are multiple; but, in rare instances, a single tumor may be found on an animal.

These tumors varied somewhat in their action under the knife. In some cases the spherical, shining pearl-like tumors popped out with slight pressure as soon as the knife cut through the thin capsules or the skin overlying them. Other tumors belonging to the same group would require the knife to sever them from their connection with the surrounding tissue.

When microscopic sections were cut of these tumors, I found that each section presented a white shining waxy appearance. On pressure, these tumors vary in their relative degree of consistency; but, as a rule, they are quite firm.

Microscopical Characteristics.—An examination of thin sections of these tumors, with the microscope, show that they consist principally of dense bundles of white fibrous tissue, which in some cases presents a somewhat embryonal appearance; but still the tissue is too highly developed to admit the tumor to the group of sarcomas.

In the case of fig. 9 we have a section through a collection of young skin tumors, which have just burst through the skin. Note in fig. 9, A, the fibrous capsules encircling the little embryonal tumors. Fig. 9, C, shows the character of the tissue of the young tumors, when magnified 534 diameters; while D shows the character of the encircling capsules when magnified the same number of diameters. Also, note that in all these cuts the fibrous bundles, of which the tumors are largely composed, run in various directions. Furthermore, notice that these tumors, as a rule, are not very vascular; and that the blood vessels, which they do contain, have not very highly organized or developed walls.

Nos. 2, 3, 4, 5, show very few blood vessels.

Fig. 9, B, represents two arteries, a cross section of one and a longitudinal or oblique section of the other. The two vessels are in the subcutaneous connective tissue and not in the tumor proper. This illustration is given to show the difference between the degree of development of the walls of the blood vessels in the surrounding normal tissues and the tumor proper.

In almost every point these tumors agree microscopically with the fibroma. Their highly developed white fibrous connective tissue cells, and the general lack of embryonal sarcomatous cellular character will serve to distinguish them from the sarcoma. Moreover, the sarcoma is always very vascular, much more so than the average fibroma.

I learned from the clinical experience of Dr. Cary, that these tumos have never given metastasis; that is, they have never extended to internal organs or surfaces. This is another point which goes to prove that they are not sarcomas. The only sarcoma that recurs without metastasis is the myeloid or giant celled variety. But the common skin tumors do not in the least resemble this variety of sarcoma. So far as I can see, there is only one point of resemblance between these skin tumors and the spindle-celled sarcoma. The embryonal cells in the young skin tumor may resemble the spindle cells of a sarcoma; but the tissues surrounding these cells and the further development of the cells in the fibroma prove conclusively that the young skin tumors are not sarcomas.

After the removal of one of these skin tumors, a peculiar tumor may form in its place, which is nothing more or less than an abnormal growth of granulation tissue, or "proud flesh" as it is commonly called. These exuberant granulation tumors occur in the following way: When the original skin tumor is removed, the cavity must be filled up and closed by granulation tissue, forming what is commonly known as scar tissue. Layer after layer of embryonal granulation cells are formed on the sides and bottom of the wound, made by the excision of the original tumor. (Sometimes the original tumor drops out or is torn out leaving a wound very similar to, but smaller than, the wound usually made when the tumor is cut out.) The layers of granulation cells are supplied with nutriment by the loops of capillary blood vessels; new capillary loops accompany the rapidly growing, dividing embryonal granulation cells. But, before the lips of the wound unite, there must be a formation of epithelium, either from the extension of the epithelial cells on the edges of the wound or from the granulation cells. When the epithelium is formed by neither of these processes, we have, as a result, a growth of what is called exuberant granulations or "proud flesh." If the wound is irritated by the animal's biting or rubbing it, and possibly by the action of septic germs, this epithelial covering can not be formed. In other words, periodic irritation will prevent the healing of a wound and produce a granulation tumor.

Some sarcomas are composed largely of embryonal connective tissue cells; granulation tumors are composed of very similar embryonal cells; hence, the latter are sometimes called sarcomas. It may be that an examination of these secondary granulation tumors has led some observers to classify the common skin tumors under the head of sarcomas.

The common skin tumors are frequently called warts, and this mistake is due to the fact that many persons designate all surface tumors as warts.

The wart is technically called a papilloma; its prototype is the papillae of the skin. The connective tissue sends up papillae which become greatly enlarged and are supplied with a network of blood vessels from the subcutaneous connective tissue. These enlarged papillae become surrounded with epithelium which varies in character with the location; foı instance, if the papilloma is on the skin it is surrounded with flat scale-like epithelium, but if it is on a mucous membrane it is surrounded with a thinner and more delicate capsule. The papilloma (wart) of the skin is usually much smaller and less vascular than the skin tumors of fibromas. In some instances it may require a microscopical examination to determine whether a tumor is one of these fibromas or a papilloma.

TREATMENT.

1. *Surgical.*—First, cut away the long matted and filthy hair around the tumor; clean the tumor and the surrounding skin with soap and water and then apply some antiseptic; such as, a two per cent. creolin solution, or 1 to 1000 mercuric chloride solution. Take the knife in the right hand, cut the skin from around the tumor, preserving as much of the skin as possible, but taking great care to remove completely all of the morbid growth. In most cases where the skin has not been broken, the tumor will pop out as soon as an incision is made through the skin and the capsule, and a little pressure is applied. In other cases, the knife must be used to remove the tumor from its at-

tachment to the surrounding normal connective tissue. Where the tumor is quite small it may be cut out with the curved scissors; this, of course, will remove a small amount of skin that surrounds and covers the tumor. In some instances, where the tumor has broken through the skin and has grown to any size, it may be torn from its attachment by a sudden pull with the hand. Occasionally, the tumor may have dropped out or have been cut out and its place filled with exuberant granulations; in such cases the superfluous granulations may be removed with the knife, the scissors, or the curette. After completely removing the tumor, apply strong carbolic acid, or pulverized copper sulphate. These may be applied and held in place for a short time by means of a small pledget of cotton.

The after treatment consists in cleaning the wound once per day with clean cotton, and water that has been boiled and cooled; then apply enough to cover the surface, of one of the following prescriptions:

(a) ℞. Creolin.............. 4 fluid drachms.
Glycerine........... 3 fluid ounces.
Pure water.......... 1 pint.

Mix. Apply after cleansing the wound as above directed.

(b) ℞. Carbolic acid....... 2 fluid drachms.
Zinc sulphate....... 4 drachms.
Glycerine .... 3 fluid drachms.
Pure water .... 1 pint.

Mix. Apply as directed for (a).

(c) ℞. Iodoform........... 1 drachm.
Tannic acid......... 3 drachms.
Sulphur............. 1 ounce.
Vaseline .... 1 "
Glycerine, quantity sufficient to make make a free flowing mixture (6 to 12 fluid ounces).

Mix. Apply as directed for (a).

2. *Potential Cautery or Sloughing.*—This method of treatment may be used when the knife is considered dangerous,

because the operator is inexperienced or the base of the tumor is very large and too much bleeding would follow the use of the knife.

Clean the tumor and the skin around it with soap and water; oil the skin around the tumor with lard or vaseline; cover the raw tumor with a thick layer of pulverized copper sulphate; place a large wad of cotton over the tumor and hold it in place by a bandage applied very tightly. (Avoid cutting off the circulation by having a broad bandage and plenty of cotton under the bandage during its application.) Leave this bandage on for a week; keep the animal standing as quietly as possible, tied in a single stall. At the end of a week, remove the bandage and if the tumor can not be readily pulled away with the fingers, apply the pulverized copper sulphate, the cotton and the bandage as before. Keep up these weekly applications until the tumor is entirely gone; then treat the wound with prescription (a), (b) or (c). It may be well to state that the bandage must be kept fixed or it will irritate and thus stimulate the growth of the tumor.

This method of potential cautery can be used only when the tumor is on a limb or in some place where a bandage can be readily applied. In places where a bandage can not be applied, the following caustic may be used:

℞.	Arsenious acid (white arsenic)...	4 drachms.
	Caustic potash (stick)..........	2 "
	Gum arabic......................	4 "
	Pure water......................	1 fluid ounce.

Mix and label "Poison." Thoroughly clean the tumor and the skin around it; oil the skin around the tumor with lard or vaseline; apply with a swab a thick layer of the sticky mixture all over the free and raw surface of the tumor; tie the animal's head so that it can not reach the tumor with its mouth, at least for one day. (In fact, it is essential to devise some means to prevent the animal from biting or gnawing the tumor or the healing wound, all the time.) In ten or twelve days, the whole tumor or part of it that has been destroyed by the arsenic, may be pulled or torn away by the fingers. In case the tumor is not all destroyed by the first application, apply it again, being very careful to cover the skin around the tumor with lard or vaseline previous to the application in all instances. Never apply this very strong caustic a second time sooner than twelve to twenty days after the first application. Usually, one application is sufficient. On the abdomen, the lips, the cheeks and the eye-lids, this remedy should be used with great caution, because it is liable to make a hole entirely through the walls of these parts.

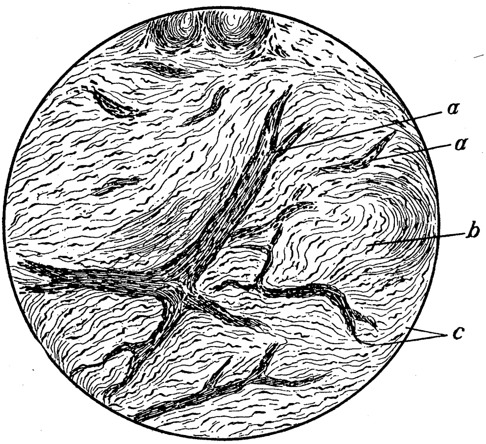
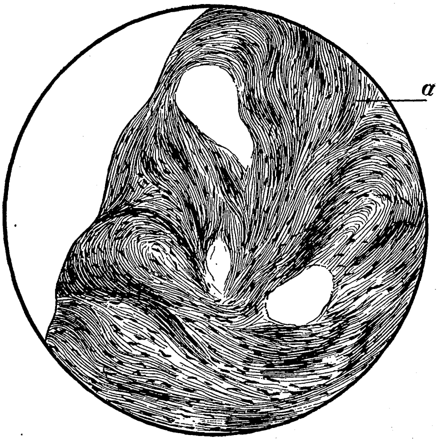
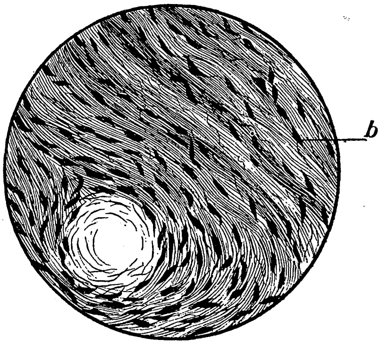
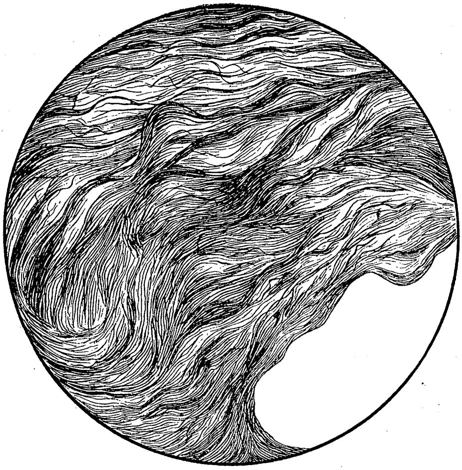


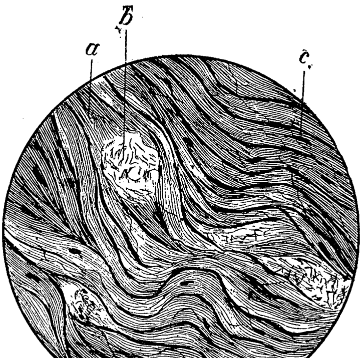
Fig. 1.—Section of tumor from side of mule. Tumor, 3 inches in diameter. a, a, blood vessels situated between the fibrous bundles; walls of vessels not well developed; b, fibrous tissue; the fibres running in various directions. Magnified 74 diameters and nuclei brought out with borax carmine.





FIG'S. 2 AND 3.—Section of hard fibrous tumor, one of many taken from skin of horse. Bundles of fibres run in various directions; blood vessels very few. a, bundles of fibres showing distinct nuclei (x74); b, nuclei under higher power (x534).





FIG'S. 4 AND 5.—Section of tumor from subcutaneous connective tissue of horse. a, dense fibrous bundles; b, dense fibrous bundles cut across; c, nucleus of connective tissue cell. Note that the nuclei or cells are less numerous in this section than in Fig's. 1 or 3. Fig. 4, x74; Fig. 5, x534.

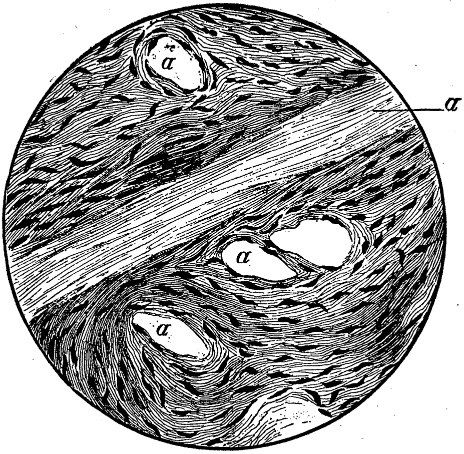
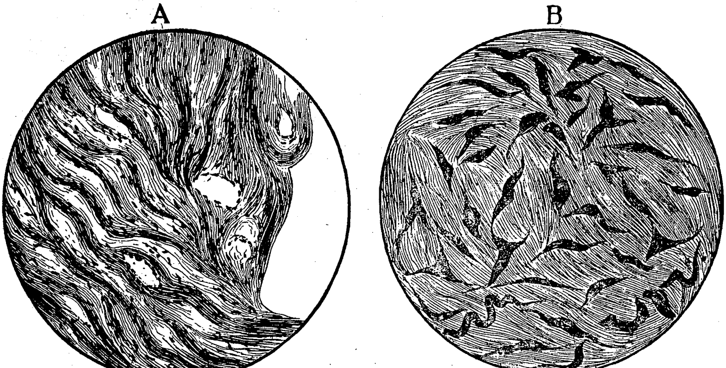


Fig. 6.—Section of fibrous tumor from subcutaneous connective tissue of horse; nuclei of cells very distinct and numerous; blood vessels large but their walls are not well organized; a, blood vessels. Magnified 534 diameters.



Fig's. 7 and 8.—Section of tumor from subcutaneous connective tissue of horse. A x74; B x534. Tumor smooth, firm; not very vascular; in loose capsule. Bundles of fibres wavy and nuclei of cells very distinct.

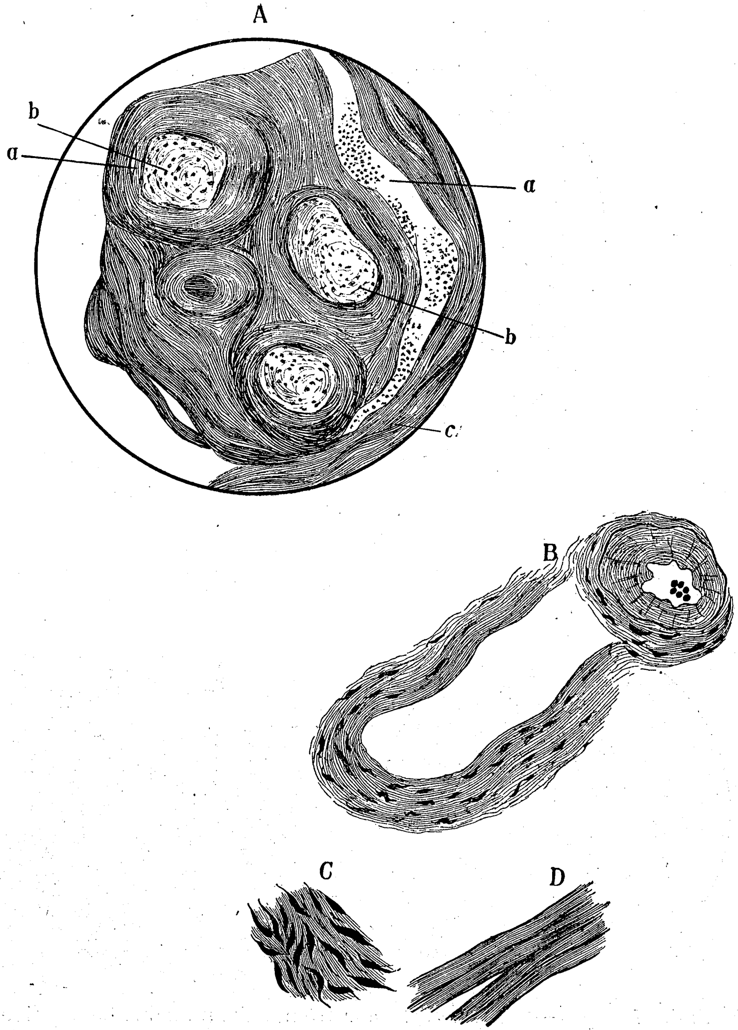


FIG. 9.—Section of multiple skin tumors, from the same horse as Fig's. 7 and 8. The blood vessels in the tumors are not well developed, but the vessels, just below the tumors in the subcutaneous connective tissue, are numerous and large. The young tumors are surrounded by concentrically arranged fibres, and young tumors are made up chiefly of young, spindle-shaped connective tissue cells.

A, (x74) a, Blood vessels; b, encapsulated multiple tumors; c, fibrous tissue. B, (x534) cross and oblique section of two arteries, jnst below the multiple tumors in A. C, (x534) represents b of A under a higher power. D, (x534) represents c of A under a higher power.

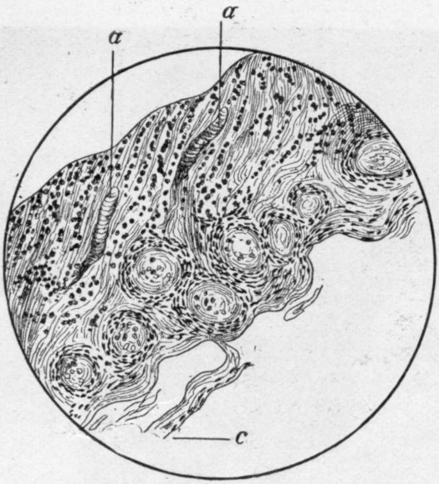


FIG. 10.- Section of multiple tumors from same horse as 7, 8, 9. a, blood vessels; b, small young fibrous tumors; c, cut off, pigmented epithelial cells (x74).

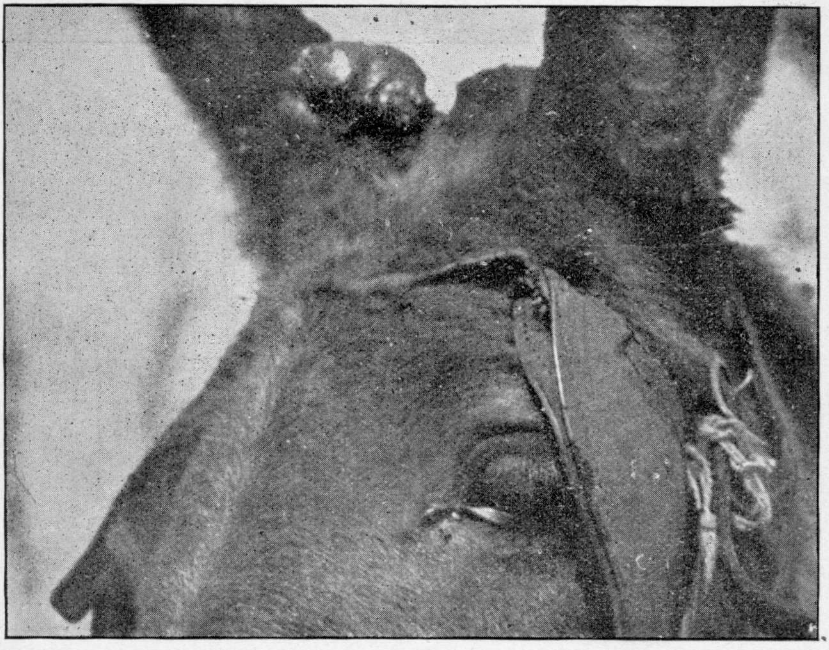


FIG. 11.

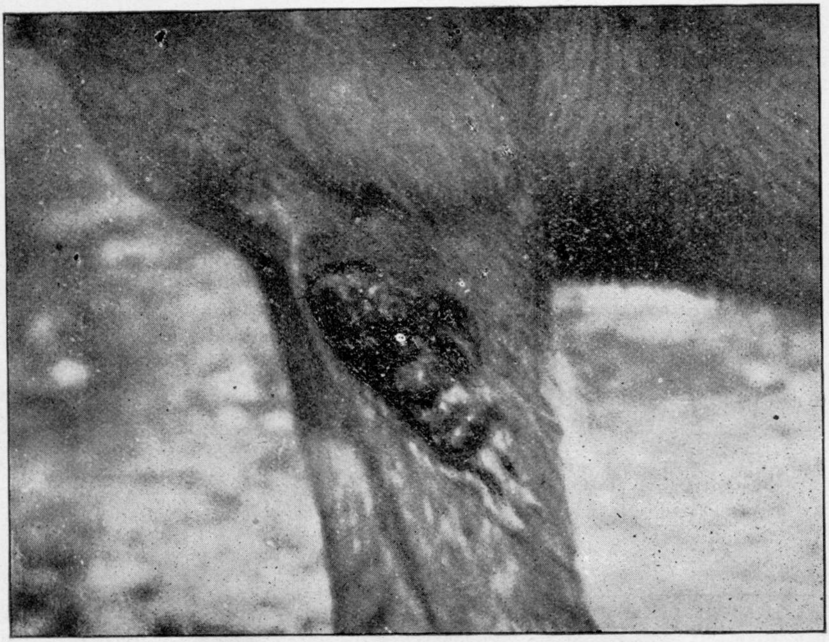


FIG. 12.

FIG'S. 11 AND 12.—Photographic representations of fibrous tumors on the ear and fore-arm; tumors have broken through the skin and look very like granulation tumors.

APPENDIX.

Classified List of Tumors taken from the Free Clinic Records for the Four Years Ending July 1st, 1896.

Fibromas.

1. Gray gelding, 4 years old, several tumors, excised and cauterized surfaces with thermo-cautery; results unknown.

2. Mule with a large raw tumor on lower part of right flank, one small tumor on sheath; excised, result unknown.

3. Mule with raw tumor on right ear, one on outside of left thigh, one on outside of forearm; excised; prescribed equal parts of tar and vaseline to be applied daily. Did not return. (These tumors illustrated in cuts Nos. 11, 12.)

4. Gelding with 2 large and 2 small tumors; removed with the knife and ecraseur; applied chromic acid; prescribed (c) page 318.

5. Colt, 2 years old, 1 tumor on leg, 1 on the abdomen and 1 on the ear; removed with shears and ecraseur; applied strong carbolic acid; never returned.

6. Mule with tumor on lip and one on rib region; excised and applied strong carbolic acid; result unknown.

7. Mule with skin tumor on side of abdomen; excised; applied strong carbolic acid; prescribed tannic acid 1 part, glycerine 4 parts; results unknown.

8. Mule with one small fibrous tumor on breast; excised; never returned.

9. Mule with a large "bleeding" fibroid on abdomen and several small ones on the perineum. Excised; no return.

10. Dark gray mule with about 50 fibrous tumors; largest ones on abdomen and around base of left ear; many small

ones, from the size of a pea to one inch in diameter, were located over the abdomen, on sides of thorax, in the groins and axillae, and over the limbs. There were so many small ones that some were over-looked in the process of cutting them out. Applied pulverized copper sulphate; prescribed (b) page 318. In six months, many of the small ones, that had been over-looked in previous operation, were now large enough to be easily located and removed. Two years after the second operation, three or four small tumors were found on this mule.

11. Gray horse with tumor in anterior part of a left axillae; upon cutting through the skin it was easily pressed out of its capsule; prescribed (c) page 318.

12. Mule with skin tumor on left knee; excised and applied strong carbolic acid; prescribed (c).

13. Colt, 2 years old, with bleeding tumor on fore-arm; excised; applied strong carbolic acid; prescribed (c). Never returned.

14. Gelding, 11 years old, with one large raw tumor on abdomen, a few small ones on the sheath, on the breast and in the axillae; excised and applied strong carbolic acid; prescribed (c). In six months the small tumors that were not easily located at the first operation were now distinct and readily removed.

15. Mule, 7 years old, with fibrous tumor in right groin and involving right side of mammary gland. excised; prescribed (b).

16. Mule, 10 years old, with fibrous tumor at base of ear; excised; applied strong carbolic acid; prescribed (c).

17. Mule, 3 years old, with a fibroid on right elbow for three weeks; excised; applied strong carbolic acid; prescribed carbolized oil.

18. Mule, 8 years old, with fibroid on sheath for two years; excised; applied strong carbolic acid; prescribed (c). Never returned.

19. Bay stallion, 3 years old, with fibroid on right upper eye-lid; excised; applied strong curbolic acid; prescribed carbolized oil.

20. Bay mare mule, 4 years old, with fibromas in left axillae; excised; applied strong carbolic acid; prescribed (b).

21. Mare, 3 years old, with fibroma on right ear; excised; cauterized with strong carbolic acid; prescribed carbolized oil.

22. Mule, 7 years old, with several fibromas; excised; applied copper sulphate; prescribed (b).

23. Bay mule, 5 years old, fibroid on abdomen; excised. Owing to neglect, a granulation tumor developed in a short time; it was excised; pulverized copper applied, and (b) prescribed. Never returned.

24. Sorrel gelding, 3 years old, with fibromas in right axilla; excised; applied strong carbolic acid; prescribed (b).

25. Bay mare mule, 10 years old, with large fibroid on abdomen just in front of mammary glands; excised; applied copper sulphate; prescribed (a). Never returned.

26. Black gelding, 5 years old, with a hard fibroid lying deep in the fascia of the external tibial region; excised; prescribed a 2 per cent. creolin solution. Never returned.

This tumor contained small pockets of fine chalky material and the fibrous tissue was thoroughly impregnated with lime in the central portion of the tumor.

27. Mule, 3 years old, with numerous fibroid tumors on upper eye-lid and on the breast. These tumors were so little and numerous that it was impossible to remove them all without cutting away large patches of skin. As many as practicable were cut out; applied copper sulphate and prescribed (b).

In twelve months, the little tumors that were not removed had developed until they were larger than those that were first removed; also, tumors were then visible on other parts of the body.

28. Gray mare, 4 years old, with fibromas on various parts of body. Excised; applied pulverized copper sulphate; prescribed (b).

29. Black mare, 7 years old, with fibromas on mammary gland, abdomen, groin and flank; excised; applied copper sulphate; prescribed (b).

30. Black mare, 5 years old, with small hard fibroid on border of lower jaw; cut out; applied copper sulphate; prescribed (b).

31. Bay mule, with fibrous tumors on pole and on left hind limb; excised; applied copper sulphate; prescribed (b).

32. Bay gelding, 5 years old, with fibrous tumors on the ears; cut off; treated same as No. 31.

33. Bay mule, 15 years old, with hard fibroid on left rib rigion, 3 to 4 inches in diameter, growing for 5 years; excised; prescribed (a). Never returned. Microscopic examination proved it to be a hard fibroid with calcareous degeneration.

34. Sorrel gelding, 5 years old, with fibrous tumor on left fore-arm; excised; applied copper sulphate; prescribed (b). Never returned.

35. Sorrel mare mule, 6 years old, with fibrous tumors on external surface of right ear; cut off; treated same as No. 34.

36. Mule, 10 years old, with fibrous tumor on right rib region, very large and hard. Excised; applied copper sulphate; prescribed (a). Never returned. This tumor had been growing for 5 years. It was a hard fibroid with calcareous degeneration.

37. Bay mule, 8 years old, with fibroid in right axilla; excised; applied pulverized copper sulphate; prescribed (a). Never returned.

38. Mule with hard fibroid in thigh region; excised; never returned. It had undergone calcareous degeneration.

39. Sorrel mule with fibrous tumor on external tibial region; excised; applied copper sulphate; prescibed 2 per cent. creolin solution.

40. Sorrel mule, 8 years old, with fibrous tumors all over the body, chiefly in the groins and axilla and on the ears. Excised (40 or 50) as many as could be easily found; prescribed (a).

41. Sorrel mule, 4 years old, with fibrous tumor on posterior surface of right knee; excised; applied copper sulphate; prescribed (a).

Granulation Tumors.

1. Mule with granulating "sores" on rib region and on breast. In curetting away the exuberant growths a slight grittiness was perceptible, indicating calcareous degeneration; this made the growths more consistent and more definitely granular. Another peculiar characteristic was observed; this hard granular growth extended quite a distance under the skin, and could be easily removed by pushing the curette up under the skin. After removing as much of the granular growths as possible with the curette, strong carbolic acid was applied and the following was prescribed: Carbolic acid, 2 drachms; Iodoform, 1 drachm; Tannic acid, 1 ounce; Glycerine, 1½ pints. Mix. Apply daily after washing. In 4 or 5 weeks the wounds had all healed and there were no more signs of their return that year. But the next spring "the same kind of sores broke out all over the body and got so bad that I took the mule off and killed him" (owner).

2. Bay mule, 6 years old, with exuberant granulations on inside of left hind pastern. Cut it off even with the surface, applied pulverized copper sulphate and then a bandage. As soon as the bandage was removed the mule was worked; the opposite foot struck the raw surface and the mule habitually gnawed it. Consequently, new growths were removed from this place eight times during the next two years. At present (June, 1896) a new growth as large, or larger than, any that were removed from the same place is now to be found; also, another tumor of the same nature has appeared, and has been removed 3 or 4 times, on the inner surface of the upper end of the canon region of the same leg. Microscopical sections of these tumors show that they are made up largely of embryonal cells not unlike the spindle cells of a sarcoma.

In one sense this tumor might be called a malignant, spindle-celled sarcoma. However, it is best to regard it as resulting and recurring from mechanical irritation, and most probably extending from the same cause. It is well to add that the mule was kept quiet only a short time during these attempts at treatment and much of the time he was at work in the plow or wagon.

3. Mule, 12 years old, with a very large granulation tumor on inside of left hock. Caused by sticking a knife into a varicosed vein (blood spavin) and injurious applications. Sliced away the greater part of the granulations; applied pulverized copper sulphate and bandaged for two weeks; prescribed (a). Good recovery in 6 or 8 weeks.

4. Spanish Jack, 4 years old, with large granulation tumors on each limb. On one hind limb the growth covered the entire outside and part of the front surface of the fetlock, the canon and the hock. The jack was greatly emaciated and had a very poor appetite. Applied pulverized copper sulphate and bandaged as directed on page 319. This jack was kept in the college hospital and the bandages were maintained in a fixed position by keeping the animal quiet and by close attention. In nine or ten weeks the bandages were left off and thereafter only creolin washes and carbolized oil and tannic acid were applied. In about six months these places had healed and the jack was in a greatly improved condition. But from some unknown cause he was impotent; "he had no ambition." It is very probable that he was impotent when received for treatment.

Recently, Dr. W. A. Heck of Keokuk, Iowa, has been very successful in treating granulation tumors by cutting them down even with the surface and then giving internally a teaspoonful of fluid extract of ergot three times daily. The ergot tends to cut off the extra blood supply to the granulation tumor.—(C. A. C.)

Papillomas (Warts).

1. Gray colt, 2 years old, with extensive growth of "seed warts" (papillomas) on inside surface of both ears. Clipped them off with the scissors; curetted the surfaces, and applied corrosives sublimate by rubbing large crystals over the raw surfaces. One week later, applied strong carbolic acid, and prescribed (c). These growths were so heavy that the ears were bent over. They never returned.

2. Colt, 1 year old, with warts on the internal surface of each ear; excised and cauterized with strong carbolic acid; never returned.

3. Filly, 3 years old, with papillomas on internal surface of each ear; curetted away the warts; applied strong carbolic acid; prescribed (c). Some of the warts were not entirely removed; hence, a second operation was required.

4. Bull calf, 2 years old, with papillomas on right thigh and groin; excised; applied strong carbolic acid; prescribed (c). Never returned.

5. Dog with papilloma on toe of front foot; excised; cauterized with strong carbolic acid; never returned.

6. Bay filly, 18 months old, with papillomas on internal surface of each ear; excised; applied pulverized copper sulphate; prescribed (c).

7. Hen, 2 years old, with two abnormal growths on one wing. Microscopic examination proved them to be composed of imperfectly developed papillae and feathers.

8. Grade Jersey heifer, 2 years old, with numerous papillomas on abdomen and limbs; excised all that were large enough to find; applied pulverized copper sulphate. In the course of a year, many of those that were invisible at the time of the operation developed into prominence.

9. Sorrel mare, 5 years old, with papillomas on inside surface of each ear; cut and curetted them away; applied copper sulphate; prescribed (c). Never returned.

10. Bay stallion, rising 3 years old, with papilloma on end of the tail; clipped it and part of tail off with bone cutting forceps; prescribed (a). Never returned.

SARCOMAS.

1. Gray mare with melanotic (pigmented) sarcoma just below the inferior commissure of the vulva; removed with the ecraseur; cauterized with strong carbolic acid; never returned.

2. Bay mare mule, 6 years old, with sarcoma in eye socket; removed the entire contents of the eye socket; the tumor returned, invaded the frontal sinus and possibly the

cranial cavity; mule died in about five weeks after the operation.

3. Gray mule, 24 years old, with melanotic sarcoma on left buttock; excised; prescribed "white lotion." Result unknown.

4. Pointer dog, 8 years old, with melanotic sarcoma on side of scrotum; excised and wound healed nicely in short time. Six months later a great number of tumors appeared in the subcutaneous connective tissue in various parts of the body; the dog exhibited symptoms of indigestion, lung trouble, and brain lesions (inability to properly control voluntary movements). Post mortem revealed numerous melanotic sarcomas in the pleura and peritoneum and two in or under the pia mater. Microscopic examination showed them to be round-celled sarcomas with less pigment than is usually found in melanotic sarcomas of the horse.

5. Gray mare, 17 years old, with numerous melanotic sarcomas in the subcutaneous connective tissue, scattered over the surface of the body. There were some signs that the lungs and other internal organs had been invaded. Only one large tumor was removed.

Carcinomas.

1. Mule with fungus-like growth on membrana nictitans (eye washer); removed with the shears the tumor and the "washer." The tumor returned in about six months; removed it again; result unknown.

2. Black Essex sow, 3 years old, with tumor in mammary gland; removed by excision three times within a year; at present no sign of return or of extension. Microscopic examination proved it to be a round-celled carcinoma.

3. Sorrel horse with a malignant tumor involving the right side of the face and extending from the right eye downward and forward into the right maxillary sinuses and destroying all the outer wall of the sinuses with which it came in contact. The animal was destroyed.

Reports of all infectious, contagious or peculiar diseases occurring in Alabama will be thankfully received by the Veterinary Department.

BULLETIN No. 73. OCTOBER, 1896.

ALABAMA

Agricultural Experiment Station

OF THE

AGRICULTURAL AND MECHANICAL COLLEGE,

AUBURN.

Edible Fungi: A Wasted Food Product.

LUCIEN M. UNDERWOOD.

MONTGOMERY, ALA.:
THE BROWN PRINTING COMPANY, PRINTERS.
1896.

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☞The Bulletins of this Station will be sent free to any citizen of the State on application to the Agricultural Experiment Station, Auburn, Alabama.

EDIBLE FUNGI: A WASTED FOOD PRODUCT.

—BY—

LUCIEN M. UNDERWOOD.

Among the neglected products of America suitable for food, none are so little understood as the mushrooms. The same is more or less true among all Anglo-Saxon peoples, yet the English are more accustomed to their use than either the Americans or the inhabitants of the colonies. Strikingly in contrast with this is the condition that prevails in continental Europe where various species of fungi form a very general article of diet and are prized alike by the nobleman in his palace and the peasant in his hut. Many species are dried during the growing season and saved for winter use when a fresh supply cannot be obtained, and in this form large quantities are imported to this country and used as food by emigrants from various European countries. In some countries, France especially, they are extensively canned and in this form are exported to America where they are used at the larger hotels and restaurants, and frequently in private families, though the price of the imported material is usually so high that their use under these conditions cannot become very general. In this connection it should be noted, that, while immense quantities of finer mushrooms annually go to waste in this country than those imported in cans from France, the native forms are rarely collected and sold for food except in the immediate vicinity of the larger cities. We pay from thirty-five to fifty cents for a small can of inferior French mushrooms, and allow bushels of the same species in much finer quality to rot in our fields and forests. A few years since I was obliged to wait for a train at a railroad crossing in Indiana. It was soon after the early fall rains and in a field adjoining the crossing I could easily have picked two or three bushels of *Agaricus campestris* while waiting for my train. When I reached Chicago on the train I found an inferior quality of the same species selling for fifty cents a pound in the open market.

Many people are not aware that a considerable number of our common fungi or "toadstools"* are valuable articles of food, equal in nutritious elements to oysters, fish, or flesh, which various forms of our native species resemble in flavor and composition.

I find many others who are well aware that certain forms of mushrooms are useful for food, but are afraid to attempt their use because they fear they will be poisoned by the use of some unwholesome species. While it is a fact that many species are unfit for food, and a certain few are undoubtedly poisonous, this is no reason why we should neglect all mushrooms as articles of food. It would be as senseless to reject all kinds of berries because some berries are poisonous, or all kinds of root-foods because certain roots are poisonous. While the discrimination of the many species of fungi in a strictly scientific way is possible only to the few, certain common fungi that are useful for food are as readily distinguished from each other as currants are from pokeberries, or wheat from barley. In Germany, children are taught to discriminate the ordinary edible and poisonous fungi as a part of their school training and they can easily separate the edible forms from among a miscellaneous pile of many species. It argues a lack of good common sense for people to claim that they cannot learn how to distinguish one form of mushroom from another, for if they know beans from corn they can learn to distinguish the more common forms of edible fungi so as to recognize them at sight.

The species of fungi growing in the state of Alabama have not yet been sufficiently studied to give a complete list of the edible species that occur here, nor even to indicate the forms that are the most common during successive years. Rev. M. A. Curtis who studied the fungous flora of North Carolina for many years, published a list of over one hundred

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* Also called "frog stools" in some parts of Alabama. Some people suppose that the so-called "mushrooms" are edible while "toadstools" are poisonous. We know no such distinction, and in different places they are called either mushrooms or toadstools irrespective of their edible or non-edible characters.

edible species occurring in that state. There is no reason why most of the same species and perhaps others should not occur within our limits. We can only give at present notes on a few species that are common and have come under our direct observation during the past season.

Mushrooms, as we are familiar with them, are seemingly of rapid growth and appear most frequent, soon after a warm rain, though at the latitude of the central portion of Alabama they may be looked for during almost any season of the year. Certain species have a somewhat definite period in which to develop and do not vary far from their season year after year. Other species seem to appear at all seasons of the year whenever the conditions of heat and moisture are favorable for their growth. The real growing or vegetative parts of the mushroom are rarely seen; they consist of slender interlacing threads called *mycelium*, which penetrate the soil or other subtratum on which the mushroom grows, and often extend to great distances and thus draw nourishment from a wide area. The mushroom having no green coloring-matter (*chlorophyll*) like ordinary vegetation, is unable to produce starch from inorganic materials, so must depend for its food on materials that have been already organized; these are found in decaying vegetable matter of various kinds scattered through the soil. The portion of the mushroom which we know as such is simply the spore-producing part of the plant. Many people cultivate mushrooms in stables or cellars or even in special pits prepared for the purpose. These mushroom beds are sown with the so-called "spawn," sold by dealers in garden seeds, which consists merely of masses of this mycelium grown among the fragments of a mixture of stable manure and muck. The species most commonly grown is one that is more or less common in a wild state throughout the United States and is known as

THE FIELD AGARIC OF FIELD MUSHROOM (*Agaricus campestris*).
[Figure 1].

This is a typical umbrella-shaped mushroom, of which form we have many species. The plant consists of a cap or pileus (*pi*) resting on a central stalk; underneath the cap appears a series of thin radiating plates which are known as the *lamellæ* or *gills;* part way down the stem appears a shreddy membranous ring called the *annulus;* this ring (*an*) is orignally in the form of a veil which extends from the stem to the margin of the pileus so as to completely cover up the gills; as the pileus grows larger the veil breaks away from the edge of the pileus and remains in the form of a more or less complete ring about the stem. These parts are shown in Figure 1 which illustrates this species.

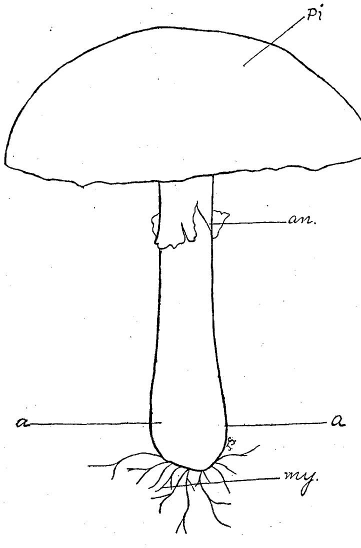

FIG. 1 Agaricus campestris; Edible; showing mycelium (*my*) constituting the underground *growing* portion of the plant; the annulus (*an*); and the pileus or cap (*pi*) being turned toward us does not show the gills or lamellæ beneath. The line *a a* represents the surface of the ground. Color of pileus white or grayish. About ⅔ natural size of ordinary specimens, though the size varies grea ly; the stem also is often very short.

The common field agaric has a normally white pileus though this may be more or less varied with grayish flecks or spots. It can be readily distinguished by the four following marks, all of which should be present to be certain of the species, though the first two will separate it from all the deleterious forms that might be confused with it:

1. The gills are at first pink and with age turn brownish and finally become watery and nearly black.*

2. There is a distinct veil which later appears as a ring or annulus on the stem.

3. The gills do not reach entirely to the stem.

4. The stem is either solid or stuffed with a cottony substance.

The field agaric more commonly appears in the fall of the year dependent to a great extent on the time of the fall rains. In Alabama it appeared last year at intervals from November to February. It more commonly appears in open places, notably in fields where sheep or horses are pastured. It can be cooked in any method which is adapted to oysters, though is best fried in a minimum of butter with proper seasoning. It is the most commonly eaten species of cool or moderately warm countries and is the species mentioned above as being imported from France as canned goods.

Another species which appears to be very common in the summer season in Alabama is known as

CÆSAR'S AMANITA (*Amanita cœsarea*). [Fig. 2.]

The species of *Amanita* are quite commonly regarded as poisonous and a number of them are known to be violently so. This noble fungus, however, is an exception to the rule and has been in use as an extensive article of food in Southern Europe since the time of the Romans. Under the name of "Boletus" it was fully described by Pliny as to its growth and development, and it was regarded as a dish of great excellence by the Roman epicures. In September, 1893, I saw hundreds of bushels of this fungus brought daily

* This darkening is due to the ripening of the spores which are borne on the gills. A pretty experiment to show the spores of this or other kinds of mushrooms can be easily performed by cutting off the pileus and placing it on a piece of white paper, gills downward, under a tumbler or bowl. In from two to twelve hours (according to the ripeness of the plant) the spores will drop down on the paper in lines radiating out from the position of the stem. In the field agaric these spores will be dark brown or almost black. In other species they may be white, salmon colored, rusty yellow or various shades of brown up to black.

into the street markets of Genoa by the peasant women and sold as a common article of food. During the past summer when it was next to impossible to procure fresh beef in the markets at Auburn, bushel upon bushel of this fungus grew and went to waste in a single piece of woods within a mile of town, and in traveling on the railroads quantities of the same bright-colored fungus could be seen from the car windows in various other parts of the State.

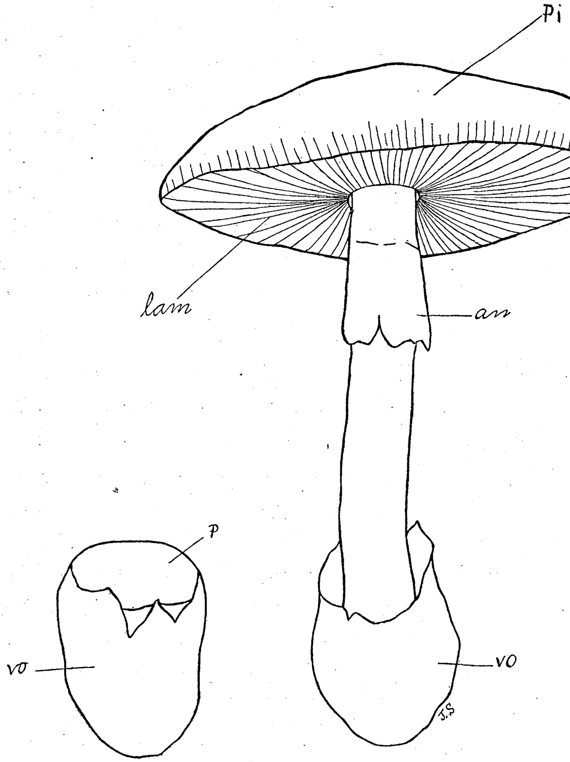

FIG. 2. Amanita cæsarea; EDIBLE, showing young plant at the left just emerging from the volva, and fully expanded plant with cup-like volva (*vo*), annulus or ring (*an*), lamellæ or gills (*lam*) and smooth pileus (*pi*). Color of pileus usually bright or orange yellow. About ⅓ natural size.

The genus *Amanita* presents an additional structure to the ones above discussed and a character which is of vital importance in discriminating this particular species. By reference to Figure 2, this structure can be clearly seen. At the base of the stem of the mature fungus appears a cup with a somewhat irregular border; this is called the volva (*vo*) for in the young condition of the plant, the volva envelopes the entire fungus like a wrapper; as the plant expands, the pileus pushes through this wrapper leaving its remains in the form of a persistent cup at the base of the stem. The species is a large one, often standing 8 to 10 inches high, and with a pileus 5 to 8 inches across when fully expanded. The pileus is of a bright reddish-yellow color, sometimes fading to a paler yellow color when older; the pileus is smooth and is never adorned with shreddy fragments of the volva; the gills and stem are pale yellow and there is a distinct veil which ultimately hangs like a skirt-like annulus on the stem; *the distinctive character, however, is the persistent cup at the base of the stem,* in connection with the combination of colors in pileus and gills above noted; if the cup (*volva*) is not present, the plant is not Cæsar's Amanita but is likely to be the fly-agaric which is poisonous! A *white* species with such a persistent cup is likely to be the white Amanita which is also poisonous! No one, however, having once seen Cæsar's Amanita with its bright orange or reddish-yellow pileus and delicate pale yellow stem and gills and distinct cup at the base could mistake it for anything else. In order, however, to emphasize the contrast between the two somewhat common members of the same genus we will present them in parallel columns:—

CAESAR'S AMANITA (*edible*)!	THE FLY-AGARIC (*poisonous*)!
1. Volva persistent at the base of the stem in the form of a cup.	1. No cup; base of stem mostly bulbous and scaly.
2. Pileus bright orange or rarely paler yellowish, smooth.	2. Pileus orange or yellow adorned with flocculent warts consisting of patches of the ruptured volva.
3. Gills and stem pale yellow.	3. Gills and stem white, the gills rarely slightly yellow-tinted.
4. Gills free, *i. e.* separate from the stem.	4. Gills attached to the stem and appearing to run down it in the form of slight ridges.*

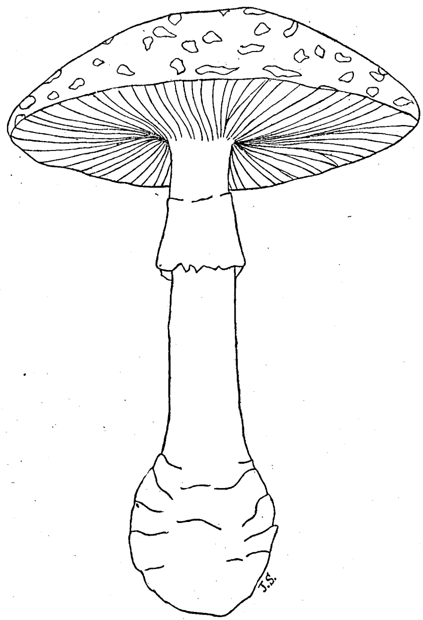

FIG. 3. Amanita muscaria; POISONOUS, showing scaly bulbous base without a cup, and the floccose volva appearing in patches on the pileus. Color of pileus pale yellow to reddish yellow. About ½ natural size.

In Figure 3 we give an illustration of the fly-agaric which resembles Cæsar's Amanita slightly. It will be noted that the cup is not present at the base of the stem. This one character combined with the bright color of the fungus is the one character on which we must rely to determine the question of its edibility. If the cup is present the plant is safe; if it is absent the plant is poisonous.

* A second smaller species (*Amanita Frostiana*) closely allied to the fly-agaric and doubtless often confused with it, differs by lacking this striate upper portion of the stem. It rarely has a pileus more than one or two inches in diameter while the fly-agaric is much larger. In other characters it is very much like the fly-agaric.

Hitherto Cæsar's Amanita has been reported from Vermont (*Frost*), New York (*Peck*), Ohio (*Morgan*) and North Carolina (*Schweinitz*, *Curtis*). It is very abundant in Alabama where the soil seems especially favorable for this species; it appears to be less common in more northern countries, being rare in the northern states mentioned and is found neither in England nor in northern Continental Europe. It is commonly found in open woods, occasionally growing in more shaded places. When it appears, usually soon after the first summer rain, it is found for a time in great abundance. Experiments with reference to the best methods of preserving this species for use at later seasons are very desirable. During the past season it was most common in July, but this period is likely to vary with the time of the summer rains.

THE PUFF BALLS (*Calvatia, etc.*)

A second group of fungi less related to the two species of edible fungi above discussed, than they to each other, are the plants commonly known as puff balls. These when dry are variously known as "puff balls" or "smoke balls" and in some portions of our state are known under the name of "devil's snuff boxes." The clouds of dust which rise from these when crushed, are the reproductive bodies or spores and are produced in prodigious quantities. These appear only when the plants are fully ripe. It is in the young condition that these "puffs balls" are edible and they are fully as nutritious weight for weight as beefsteak. There are a large number of species widely distributed throughout the country and several of these are common in Alabama. The various species vary in size from that of a marble to that of a man's head or even larger. When young they will appear of a pure white color when broken in two, and of a consistency somewhat intermediate between cottage cheese and curd. When the spores commence to ripen the interior become softer, and soon takes on either a purplish or olive color according to the color of the mature spores. It is only when the flesh is white that they are suitable for food, and at this time they may be sliced thin and fried in butter after first removing the outer skin. All the species of thin skinned puff-balls are edible* but with few exceptions the smaller ones are not as valuable as the species that vary from the size of one's fist upward.

* The tough skinned species of *Scleroderma* with a blue black interior would not be likely to attract anyone as articles of food. With this exception all the puff balls belonging to the genera *Calvatia*, *Lycoperdon*, *Bovistella* and *Bovista* are edible and could not be confused with anything else.

In conclusion, it should be said that there is a wide field of unused food products which may be made valuable articles of domestic consumption; these products are produced by nature with a lavish hand. The use of them as an article of food requires careful discrimination to distinguish the edible from the deleterious, but the discrimination of certain useful species when they are once known is as simple as the discrimination of cereals, or small fruits. Species are as clearly marked as among higher plants and the characters are just as constant. There is much to be done (1) In further learning what species occurring in this state, are useful for food; (2) In methods of cultivation or of extending the natural season of the native plants, and (3) In methods of preserving the plants so that they may serve as an article of export, or be made available for domestic use after their natural or prolonged season has passed by.

Literature.

The literature relating to the edible fungi that can be recommended is unfortunately not very extended, corresponding with the slight extent to which the plants are used in this country. In Germany where fungi form a common article of diet, small works with colored illustrations of from forty to fifty edible and poisonous species can be obtained for a mark and a half (about thirty-five cents). The only work of a similar kind published in this country is Gibson's "Our Edible Toadstools and Mushrooms" which costs seven dollars and a half. Mr. Gibson has, however, an article in Harper's Monthly for August, 1894, that is valuable as far as it goes, giving good black and white illustrations of several species.

The Agricultural Experiment stations have published very little on this subject. Dr. Sturgis of the Connecticut station has recently issued (Annual Report for 1895) an excellent account of edible and poisonous fungi, illustrated by a series of half-tone plates which unfortunately do not bring out the best results. The U. S. Department of Agriculture has issued under the title of "Food Products," an account of various edible and poisonous fungi with fairly good colored plates. Nos. I, II and III have been issued already. The "Report of the Microscopist for 1892," issued from the same authority, also contains some illustrations. Dr. Farlow of Cambridge, also published "Notes for Mushroom Eaters" in Garden and Forest, Nos. 309–314 (Jan., Feb., 1894). Beyond the above, little American literature is available to the general public.

BULLETIN No. 74. OCTOBER, 1896.

ALABAMA

Agricultural Experiment Station

OF THE

AGRICULTURAL AND MECHANICAL COLLEGE,

AUBURN.

Flour Considered from the Standpoint of Nutrition.

LUCIEN M. UNDERWOOD.

MONTGOMERY, ALA.:
THE BROWN PRINTING COMPANY, PRINTERS.
1896.

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FLOUR CONSIDERED FROM THE STANDPOINT OF NUTRITION.

LUCIEN M. UNDERWOOD.

There is a German proverb involving a play of words in similar sounds which says: "*Was ein Mann isst, er ist,*." This is translatable into our tongue as, *What a man eats he is.* Without entering into the philosophic consequences that would result from a complete acceptance of such a doctrine, we can content ourselves with learning a few lessons that are suggested by the large germ of truth that is involved in the proverb. The question of "what shall we eat and what shall we drink and [with what clothes] shall we be clothed" is perhaps the most important personal question that can be considered by the American people. Although it might not be so considered at first thought, it is a question of *biology*, and moreover one of the most important practical questions biology has to consider, for it involves directly the welfare, happiness and productiveness of all of our people, as dependent upon the biological principle of nutrition. There can be no question but that the amount and quality of food directly affects man's actions; courage, disposition, mental activity are more or less directly dependent on what and how much food a man eats and the time and manner in which he eats it. There is much more wisdom than humor in the answer to the question: "Is life worth living?" that was asked in the funny column of the newspaper; and answered: "It depends upon the liver."

The customs of a people regarding food, change from time to time and ought to change, for people ought to take advantage as soon as possible of any discovery of science, or of any improvement in the method of the production or manufacture of articles of domestic use. The man who lives as his grandfather did, works as his grandfather worked, and eats only the kind of food that his grandfather ate, is out of place in these closing years of the nineteenth century—he is a worm crawling in a rut with no ideas of the possibilities outside it. We are so much the creatures of custom and do things because they have been done, that unless we are rudely interrupted, we are sometimes likely to keep on doing the same old things in the same old way.

One or two illustrations will show how the habits of the American people change with regard to food. Thirty years ago if a resident of a town of 5000 or less wished for some oat-meal he would call at the drug-store instead of the grocery. The druggist would hand down from among his jars and packages of drugs a can containing some stale, granular, often mouldy oat-meal imported from across the sea. This with all its mouldiness and taints resulting from standing among vile-smelling drugs, would be weighed out by apothecaries' weight as a prescription for invalids or for some one whose delicate appetite needed something tempting. This was the relative position of oat-meal as a food supply only a generation ago. None of the nutritious and appetizing cereal preparations that are now so abundantly manufactured in this country and so universally used for food, were even known or thought of in those days. And I might add a remark that so soon as people learn the simple art of properly cooking these breakfast cereals and give us the light appetizing dishes that are possible where now we often have only the soggy, sloppy, flavorless preparations that are far from inviting—the favor of these healthful breakfast cereals will still more rapily extend.

Thirty years ago bananas were rarely seen outside the large cities and they were scarcely more than an occasional luxury even there, within the means of the better classes. Only now with the largest port of entry for bananas within our own State, and with special trains loaded with that fruit alone moving northward from Mobile every day to be distributed from Chicago and St. Louis into every little town and hamlet in the upper Mississippi Valley, we see a vast change in the use of fruit as an article of diet compared with the custom of a generation ago. Right here let me interpose another protest that more of this fruit should be stopped before it leaves the borders of Alabama, for of all peoples that need fruit as a considerable article of diet, those who live in a warm climate need the most, and more fruit could well replace much of the fatty foods that are in common use throughout our State in city, town, and country homes.

We must, therefore, outgrow the customs of our fathers in regard to our food just as we have replaced the horse of our grandfathers by steam and electricity, and the blaze of the pine knot by the electric light. We owe it especially to the children of the rising generation that we give them the best food that science can discover, and give it to them in that form, that their dispositions, which are none too good by inheritance, may be improved, their mental capacity, which depends far more than we realize on what they eat, may be largely increased, and their happiness and long life which depend on their state of health and proper nutrition and these in turn on what they eat and how they eat it, may be conserved in the best possible way.

Since wheat is one of the commonest and most widely used food plants in America, it is strange that the question of its nutritive properties have so long given way to questions of color and appearance. The object among most maufacturers seems to have been to produce the whitest and finest flours possible, regardless of the nutritious qualities involved in the food product itself, thus depending for sales on *looks* rather than on *life giving function*—another pernicious custom far too prevalent in America. The purpose of this bulletin is to call attention to the constituents of wheat flour that have resulted not only from a study of the structure and composition of the wheat kernel itself but from a long series of practical experiments respecting the bread produced from various flours.

The kernel of wheat as nature produces it is covered with a tough, almost horny outer layer which in portions of the kernel, especially at its upper end and often within the groove is fringed with hairs. This outer covering, which forms the greater part of the bran when ground, is composed of cellulose with more or less hardening elements all of which are indigestible and consequently not suitable for food. Underneath the outer husk is an inner husk that contains considerable gluten and a large part of the phosphates and other mineral elements of the kernel. Under these two coverings is a layer rich in the gluten and other nitrogeneous elements of the wheat, and usually of a darker color than the interior which contains principally starch, with a much less proportion of gluten. The nutritive food elements of the kernel, therefore, increase from the interior outward. In the ordinary process of making flour, in which whiteness is regarded as a mark of the greatest purity, all the inner covering and much of the nutritive outer layer of the kernel is bolted out and only the inner, whiter portion containing more starch and less proteids is left. In other words the finer and whiter a grade of flour is, the less likely is it to contain the most nourishing elements of the wheat.*

A knowledge of these facts led, many years ago, to the introduction of "Graham" flour, which, for the most part, is either an unbolted flour or one in which only the very coarsest part of the bran or outer husk is removed after the wheat is ground. Graham is an improvement on ordinary white flour, so far as the question of nutritious constituents is concerned, but it contains the indigestible outer coat of the grain which is not only indigestible but irritating to the mucous membrane which lines the alimentary canal. Graham flour, moreover, is usually ground without thorough cleaning of the wheat, and the flour often contains various particles of dust that accumulate in the groove of the kernel

*It should not be understood that a *dark* grade of *white flour* is necessarily better on that account. As a rule it is made of an inferior quality of wheat or from wheat improperly cleaned.

and in the hairs at the end of the kernel, and the finely broken fragments of the hairs themselves, all of which are a detriment to the flour.

The ideal flour, so prepared that all the objectionable elements of the kernel are removed while all the nutritious parts are left in, is prepared by subjecting it to a process which removes the husky outer coating of the kernel before the grinding takes place, and then grinding the flour without separating any of the proteid portions of the grain from the starch, thus conserving all the nutrition in the grain; the product thus obtained is known as the "flour of the entire wheat." The bread made from this flour is of a light brown color, is more moist, richer in flavor and lacks the dry and unsubstantial character so common in white bread, especially that made by bakers. Having personally used bread made from this flour for the past fourteen years, and having compared it with many other kinds, I am prepared to say that I cannot find its equal in nutrition or flavor. It must be said, however, that something depends on the method by which it is made, and for that reason I have appended the most approved method followed in its preparation. It will be seen that it is more easily made than any other kind of bread. Unlike most bread it does not deteriorate with age if properly kept, up to a reasonable limit of time. I have taken it on camping expeditions and had it keep for a week with no necessity for renewal and no loss of flavor. In 1891 I met a gentleman at Lake Worth, who had spent three weeks in Florida. He was a chronic dyspeptic and could eat no other bread than this. He had brought a supply of it with him and had used from it during the three weeks of his stay, and was then obliged to go home because his supply was exhausted. If the bread becomes dry it is only necessary to wrap it in a moist cloth and place it in the oven for fifteen minutes, when it resumes its usual condition. It also makes the most delicious form of toast imaginable.

It should also say that this bread is not so palatable when perfectly fresh as when at least a day or two old. In fact from a hygienic standpoint no bread when first baked is suitable for food. There is no question but that the wide spread dyspepsia that is common throughout the country is largely due to the excessive use of fatty foods, strong coffee and hot bread.

The peculiarities of bread made from the flour of the entire wheat as a food, are, of course, due to its flour containing all the nutritious elements of the wheat. It thus adapts itself to the needs of the system and builds brawn, bone and brain. It is, therefore, specially valuable for young people whose bodies are growing, or for those whose brains are in the process of growth and expansion. It is a pitiable sight to see so many children and young people robbed of the food elements necessary to their proper development by the use of those forms of food from which the chief good has been thrown away, for in the preparation of white flour, the middlings or *canaille* is bolted out and is used in the preparation of various food stuffs for our domestic animals. In this way we treat our domestic animals better than we do our children by giving the children the flour from which the best and most nutritious elements have been separated, and then giving these same nutritious portions to pigs and cattle.

Another special advantage of this bread is its regulative action on the human system. Probably the largest number of chronic disorders of the human system can be traced to the matter of indigestion and the attendant constipation that follows as a natural result. The most ordinary method employed for this difficulty is the one that is most unreasonable from the standpoint of either biology or common sense. When the system has become overcharged by unsuitable food or by too much of it, it is manifestly folly to follow this up by an additional load in the form of drugs of any kind. It would be considered insane to load a beast of burden, already staggering with its pack, with an additional weight of merchandise, and yet we do this same thing with our poor overloaded digestive system, when we follow the ordinary plan of dispensing physic. Shakspeare uttered a sublime command when he caused Macbeth to utter the words, "Throw physic to the dogs." The simple and rational method of treating such conditions is through the proper use of food. There are sufficient forms of food supplies among our standards so that any one by a proper selection and combination can secure that which will at once supply proper nourishment to the body and at the same time act as a regulative that will render unnecessary either drugs or doctors. Perseverance will be necessary in obstinate cases, *but they can be overcome by this treatment.* In the list of foods that stand high in regulating the system against a tendency to constipation is this flour of the entire wheat.*

It should be said that several other forms of hygienic flours are made which claim to be equal to this, but so far as I have tested them they lack both in nutritive qualities and flavor, the high character of the preparations above described. The cereal foods prepared at Battle Creek, Michigan, and recommended by its well known sanitarium, are valuable additions to the list of useful foods.

In order to verify the results of microscopic examination and experience, samples of the "flour of the entire wheat" manufactured by the Franklin Mills Company of Lockport, New York, together with samples of the best grades of white

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*CONSTIPATING FOODS.—Hot bread, bread and rolls made with baking powder, cake, custards, salted, dried and smoked meats, poultry, potatoes and starchy foods generally, blackberries, raspberries, tea, coffee and chocolate.

LAXATIVE FOODS.—Rolled and cracked wheat, all forms of bread made from the entire wheat, fresh acid fruits like the orange or lemon, tropical fruits like bananas, stewed dried fruits, especially peaches, prunes and apricots, tomatoes, oysters, raw cabbage, and most green vegetables, wild game, etc.

FOODS OF NEUTRAL CHARACTER.—Lean, fresh meats, fresh fish, eggs, uncooked milk, oat-meal and sweet potatoes.

flour offered for sale in Alabama, were submitted to Prof. B. B. Ross, State Chemist of Alabama, with the following results:

Constituents.	Flour of the Entire Wheat.	Best white flour. Sample I.	Best white flour. Sample II.
Water	6.36	11.07	10.74
Fats	1.51	0.88	0.79
Protein	14.19	9.94	9.22
Carbohydrates	77.03	77.73	78.91
Ash	0.91	0.38	0.34
	100.00	100.00	100.00

The greater percent of ash in the first column is largely due to excess of phosphates, the percent of phosphoric acid being 0.50 for the flour of the entire wheat and only 0.23 for the white flour.

It will be noted that while the percent of water is less in the flour of the entire wheat, the percents of proteids (gluten), fats and phosphates are larger than in the best white flour, while the percent of carbohydrates (mainly starch) remains very nearly the same.

After the first analysis of the flour of the entire wheat, made from the barrel, two additional tests were made from samples of flour furnished by the Franklin Mills Company direct to the chemist. These samples did not materially differ from the first analysis except that the percent of protein was a trifle higher, the ratio being 228 and 229 as against 227 in the first analysis.

To show more forcibly the comparative values, we present the ingredients of a standard barrel of flour (196 pounds) in actual weights; we use the average of the two samples of white flour for this comparison:

INGREDIENTS.	Flour of the entire Wheat.	Average of two Samples of White Flour.
Water	12.47 pounds.	21.36 pounds.
Fats	2.96 "	1.64 "
Protein	27.81 "	18.68 "
Carbohydrates	150.98 "	153.61 "
Ash	1.78* "	0.71† "
Totals	196 00 pounds.	196 00 pounds.

* Of this 0 98 pounds is phosphoric acid.

† Of this 0.45 pounds is phosphoric acid.

It will thus be seen that Dr. Cutter of Harvard University, was not very wide of the mark when he used the following language with reference to the flour we commonly eat. We quote from the *American Medical Weekly*, and use his italics: "The gluten of cereal foods is their nitrogenized element, the element on which depends their life-sustaining value, and this element is, in the white and *foolishly fashionable* flour, almost entirely removed, while the starch, the inferior element, is left behind and constitutes the entire bulk and inferior nutriment of such flours. To use flour from which the gluten has been removed, is *almost criminal.*"

The flour of the entire wheat is recommended by a large number of prominent physicians who have made a study of nutritive foods; and either this or similar grades of flour are used at all first-class sanitariums where invalids are built up in accordance with the most advanced ideas of nourishment.

In order to make this bulletin as practical as possible, we add a recipe for using the flour of the entire wheat, since the process is somewhat different from that followed in ordinary bread making:

"For making bread from the flour of the entire wheat, take two quarts of unsifted entire wheat flour, a little less than a quart of warm water, one-half cup of sugar (or less if desired), one-half cake of compressed or ordinary dry yeast, and a little salt. Dissolve the yeast in part of the water, mix sugar, flour and salt and add the yeast and the remainder of the water. Stir well and set in a warm place. When the dough has risen to twice the original amount, stir down and put in tins for baking, allowing it to rise a second time. This bread requires longer and slower baking than ordinary white bread. This quantity makes two loaves of bread of ordinary size."

It will be seen from the above that this bread requires no kneading and its preparation is consequently much simpler than that of ordinary white bread. All forms of cake made with molasses, all fruit cakes and steamed breads are much better made of this flour and keep moist for a much longer time. The flour also makes most excellent gems and griddle-cakes, so that those who will persist in using hot breads can find this flour adapted to their purpose and can at least take advantage of its added nutriment.

It is proper to acknowledge, with thanks, the assistance rendered by the Chemical Department through Prof. B. B. Ross, under whose direction the analyses were made, and to the Franklin Mills Company for kindly furnishing samples of their flour for analysis.

BULLETIN No. 75. DECEMBER, 1896.

ALABAMA

Agricultural Experiment Station

OF THE

AGRICULTURAL AND MECHANICAL COLLEGE,

AUBURN.

EXPERIMENTS WITH CORN.

J. F. DUGGAR, Agriculturist.

MONTGOMERY, ALA.:
THE BROWN PRINTING COMPANY, PRINTERS.
1896.

☞The Bulletins of this Station will be sent free to any citizen of the State on application to the Agricultural Experiment Station, Auburn, Alabama.

EXPERIMENTS WITH CORN, 1896.

By J. F. Duggar.

SUMMARY.

I. The spring and early summer of 1896 were extremely dry.

II. Among fourteen varieties of corn tested, the largest yield was made by St. Charles, followed by Early Mastodon and Blount Prolific.

Averaging many tests of varieties made in Southern States, the varieties giving the largest yields were found to be as follows : (1) Cocke Prolific, (2) Mosby Prolific, (3) Calhoun Red Cob, (4) St. Charles, (5) Mammoth White Surprise, and (6) Blount Prolific.

III. In the unusual season of 1896, seed corn from Illinois afforded a larger yield than did that from Alabama and Georgia.

IV. Kernels from the middle of the ear of dent varieties afforded a smaller yield than grains from the butt and tip ends of the ear.

This result was confirmed by averaging the relative yields obtained in fourteen tests at five experiment stations.

V. In this dry season the yields were practically the same whether the distance between single plants in rows five feet apart was three or four feet ; a distance of two feet in the row greatly reduced the yield.

VI. On sandy branch bottom land the yield of corn was 3.1-10 bushels greater where 426 pounds per acre of crushed cotton seed was used than where 180 pounds of cotton seed meal was employed, the amount of nitrogen furnished per acre being the same in each fertilizer.

VII. On sandy branch bottom land which had borne two crops of weeds, the loss when the weeds were burned, instead of being plowed under, was 2.8 bushels of corn per acre.

VIII. The yield of grain was less when the entire stalks were cut and cured before pulling the ears and also less when topping was practiced than when the plants were not disturbed before gathering the ears. Financially, topping was unprofitable, and the profit in harvesting the entire stalks was doubtful where no shredder was available to prepare the stalks for feeding and when corn was valued at 45 cents per bushel, and stalks at 25 cents per 100 pounds.

A compilation of results of stripping the blades or pulling fodder showed an average loss of 2.9 bushels of corn per acre from pulling fodder. Only when fodder is high and corn low in price can fodder-pulling be regarded as profitable. Hay making would generally give better returns than fodder-pulling for the labor employed.

I. The Rainfall During the Growing Season of 1896.

Of all the factors in crop production that are beyond the farmer's control, the most important is the amount and distribution of the rainfall. With ample and well distributed rainfall in April, May, June, and July, a relatively good crop is almost certain. A deficiency in the total rainfall for these months, or the occurrence of long dry spells at this time, almost invariably causes a poor yield, no matter what the method of fertilizing and cultivating the crop.

The greater part of the growing season of 1896 was abnormally dry. The rainfall for March and May was only about half the normal, and in April and June it was only about one-third the usual quantity.

Very heavy rains, accompanied by damaging winds, fell about the middle of July, but this was too late to be of much benefit to the corn crop.

The following table shows the periods in which there was little or no rain :

		Rainfall in inches.
28 days immediately preceding	April 29, ...	0.00
9 " " "	May 14, ...	0.00
7 " " "	May 22, ...	0.00
18 " " "	June 21, only....	0.22
14 " " "	July 6, only....	0.13
24 " " "	Aug. 16, only....	0.26
27 " " "	Sept. 21, only....	0.05

Some of these periods of drought appear short, but many of them were in reality longer than they seem, for the showers separating them were light and altogether insufficient.

The effect of the dry season is shown by the low yields obtained in nearly all experiments conducted on upland.

II. Variety Test of Corn, 1896.

For this test sixteen plots were used. The land was quite uniform in fertility as was indicated by the close agreement between the duplicate plots. Fertilization, culture, etc., were identical for all plots. The distance, 4⅔ by 3 feet, or 14 square feet per plant, is probably less than is advisable for most of the upland of this vicinity.

The following table gives the number of pounds of thoroughly dry unshucked corn required to afford 56 lbs. of shelled corn, the percentage of grain in the unshucked corn, and the yield per acre of each variety, arranged in order of productiveness:

Variety test of corn.

Plot No.	VARIETY.	Unshucked corn per bushel.	Grain in unshucked corn.	Yield of shelled corn per acre.
		Pounds.	*Per cent.*	*Bnshels.*
8	St. Charles	71.1	78.8	25.1
13	Early Mastodon..........	73.7	76.	22.7
16	Blount Prolific	74.1	75.6	22.3
11	Golden Giant............	77.3	72.4	21.2
14	Champion White Pearl..	72.9	76.8	21.3
5	Hickory King............	71.8	78.	20.7
4	Yellow Dent.............	71.8	78	19.8
1	Peabody.................	82.8	67.6	18.2
10	Experiment Sta. Yellow.	81.4	68.8	16.9
7	Jones Pearl Prolific......	84.3	66.4	16.8
12	Chester County Mammoth	77.3	72.4	15.9
2	Mosby Prolific...........	83.3	67.2	15.5
3, 9, 15	Renfro, average..........	81.3	68.8	14.7
6	Higgins..................	86.4	64.8	12.2

In this test St. Charles, a white variety, stood first, followed by Early Mastodon and Blount Prolific.

As the Alabama Experiment Station has no seed for sale or distribution, a list is given below of the parties from whom our seed corn was obtained :

VARIETY.	Color of grain.	SEED FROM—
Peabody..................	W	W. B. Tucker, Opelika, Ala.
Mosby Prolific..............	W	Miss. A. & M. Col., Starkville, Miss.
Hickory King...............	W	C. C. L. Dill, Dillburg, Ala.
Higgins....................	W	W. J. Higgins, Larkinsville, Ala.
Jones Pearl Prolific.........	W	H. P. Jones, Herndon, Ga.
Blount Prolific..............	W	" " " "
St. Charles.................	W	J. C. Suffern, Voorhies, Ill.
Champion White Pearl.....	W	" " " "
Yellow Dent...............	Y	" " " "
Golden Giant..............	Y	E. G. Packard, Dover, Del.
Early Mastodon...........	Y	" " " "
Chester County Mammoth.	Y	" " " "
Renfro.....................	W	Ala. Exp't Station, Auburn, Ala.
Experiment Sta. Yellow....	Y	" " " "

The result of a single test of varieties is apt to be misleading, especially in such an unusual season as 1896. Much more reliable conclusions are obtainable by taking average results for a large number of tests.

In order to learn what varieties succeed best in the South, a compilation was made of all published tests conducted at the Agricultural Experiment Stations in the Gulf States, Arkansas, Georgia and South Carolina. Since no one variety entered into all of these tests, it was impossible to use any one variety as a standard of comparison. To make comparisons possible the average of the yields of all varieties in each test was calculated and this average yield was taken as 100; any variety yielding more than the average in a certain test was given its proportional grade above 100, and any variety falling below the average was given a rating correspondingly below 100.

By averaging all relative yields calculated as above for each variety, a figure is obtained for each variety which is more satisfactory than is the result of a single test.

In making this compilation calculations were made for nearly 700 tests with 260 varieties. The greater the number of experiments into which a given variety enters the more reliable is the average yield for that variety. The list given below contains the average for only such varieties as have each been tested five or more times, and the varieties are arranged in the order of productiveness :

Relative yields of varieties of corn repeatedly tested in the Gulf States, Arkansas, Georgia, and South Carolina.

	No. of tests.	Relative yield.
Cocke Prolific	5	136
Mosby Prolific	19	126
Calhoun Red Cob	6	122
St. Charles	11	121
Mammoth White Surprise	6	115
Blount Prolific	26	111
Banks Improved	7	111
Early Mastodon	6	110
Experiment Station Yellow	5	110
Virginia Gourd Seed	5	110
Welborn Conscience	18	109
McQuade	9	109
Piasa King	10	107
Brazilian Flour	8	107
Patterson	7	107
Maryland White Gourd Seed	5	107
Giant White Normandy	13	106
Pride of America	5	105
New Madrid	5	103
Giant Broad Grain	9	103
Shoe Peg Improved	7	103
Clarke Early Mastodon	7	102
Champion Early White Pearl	8	101
Clayton Bread	6	100
Mexican Flint	5	99
White Mexican	6	99
Alabama	7	98
Hickory King	19	96
Hendron White Bread	5	95
Leaming White	8	93
Common White	5	93
Golden Beauty	20	92
Chester County Mammoth	7	92
Improved Leaming	8	88
Champion White Pearl	11	86
Golden Dent	9	86
Western Yellow	5	85
Riley Favorite	5	83
New Hickory King	5	81

The results of two tests in which St. Charles was the most productive variety are unavailable for the above compilation because published only in the form of a summary. If these figures could have been used, St. Charles would have ranked higher, possibly first, instead of fourth, in the above table.

Three of the varieties standing near the head of the list, Cocke Prolific, Mosby Prolific, and Blount Prolific, bear several small ears on each stalk.

III. Seed Corn from Different Latitudes.

Early in 1896 Hickory King corn was obtained from Illinois, Delaware and Alabama, and Blount Prolific corn from Illinois and Georgia. Six plots, each one-tenth acre in area, were used for this experiment; plots 1 and 4 were both planted in Hickory King corn grown in Alabama, the purpose of this duplication being to learn whether the different plots were nearly of uniform fertility.

Preparation, fertilization, and culture were the same for all plots. The young plants were thinned so as to leave the same number on each plot, the distance between plants averaging 2.4 by 4.5 ft., which is at the rate of about 4,000 plants per acre.

The following table gives the locality from which seed was procured, the yield of shelled corn per acre on each plot, and the increase or decrease of Northern seed over Southern seed:

Seed corn from different latitudes.

Plot No.		SHELLED CORN PER ACRE.	
		Yield.	Increase (—) or decrease (—) from Northern seed.
	Hickory King.	*Bus.*	
1	From Pickens Co., Alabama..	16	....
2	From Voorhies, Illinois	19.3	—2.8
3	From Dover, Delaware	15.6	— .9
4	From Pickens Co., Alabama..	17.1	....
1& 4	Average of Alabama seed...	16.5	....
	Blount Prolific.		
5	From Voorhies, Illinois	14.2	—1.1
6	From Herndon, Georgia......	13.1	....

The above table shows that with both varieties seed corn from Illinois produced a larger crop than that from the South. However, since the differences are only slight in most cases, it is not safe to conclude that Northern seed will generally afford a larger yield than that of the same variety grown in the South. But it is an interesting fact that in the abnormally dry season of 1896, Hickory King corn grown in Illinois, was more productive than the strain of that variety already acclimatized in this State.

The results secured in the test of varieties (p. 364) are also suggestive as showing relatively heavy yields produced by Northern varieties.

The average yield in 1896 for eight Southern varieties was 17.2 bushels per acre ; for six Northern varieties 21 bushels. Of the Northern varieties in that experiment the three from Illinois averaged 22 bushels, while the three varieties from Delaware averaged 19.9 bushels per acre. Results of a variety test in Oklahoma (Bulletin No. 10) in a very dry season also showed a larger yield of grain from Northern than from Southern varieties. However, results from averaging a number of varieties of Northern origin and comparing the average yield with that of dissimilar varieties of Southern origin are valuable in this connection only when the number of varieties from each section is large.

The results recorded in the preceding table do not confirm the common belief that Northern seed corn is inferior to pure Southern varieties.

Differences in yield between the same varieties from different latitudes are not wholly due to climate, but also to the kind of soil and culture which produced each strain. Thus seed of the same variety grown on adjacent farms may vary in productiveness—an encouraging fact for one who may desire to improve his corn by good culture and careful selection.

IV. Butt, Middle, and Tip Kernels for Seed.

It is a common practice in selecting seed corn to discard the kernels growing at the tip and butt ends of the ear. To obtain more light on the advisability of this practice, the experiment recorded below was undertaken.

There were selected good, well filled ears of Experiment Station Yellow corn, a variety with ears of medium size, and usually a single ear to the stalk. From each ear the grains which grew within one inch of the tip end were shelled to obtain tip kernels for planting. Likewise kernels growing within an inch of the butt end were obtained. Near the center of the ear, a space of one inch was shelled to obtain middle kernels for planting.

The field used for this experiment was divided into nine plots, each one-ninth acre in area.

Three plots were planted with butt grains, three with middle grains, and three with tip grains, the arrangement of plots being such as to distribute equally to all classes of seed any advantage due to differences in the fertility of different plots.

Preparation of land, fertilization, and culture were the same for all plots. The yields from all three kinds of seed were poor, the unusually severe drought causing an undue proportion of nubbins and poorly filled ears.

Yield of shelled corn produced by seed corn from middle, butt, and tip of ear.

Kind of Seed.	Yield corn per acre.	Grain in unshucked corn.
	Bus.	*Per cent.*
Middle kernels (average of 3 plots).........	11.7	68.3
Butt kernels (do).........	12.6	69.2
Tip kernels (do)........	12 7	70.1

The differences in yield are probably too small to point to the superiority of the kernels from any particular part of the ear. There is certainly no evidence here that the removal of tips and butt grains from seed corn is advantageous.

As a check on the above experiment a more comprehensive test was undertaken on plots so small as to permit of the weighing on chemical balances of all the seed planted. In this experiment butt, tip, and middle grains were obtained from spaces of one inch located respectively at the butt, tip, and middle portions of the ear. All unsound kernels, found chiefly among the tip grains, were rejected; otherwise the kernels which were weighed were not selected but represented average grains from the several parts of the ear.

From each large, well filled ear, used in this experiment, 50 grains from each part of the ear were weighed, and these 50 kernels were planted in 24 hills, spaced 4 by 4 ft. Later the stand was reduced to one stalk per hill and the missing hills were replanted with Brazilian Flour corn, the replanted hills equalizing the stand, but forming no part of the experiment.

The following table gives the weight of the middle, butt, and tip kernels planted, and the weight, in apothecaries' grains, of the shelled corn grown from each kind of seed :

Weight of middle, butt, and tip kernels planted and yield of shelled corn produced by middle, butt, and tip seed.

Plot No.	Ear No.	VARIETY.	Seed kernels from	Weight of 50 kernels planted.	Yield of shell'd corn per plant.
				Grains.	*Grains.*
1	A	Expt. Sta. Yellow...	Middle...	210.2	1836
2	"	do	Butt. ...	212.6	2100
3	"	do	Tip	153.9	1789
4	B	Expt. Sta. Yellow. .	Middle...	306.6	2360
5	"	do	Butt	323.9	2346
6	"	do	Tip	214.1	2294
7	C	Renfro...............	Middle...	427.3	2221
8	"	do	Butt.	491.3	3350
9	"	do	Tip	391.2	2916
10	D	Hickory King.......	Middle...	352.9	1950
11	"	do	Butt	437.3	1960
12	"	do	Tip	276.7	1750

In three instances the butt grains led in productiveness and in the fourth case they wanted only a very slight weight of taking first place. In three cases tip grains were least productive. Taking an average for the four ears planted, the weight of the shelled corn produced was as follows :

WEIGHT OF SHELLED CORN PER PLANT.	*Grains*
From planting butt kernels, ...	2439
" " middle kernels, ...	2092
" " tip "	2187

Attention is called to the fact that butt kernels led in average weight and in productiveness ; that tip kernels fell much below the others in weight, and that tip kernels were least productive in three out of four cases, although the relatively large yield with tip kernels of the Renfro variety made the average figure for tips higher than for grains from the center of the ear. The frequent correspondence between weight of seed and productiveness in this test is suggestive and is worthy of further study in future experiments.

The following table brings together in a form for easy reference the results of our tests and of previous tests at other experiment stations on the relative productiveness of grains from different parts of the ear.

In each test the lowest yield, whether made by middle, butt, or tip kernels is graded at 100, and the two higher yields at correspondingly higher figures :

Summary of results of planting kernels frm middle, butt, and tip of ear.

Station.	Variety.	Relative yield produced by seed from— Butt.	Middle.	Tip.
	Dent Varieties.			
Alabama....1896	Experiment Sta. Yellow... (Six small plots.)	109	103	100
" "	Experiment Sta. Yellow... (Nine large plots.)	109	100	109
" "	Renfro....................	151	100	131
" "	Hickory King............	112	111	100
Arkansas...——	....	112	101	100
Kansas 1891	St. Charles	108	102	100
Ohio.......1886	——Dent...............	120	100	111
" 1888	——Dent...............	105	106	100
" 1889	——Dent...............	100	100	101
" 1890	——Dent...............	117	100	112
	Flint Varieties.			
N. Y. State, 1882	—— Flint...............	101	100	104
" " 1883	—— Flint...............	100	101	106
" " 1884	—— Flint...............	100	103	103
" " 1885	—— Flint...............	100	105	103
Average of all	tests with dent varieties...	114	102	105
" "	" " flint " ...	100	102	104
" "	" " " & dent variet's	110	102	106

The average of all tests shows that butt kernels have been most productive, and that tip kernels have stood ahead of grains from the middle of the ear. The few figures for flint varieties do not agree with the average, but favor tip kernels.

The most striking fact about the above table is that in no case do the middle kernels show a marked superiority over those from other parts of the ear. This indicates that the farmer can advantageously dispense with the labor of removing the butt and tip grains from the ears used for seed.

V. Distance for Upland Corn.

This experiment occupied 6 plots near the top of a hill. Plot 1 was on the highest ground, from which there was a slight slope to plot 6.

The altitude of all the plots and the sandy character of the soil made the position a dry one and hence unfavorable to thick planting. The very dry season also militated against thick planting.

Fertilizers and culture were the same for all plots. Seed of Renfro corn, a variety with large ears, was planted at measured distances March 23. A single plant was left in each hill and the stand was regular. On plots 1, 2 and 3, the distance between the rows was the same, 5 feet, but the distance between plants in the drill varied from 4 to 2 feet, affording wide variations in the number of plants per acre. On the other hand the thickness of planting was the same on each of plots 4, 5 and 6 ; the only difference between these latter plots was that on plot 6 the rows were close together and the distance between plants in the drill was considerable, while on plot 4 the rows were 6 feet apart and the plants correspondingly closer in the drill. The arrangement on plot 5 was intermediate between that of plots 4 and 6.

The following table gives the number of stalks and the yield of corn per acre when the plants stood at different instances apart :

Yield of corn when Plants stood at different distances apart.

Plot No.	Distance.		Number of plants per acre.	Yield per acre.
	Between Rows.	Between plants.		
				Bus.
1	5 feet.	4 feet	2178	12.4
2	5 feet.	3 feet	2904	12.9
3	5 feet.	2 feet	4356	9 8
4	6 feet.	2 feet 6 in.	2904	13.1
5	4 feet 10 in.	3 feet 1½ in.	2904	15.6
6	4 feet.	3 feet 9 in.	2904	16.9

Where the rows were 5 feet apart there was practically no difference in yield for distances of 3 and 4 feet between plants. A space of two feet between plants was much too close for this poor soil and dry season. On the three plots where the thickness of planting was constant, but the arrangement of plants different, the figures at first view suggest a continuous increase in yield as the constant area devoted to each plant approaches a perfect square in shape. However the land was not perfectly uniform, as seemed the case when the plots were located. There is a slight increase in fertility towards the lower plots, which is apparent on comparing the yields of plots 2 and 5,—plots which are practically duplicates.

Allowing for this natural advantage which their position gives to the narrow rows, the yield becomes practically the same for rows nearly 5 feet apart as for narrower rows less thickly planted. For land of this character, high, sandy, dry, and poor, 5 feet between rows is the minimum distance that can be recommended, and on very poor land wide rows are best. Rather wide rows are necessary to economy of cultivation and to allow the planting of a row of cow peas in the middle between the corn rows.

In order to make this test as accurate as possible, our usual custom of planting a row of cowpeas in each middle was not followed in this experiment. As compensation for this omission, crimson clover seed was sown broadcast soon after the corn was gathered, and covered by using a Planet, Jr., cultivator, supplied with five very small shovel points. This seeding was made in September with the expectation of plowing under the growth of crimson clover late in March, 1897.

VI. Cotton Seed Meal Versus Crushed Cotton Seed for Corn.

An experiment to compare the fertilizing effect of nitrate of soda and cotton seed meal and to test the effect of applying only half the cotton seed meal at planting time and the other half later was located on a poor hill-side, having a rather stiff soil. This spot suffered more from the protracted drought and gave a smaller yield, only 6.9 to 8.7 bushel per acre, than any other field on the Station farm. The failure of the crop on all plots on this hillside rendered the experiment worthless.

A test of the relative values of cotton seed meal and crushed cotton seed was made on a piece of sandy branch bottom which had borne a crop of oats in 1894 and had since grown up in weeds. The heavy growth of weeds was plowed under with a one-horse turn plow February 27, 1896, and Renfro corn planted March 18. Immediately before planting, rows were marked off with a shovel plow; in this furrow fertilizers were drilled. Then a scooter was run once in this furrow to mix the fertilizer with the soil, after which corn was planted and covered with a double-foot plow stock furnished with two small scooters. Each plot received acid phosphate at the rate of 360 pounds per acre and kainit at the rate of 120 pounds per acre, the mixture of these two fertilizers constituting what is frequently, for convenience, called "mixed minerals." In addition, one plot received 180 pounds of cotton seed meal per acre; the other 426 pounds of crushed cotton seed. Both cotton seed meal and cotton seed are valued as fertilizers chiefly because of the nitrogen which they contain. The same amount of nitrogen is contained in 180 pounds of cotton seed meal as in 426 pounds of cotton seed.

The yields in bushels per acre were as follows, 83.8 pounds of corn in the shuck being required for 56 pounds of shelled corn:

With 426 pounds crushed cotton seed, (and mixed minerals)	26.7 bushel
With 180 pounds cotton seed meal (and mixed minerals)	23.6 bushel
Difference in favor of cotton seed	3.1 bushel

The increased yield from cotton seed is 3.1 bushels per acre, or 13 per cent in excess of the yield from the same amount of nitrogen in the form of cotton seed meal. Cotton seed is believed to pay better on land deficient in vegetable matter than on soil well supplied with this material. And yet even on this piece of weed land, fairly well supplied with organic matter, cotton seed was the most efficient source of nitrogen.

It does not necessarily follow that cotton seed is the most profitable fertilizer. That depends on the relative prices of cotton seed and meal, or on the quantity of cotton seed meal which the oil mills are willing to give in exchange for a ton of cotton seed.

The cotton seed meal used in this test cost $20.00 per ton delivered in Auburn, or $1.82 per acre.

The 426 pounds of crushed cotton seed on one acre also cost $1.82, if we assume a price of $8.56 per ton or 42.8 cents per hundred pounds. With both articles at prices named above, one ton of cotton seed would purchase only 845 pounds of cotton seed meal, and the results reported above indicate that such an exchange would have been unprofitable to the grower. The oil mills usually give considerably more than 845 pounds of cotton seed meal for one ton of seed.

The exchange value of cotton seed and cotton seed meal will be more fully discussed in a future bulletin from this Department.

Burning Weeds vs. Plowing Them Under.

This test was made on two plots in a sandy bottom (the same as that noted in the preceding section) where the land had been given over to weeds after harvesting the oat crop in 1894; so that there was considerable accumulation of litter from two crops of weeds. The dead weeds on both plots stood about five feet high at the time when the trash on plot 1 was burned, February 27, '96. Plot 2 was plowed without first setting fire to the vegetable matter. Fertilizers, culture, etc., were the same for both plots.

The yield of corn in bushels per acre was as follows:

Burning trash vs. not burning it.

Plot No.	Treatment.	Yield per acre.
		Bus.
1	Trash burned	24.5
2	Trash not burned but plowed under	27.3
	Difference in favor of not burning	2.8

The increase of nearly three bushels per acre on the plot where fire was not used is a strong argument against wholesale burning preparatory to breaking land. While it is often inconvenient both in preparation and in subsequent cultivation to contend with dead weeds, cornstalks, etc., yet one can scarcely doubt the good effect of such material in the permanent improvement of the soil. The crying need of the majority of Southern soils is for vegetable matter, which is valuable (1) for its fertilizing ingredients, and (2) especially for its effect in so changing the texture of the soil as to make the latter less sensitive to drought. The custom of always burning cornstalks and weeds must inevitably result in decreased productiveness, and this is true of prairie land as well as of sandy and clay soils.

VIII. Methods of Harvesting Corn.

For this experiment one measured acre of branch bottom land was used. Mosby Prolific corn, a variety with several small ears per stalk, was planted April 6 in rows $4\frac{1}{2}$ feet apart. Fertilizers, which were applied in liberal quantity, were separately weighed for each row.

The original plan was for the entire stalks on every fourth row to be cut and cured, for the tops to be cut from a second set of rows, for the blades or "fodder" on a third lot of rows to be pulled, and for the ears alone to be harvested from another set of rows. Circumstances prevented a test of the effect of stripping or fodder pulling, but the other comparisons were carried to a conclusion.

August 13, on a portion of the field the tops were cut just above the ear. At that date the lower leaves had "fired" too much to make good fodder.

August 22 on other rows the entire stalks were cut, put into large shocks and left until Sept. 12.

A third set of rows remained undisturbed until Sept. 12. On this last date the ears were pulled from all three classes of plants, viz: (1) those not previously disturbed, (2) those plants which had been topped, and (3) those stalks which had been cut near the ground and shocked.

Weather conditions were favorable to the curing of the stalks.

The following table gives the yields per acre both of grain and forage on the plots differently treated:

Yield per acre of corn and forage from different methods of harvesting.

METHODS OF HARVESTING.	Corn per acre.	Forage per acre.
	Bus.	*Lbs.*
Only ears harvested	34.9	00
Tops cut and ears harvested	30.2	312 (tops)
Entire stalks cut and ears afterwards harvested	29.2	2103 (stalks)

Apparently both topping and cutting the stalks before pulling the ears injuriously affected the yield of grain.

We have next to consider whether the forage gained by harvesting tops or stalks exceeded in value the grain which seems to have been lost by these processes.

With corn at 45 cents per bushel, tops at 50 cents per 100 lbs., and entire stalks with adhering blades at 25 cents per 100 lbs., and assuming that the different plots were uniform in fertility, we obtain the following financial results:

Value per acre of products from different methods of harvesting corn.

Method of Harvesting.	Value of grain.	Value of forage.	Value of total product.
Only ears harvested...........	$ 15 70	$ 0.00	$ 15.70
Ears and tops harvested........	13 59	1.56	15.15
Ears and entire stalks harvested.	13.14	5.26	18.40

At the prices assumed above, the highest value was secured by cutting and curing the entire stalks, this process showing a gain of $2.70 per acre over harvesting only the ears. Will this amount cover the cost of handling a weight of fresh stalks sufficient to produce about one ton of cured stalks? That is a local question the answer to which is largely dependent on the price and efficiency of labor. The value assumed for entire stalks, or stover, is necessary only on estimate, as the feeding value of stover from large southern corn has never been determined.

The low price of 25 cents per 100 lbs. of stalks has been assumed because of the immense waste in feeding the coarse forage, a waste which is inevitable unless one purchases a shredding machine and expends considerable labor in preparing shredded forage. Chemical analysis shows that even the butt of the stalk, the part which, unless shredded, is rejected by cattle, has some feeding value.

In an experiment at the Georgia Experiment Station, (Bulletin 30), where a shredder was used, a price of 40 cents per 100 lbs. was assumed for the cured stalks. In that test no reduction in yield of grain resulted from cutting the entire stalks, and at 40 cents per 100 lbs. of stalks, this method afforded a total product valued at $9.59 per acre more than the worth of the grain alone.

The effects of topping corn plants are variable. Results at the Arkansas Experiment Station, (Bulletin 24) showed a reduction in grain where the entire stalks were cut at a time when the bottom leaves of the plant were dying, and the kernels, nearly past the milk stage, were denting; the loss from cutting and curing the stalks before pulling the ears was nearly 3 bushels per acre.

Summarizing the results of experiments in topping we find that four* experiments show a loss of grain as a result of topping and that in three† others topping did not diminish the yield of grain.

It is apparent that topping, if postponed rather later than the usual time for pulling fodder, may be practiced without reducing the yield of grain.

If sufficient hay is not available and either topping or fodder pulling must be resorted to, topping is probably preferable. For though blades form a more palateable forage, topping has the advantage of requiring less labor, of affording a somewhat larger yield of forage per acre, and being less injurious to the crop of grain.

That stripping reduces the yield of grain more than does topping has been demonstrated in several experiments.

In an experiment in Texas the labor of pulling and storing a ton of "fodder" was three times as much as in harvesting a ton of tops.

Not only does fodder pulling require a large amount of labor, which could be more effectively employed in making hay, but its more serious disadvantage is that it almost invariable reduces the yield of grain. Summarizing the results

*Arkansas Bulletin 24; Alabama (Col.) Bulletin 75; Kansas Report '88, p. 27; and Mississippi Report '90, p. 20.

†Alabama (Canebrake) Bulletin 10; Illinois Bulletin 20; and Texas Bulletin 19.

of numerous experiments made in Southern states, we find that on an average stripped stalks have yielded 2.9 bushels per acre less than those not stripped. This loss, together with the cost of pulling the blades on an acre, which has been variously estimated at from 78 cents to $1.69, should be charged against fodder pulling, and the value of the fodder obtained should be credited. In the experiments where the yield of fodder is recorded, the average amount per acre is 542 lbs.

Assuming the prices below, which each reader can change to suit his judgment, we have the following financial statement relative to pulling fodder:

To 2.9 bus. corn at 45c	$1.31	
To cost of pulling, tying and storing fodder from 1 acre (estimated)	1.35	
By 542 lbs. fodder at 60c per 100 lbs.		3.25
Balance in favor of fodder pulling	59	
	$3.25	$3.25

If values assumed are correct the margin of profit in pulling fodder here averages only 59 cents per acre, which is probably insufficient to cover the single item of risk from bad weather, which sometimes almost completely destroys this forage. Moreover, the yield of fodder obtained in these tests was much above the average, as shown by the fact that in one instance it reached 936 lbs. per acre and by the additional fact that the yield of corn even on the stripped plots averaged nearly 25 bu. per acre, a yield which shows a vigor of growth much above the average of southern corn fields. Probably 350 lbs. of fodder would be a more correct estimate as the amount likely to be obtained on fields yielding 15 bushels of corn per acre. This yield would make the financial statement show a direct loss from fodder pulling in addition to risk from unsuitable weather. Undoubtedly labor could be more profitably employed in saving hay, especially if cow peas, melilotus, lespedeza, or other renovating plant were grown for hay, thus benefiting the land through the roots and stubble left in the soil, while furnishing a cheap and highly nutritious forage for live stock.

BULLETINS

OF

ALABAMA

Agricultural Experiment Station

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ROBERTS & SON.
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ALABAMA

Agricultural Experiment Station

OF THE

AGRICULTURAL AND MECHANICAL COLLEGE,

AUBURN.

EXPERIMENTS WITH COTTON.

J. F. DUGGAR, Agriculturist.

MONTGOMERY, ALA.:
THE BROWN PRINTING COMPANY, PRINTERS.
1897.

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EXPERIMENTS WITH COTTON.

By J. F. Duggar.

SUMMARY.

I. Of seventeen varieties of cotton tested in 1896, Hutchinson ranked first in yield and value of lint and value of total product. Truitt stood second, Dickson Cluster third, and Peerless fourth.

II. Seed from different parts of the Cotton Belt showed no very marked difference in productiveness.

III. No constant difference in productiveness was apparent when fresh and 2-year-old cotton seed were planted.

IV. The use of a roller after planting cotton caused the seeds to come up promptly and greatly improved the stand of young plants. Favorable weather in May resulted in a perfect stand on plots not rolled, as well as on the rolled plots, so that when the crop was gathered the rolled plots had lost nearly all of their early advantage.

V. At first cultivation barring off with a turn plow run very shallow did not reduce the yield of cotton when rain fell in time to prevent injurious drying of the soil.

VI. In rows 3.5 feet apart larger yields were obtained where the single plants stood 12 or 18 inches apart than where the distance between plants was 24, 30, or 36 inches.

VII. Subsoiling with a scooter gave an increase of 46 lbs. of lint and 93 lbs. of seed per acre over the yield of land not subsoiled. This result was secured on rather stiff red land in a very dry season, both of which conditions favored subsoiling.

VIII. In the dry season of 1896 slightly larger yields

were obtained from bedding on all the fertilizer than from reserving one-third of the fertilizer and applying this portion in the seed drill at planting time.

IX. Fine horse manure, crushed cotton seed, and acid phosphate, applied separately and mixed in the center furrow about one month before planting, were more effective than was a compost made of the same kinds and amounts of material and applied in the center furrow immediately before planting. Seed planted over the mixture had a settled seed bed, those over the compost were planted in loose soil. This difference in compactness is probably the chief cause of the more favorable result from the mixture.

X. On the field used for a fertilizer experiment a mixture of kainit and cotton seed meal proved more profitable in the dry season of 1896 than any other combination. The conditions of this test were peculiar, for the season was dry and fertilization and cropping in previous years had been unusual. Tests in other localities under more nearly normal conditions, indicate that cotton on most soils responds generously to acid phosphate and cotton seed meal.

Florida soft phosphate proved inferior to acid phosphate. Slaked lime did not increase the yield of cotton either on grey, sandy or red soil.

Introductory.

Cotton, like nearly all other farm crops, was injured by the dry weather of the spring and summer of 1896. In Bulletin No. 75, of this Station, is a statement regarding the periods of drought from which the station farm, as well as a large part of the entire State, suffered during the past year. When abundant rains came in July they were accompanied by violent winds. During July cotton plants dropped a large proportion of their squares, blooms, and small bolls.

All the experiments here described were made on carefully measured plots, which in different fields varied from one-twenty-first to one-fifteenth of an acre in area. Whenever practicable experiments were conducted on duplicate plots. In fertilizer experiments every plot was separated from the adjacent one by an unfertilized row of cotton which was not counted as part of the experiment. On all plots the rows were 3.5 feet apart, and in all cases, except in the distance experiment, the space between plants averaged 18 inches. Thinning was done in such a manner as to leave a uniform stand on all plots.

In addition to the experiments recorded in this bulletin other investigations relative to cotton were begun, the result of which are withheld until verified by another year's work.

The results of tests of varieties originated by Prof. P. H. Mell, Botanist of the Station, were turned over to him.

I. Varieties.

In the field used for this experiment every fifth plot was planted with King seed as a check on the fertility of the land. The field proved to be quite uniform.

All varieties were spaced equally, the distance between plants in 3.5 feet rows averaging 18 inches.

Preparation, fertilization, and cultivation were alike for all plots.

The following table shows the varieties tested, arranged in order of yield of lint; their relative earliness as indicated by the per cent. of the total crop gathered in the first picking, August 20th; and the per cent of lint in seed cotton:

Yield per acre of varieties of cotton.

Plot No	Variety.	Per cent of total crop at 1st picking.	Per cent of total crop at 2d, 3d, & 4th pickings.	Per cent. lint.	Yield of seed.	Yield of lint.
					Lbs.	*Lbs.*
1	Hutchinson Storm Prolific	43	57	32.3	845	403
5	Truitt Imp'd Premium Prolific	47	53	32.1	811	384
4	Dickson Cluster	72	28	33.6	696	368
8	Peerless	53	47	30.6	725	342
2,7,12,17	King, (average of 4 plots)	71	29	35.1	607	328
6	Tyler	50	50	30.9	724	320
9	Peterkin	48	52	34.6	603	320
16	Hawkins	48	52	31.4	691	317
13	Duncan Mammoth Prolific	56	44	31.7	670	312
15	Jones Improved	50	50	33.1	622	309
0	Allen New Hybrid Long Staple	....	....	26 4	830	298
14	Hunnicutt Choice	57	43	31.6	640	296
10	Herlong	45	55	32.3	619	296
11	Jones Long Staple	48	52	29.2	691	288
3	Welborn Pet	74	26	31.5	624	288
20	Whatley Improved	54	46	32.7	561	272
18	Petit Gulf	44	56	32.6	528	256

In the preceding table Hutchinson stands first in yield of lint followed by Truitt, Dickson Cluster, and Peerless.

The earliest varieties tested were Welborn Pet, Dickson Cluster, and King. Climatic conditions caused all varieties to mature early.

King afforded the highest per cent of lint, 35.1, which is higher than the record made by Peterkin in this test, which latter variety generally stands at the top in percentage of lint. The lowest per cent of lint as usual was with the long staple varieties.

The following table gives the value per acre of seed, lint, and total crop, and also the classification and market price January 1, 1897, in Opelika, as determined by an expert cotton buyer, Mr. H. L. Bandy:

Classification, market price of lint, and value per acre for varieties of cotton.

Plot No.	Variety.	Classification of staple.	Opelika price per lb. Jan. 1, '97.	Value of seed at 37½ c. per 100 lbs.	Value of lint.	Value of seed & lint per acre.
			Cents.	*Dollars.*	*Dollars.*	*Dollars.*
1	Hutchinson Storm Prolific............	Strict good middling.	7	$ 3 17	$ 28 21	$ 31 38
5	Truitt Improved Premium Prolific.....	Good middling.......	6¾	3 04	25 92	28 96
4	Dickson Cluster	Middling............	6½	2 61	23 92	26 53
8	Peerless	Strict middling	6⅝	2 72	22 66	25 38
	King...............................	*	6.11-16	2 27	22 05	24 32
6	Tyler..............................	Good middling.......	6¾	2 71	21 60	24 31
9	Peterkin	Good middling.......	6¾	2 26	21 60	23 86
16	Hawkins	Strict middling.......	6⅝	2 59	21 00	23 59
14	Hunnicutt Choice	Good middling	6¾	2 40	20 68	23 08
15	Jones Improved.....................	Strict middling	6⅝	2 33	20 47	22 80
0	Allen New Hybrid Long Staple.........	† (estimated)	7¼	3 11	21.60	24.71
13	Duncan Mammoth Prolific............	Good middling	6¾	2 51	21 06	23 57
11	Jones Long Staple (1⅛ inch)...........	† (estimated).........	7	2 67	20.16	22.83
10	Herlong.............................	Strict middling	6⅝	2 32	19 61	21 93
3	Welborn Pet.........................	Strict middling	6⅝	2 34	18 08	20 42
20	Whatley Improved	Good middling........	6¾	2 10	18 36	20 46
18	Petit Gulf	Strict middling	6⅝	1 98	16 96	18 94

* King on 2 plots was rated as good middling and on 2 plots as strict middling, hence the average price of 6.11-16 cents used in this table.

† "Staple of 1⅛ inch does not command much premium here where our receipts ordinarily average 1 inch; we get considerable cotton as long as 1.1-16. Cotton 1¼ inch in length brings all the way from ¾c. to 1c. more than upland, based on middling." Letter from Jno. H. Clisby & Co., Montgomery, Ala.

The varieties which yielded most lint, Hutchinson, Truitt, Dickson, and Peerless, gave also the highest combined value of seed and lint. The two long staple varieties take a higher rank in this than in the preceding table, on account of the higher price assumed for long staple lint. However, this higher price can be obtained only in the large cotton markets. In Opelika, and presumably in most towns of similar size, long staple commands no higher price than short staple cotton.

A single variety test cannot determine the true value of a variety. The average of many tests is more reliable. The table below, compiled for a recent publication of the U. S. Department of Agriculture, Office ot Experiment Stations (Bul. 33), gives average results of variety tests of cotton published prior to 1895. Only those varieties are included which has been tested 10 or more times. The figures showing average relative yields are obtained by taking the average yield of all varieties in any one experiment as 100, and giving correspondingly higher or lower values to varieties exceeding or falling below that average. The average of the 10 or more figures thus obtained is taken as indicating the relative productiveness of a given variety. The varieties are arranged in order of average yield of lint.

Relative yield of lint of varieties often tested at Southern Experiment Stations.

Variety.	Number of tests	Relative productiveness. Maximum	Minimum	Average.
Peterson	53	171	70	131
Excelsior	10	154	84	109
King	44	173	76	108
Boyd Prolific	10	156	68	107
Truitt Premium	45	161	40	106
Jones Improved	23	135	82	105
Peerless	36	143	76	105
Texas Storm Proof	27	176	69	104
Dickson	21	141	74	103
Deering	19	150	80	103
Shine Early	18	132	61	103
Welborn Pet	37	185	73	103
Ben Smith	11	139	73	102
Crawford Peerless	20	155	58	101
Hawkins	34	148	57	101
Ozier	17	119	45	100
Southern Hope [Long Staple]	34	139	68	99
Jowers	11	128	76	97
Cherry Long Staple	14	132	74	96
Jones Long Staple	26	136	57	96
Petit Gulf	15	132	46	96
Okra	28	124	67	95
Allen [Long Staple]	34	144	52	94
Cherry Cluster	13	123	55	90
Cook, (W. A.) [Long Staple]	12	123	56	85

Where to Get Seed.

As this Station cannot supply seed, the addresses of parties from whom the Station obtained its supply of seed are given below :

Allen New Hydrid Long Staple, J. B. Allen, Port Gibson, Miss.

Dickson Cluster, Mark W. Johnson Seed Co, Atlanta, Ga.

Duncan Mammoth Prolific, Ala. Expt. Station, Auburn, Ala.

Hunnicutt Choice, Ala. Expt. Station, Auburn, Ala.

Jones Improved, Ala. Expt. Station, Auburn, Ala.

Petit Gulf, Ala Expt. Station, Auburn, Ala.

Herlong, H. P. Jones, Herndon, Ga.

Jones Long Staple, H. P. Jones, Herndon, Ga.
Peerless, H. P. Jones, Herndon, Ga.
Peterkin, H. P. Jones, Herndon, Ga.
Hawkins, Alexander Drug and Seed Co., Augusta, Ga.
King, T. J. King, Richmond, Va.
Hutchinson, J. N. Hutchinson, Salem, Ala.
Truitt, G. W. Truitt, La Grange, Ga.
Tyler, K. J. Tyler, Aiken, S. C.
Welborn Pet, Mark W Johnson Seed Co., Atlanta, Ga.
Whatley Impd, T. A. Whatley, Opelika, Ala.

II. Seed From Different Latitudes.

Seed of the variety King was obtained from the northern part of South Carolina, from Pickens Co., Ala., and from Baton Rouge, La.

The yields per acre were as follows:

Seed from different latitudes.

Plot No	Seed from	Yield of lint per acre.
		Lbs.
17&23	Northern part South Carolina	292.
24	Pickens county, Alabama	288.
19	Baton Rouge, Louisiana	259.

The figures are slightly in favor of seed from the most northernly locality, but the differences aie small.

III. Old versus New Cotton Seed.

In selecting seed of most cultivated plants, new or fresh seed are to be preferred. However, it has been stated that old seed of some species are more productive than new. The writer has never met with any evidence in support of this claim. Old seed as a rule germinate poorly, thus affording a poor stand.

At least one dealer in cotton seed has advertised the alleged superiority of old cotton seed over new seed. The substance of his claim is that when old seed are planted, the weaker or poorer seeds fail to germinate, and that only such old seeds as have strong vitality or natural superiority are able to come up. Thus we are told that the planting of old cotton seed insures a process of natural selection, and that only the best seeds grow.

In order to compare old and new seed, three samples of seed were obtained from the originator of the Gold Dust variety, and three from the originator of the Whatley Improved. Each lot of three samples represented respectively the crops of 1893, 1894, and 1895, grown on the same farm.

All were planted in the same field April 17, 1896, and given identical culture and fertilization.

The following table gives the results:

Yield of lint per acre produced by seed of different ages.

Age of Seed.	Lint per acre.		
	Whatley Impd.	Gold Dust.	Average for two varieties.
	Lbs.	*Lbs.*	*Lbs.*
Seed from crop of '95	272	242	257
" " " '94	237	248	242
" " " '93	246	277	262

There was a slight difference in the fertility of the plots used in this experiment, but this is corrected by averaging the two varieties together. Taking the average figures for the two varieties, the differences in yield are too small to justify the conclusion that old seed are better than new.

The percentage of lint was practically the same for all classes of seed. There is no valid evidence here that an old cotton seed, if it grows, will develop into a more productive plant than a new seed. Very often the old seed will not grow, and a poor stand results. Since new seed usually insure the better stand of plants, we should expect them to afford the better crop.

IV. The Use of the Roller in Cotton Planting.

For this test light sandy land was used. The field was turned or flushed about a month before planting, but not bedded until a week before planting. Undoubtedly it would have been better to have formed the beds earlier so as to give time for rain to settle or slightly pack the soil.

When the seed was planted, April 17, with a Banner planter, the ground was very loose and dry, no rain having fallen for more than two weeks previous. Before planting, the beds were pulled down almost to a level by the use of a smoothing harrow.

After planting, there was used on one plot a one-horse roller; on another a narrow roller consisting of a heavy iron pulley with a 6-inch face, which compacted only a narrow strip of soil immediately over the line of seed; on a third plot an iron pulley was used as before, and in addition loose dirt was drawn over the compacted path of the narrow roller. Subsequent treatment was identical for all plots.

The yields were as follows:

Effect of rolling after planting cotton seed.

Treatment.	Yield of lint per acre.
	Lbs.
Entire surface of plot rolled	229
Not rolled	226
Narrow space over seed rolled	236
Narrow space over seed rolled and loose dirt drawn on rolled space	258

The effects of rolling as shown by the above table are far less decided than would have been predicted from appearances of the different plots two weeks after planting. At that time there was a perfect stand on all rolled plots in spite of the dry weather of the preceding 28 days, while on the plot not rolled the stand was very poor. This was the appearance at the end of a long dry spell, but showers which fell about two weeks after planting moistened and settled the soil and caused the majority of the seeds on all plots to grow, so that by June all differences in the appearance of the plots had disappeared. In short, during the continuation of dry weather after planting, rolling was plainly advantageous, in that it produced a perfect stand and prompt growth. But a perfect stand appearing later on all plots, this early advantage of rolling was almost lost before the crop was gathered.

A word in regard to the usual effects of rolling may be appropriate here. The immediate effect of rolling is to cause moisture to rise by capillary attraction from the subsoil into the upper layer of soil. This is clearly an advantage to seed planted in loose dry earth, more especially since rolling presses the soil particles closer to the seed and thus renders the latter better able to absorb moisture from the soil.

But rolling may be harmful if its effects are too long continued, that is, if water continues to be lifted from the depths of the soil to the surface where it evaporates and is lost. The top soil in which the seed lie is supplied with moisture by an upward current, so to speak, and when this upward movement continues for a long time in a dry season there comes a time when the supply of water in the subsoil is no longer sufficient to supply moisture to the stratum above. Thus not only the surface layer, but a great depth of soil, becomes parched.

The farmer may secure the benefits of rolling without its disadvantages by forming on top of the compressed soil a thin layer of loose dirt, which loose layer or soil mulch serves to check the further rise and evaporation of moisture, retaining it in the rolled stratum in proximity to the seed. In sowing small grains this end can be attained by following the roller (used to hasten germination in loose soil and dry weather) with a smoothing harrow which leaves a loose layer of soil on the surface. It is believed that this principle could be advantageously introduced into the construction of cotton planters. It would be necessary only to substitute for the small roller now used at the rear end of some planters a heavier and narrower roller and to attach behind the roller two small blades or rakes to draw loose dirt over the compacted soil.

V. Barring Off.

A practice which is quite common is to use a small turn plow in the first cultivation of cotton, throwing the dirt away from the plants and leaving them standing on a very narrow ridge. At experiment stations and on a great number of well managed farms, barring off is never practiced, but shallow cultivation with some form of scrape is substituted.

On one plot barring off was done with a one-horse turn plow running to as shallow depth as possible. This was 26 days after planting the seed. At this date adjacent plots were cultivated as usual with a heel scrape. After the first plowing all plots were cultivated alike. In 1896 no injurious effects were produced on our barred-off plot, which yielded at the rate of 253 pounds of lint per acre against 246, the average of two plots, one on each side of the barred off plot and cultivated entirely with a heel scrape. The reason why barring off was harmless in this case is obvious, when we add that it rained in a few hours after the turn plow had been used. This prevented any drying out of the ridge, which drying is probably the chief injury from this method of cultivation. If such an opportune shower could always be counted on, then no strong objection could be urged against this practice. But since a drying sun is more usual than a timely shower on a given day in May, we prefer the method of cultivation with scrape, which is as good as barring off in wet weather and far better in dry weather.

VI. Distance Experiments.

Peerless cotton was planted April 14th on a sandy hill top in rows 3½ feet apart. All plots were prepared, fertilized, planted, cultivated, and chopped alike. The final thinning was done June 12th while the plants were still small, by pulling up superfluous stalks and leaving on the different plots stalks sufficient to average 12, 18, 24, 30, and 36 inches apart. Nematode root worms did some damage over the whole field. All plots were duplicated. The yields were as follows:

Yield per acre of seed cotton with single plants at different distances.

Plot No.	Distance.	Yield of seed cotton per acre.
		Lbs.
1	12 inches by 42 inches	887
2	18 " " 42 "	938
3	24 " " 42 "	722
4	30 " " 42 "	619
9	36 " " 42 "	546
10	24 " " 42 "	624
11	30 " " 42 "	469
12	36 " " 42 "	515
13	12 " " 42 "	653
14	18 " " 42 "	670
	Average for 12 inches	770
	" " 18 "	804
	" " 24 "	673
	" " 30 "	544
	" " 36 "	530

The table shows that there was but little difference in yield between distances of 12 and 18 inches. When the distance between single plants in the drill was greater than 18 inches there was a large reduction in yield.

VII. Subsoiling and Liming.

For this experiment there was selected a level piece of red land containing more clay than the majority of soils in this locality. This particular soil is shallow, the change of color occurring at a depth of only 3½ or 4 inches; it is inclined to bake and is very sensitive to drougth.

On January 29th, 1896, one plot was broken to the usual depth, 3 or 4 inches, with a one-horse turn plow. In this furrow followed a scooter drawn by one mule, which loosened a part of the soil to an additional depth of $3\frac{1}{2}$ inches. In this way the soil was loosened to a depth of about 7 inches without throwing up to the surface the clay of the subsoil, which is temporarily poorer than the surface soil.

At the same time two other plots were broken with a one-horse turn plow in the usual way without the subsoiling scooter, and on one of these slaked lime was applied broadcast at the rate of 640 lbs. per acre. Rows were laid off $3\frac{1}{2}$ feet apart, and in these furrows fertilizers were applied as follows on all three plots:

80 lbs. Acid phosphate per acre.
160 lbs. Cotton seed meal per acre.
40 lbs. Muriate of potash per acre.
———
280 lbs., total, per acre.

After drilling the fertilizers they were mixed with the soil by running a narrow scooter in each furrow containing fertilizers. Then ridges or beds were formed, and planted with a Banner cotton and corn planter. The yields of lint cotton were as follows:

Yield per acre of lint on untreated, subsoiled, and limed plots.

Treatment.	Yield of lint per acre.
	Lbs.
Neither subsoiled nor limed	195
Subsoiled	241
Limed	203

In this experiment a light surface dressing of slaked lime did not materially increase the yield of cotton.

The figures in the above table show an increase of 46 lbs. of lint on the subsoiled plot. The value of this lint at $6\frac{3}{4}$ cts. per pound, $2.84, may be taken as clear profit from subsoiling. For the gain of 93 lbs. of seed on the subsoiled plot covers at least one-third of the extra expense of subsoiling, and only a part of the expense of subsoiling is justly chargeable against the first crop, since its effects are usually felt for several years.

It should be noted that this very favorable result from subsoiling was obtained in an unusually dry year, and that in wet seasons and on land with a loose subsoil, less beneficial results should be expected.

Doubtless many compact upland soils that suffer serious injury from drouth, would be benefitted by subsoiling. The expense is slight, since subsoiling is usually necessary not oftener than every third year. Subsoiling should be done, if at all, a long time before the planting season, so as to give an opportunity for at least some of the winter rains to moisten and settle the deeply stirred soil.

VIII. One-Third of Fertilizer in Seed Drill.

At the Georgia Experiment Station a larger yield of cotton was obtained by bedding on two-thirds of the fertilizer to be used, reserving one-third and applying it at planting time in the seed drill in immediate contact with the seed. To test this question on the light sandy soil of this vicinity, the experiment was repeated here with two varieties of cotton, both heavily but differently fertilized, and growing in different fields.

The results are given in the following table:

Application of part of fertilizer in seed drill.

METHOD OF APPLYING FERTILIZER.	Yield per acre of seed cotton.
Peerless.	*Lbs.*
All fertilizer bedded on (av. 2 plots)	681
{ 2/3 of fertilizer bedded on / 1/3 of fertilizer in seed drill } (av. of 2 plots)	655
King.	
All fertilizer bedded on	633
{ 2/3 of fertilizer bedded on / 1/3 of fertilizer in seed drill }	611

With both varieties there was a slightly smaller yield where a part of the fertilizer was put in the seed drill. The loss was too slight to give very positive indications.

IX. COMPOSTING VERSUS MIXING IN THE FURROW.

March 17th two lots of acid phosphate, two of crushed cotton seed, and two of fine horse manure were weighed. One lot of each material was made into compost, moistened, and stored under shelter for four weeks. The other lots of fertilizing materials, equal in weight to those used in the compost, were separately drilled in the marking off or center furrow of one plot, mixing being effected by running a scooter through the furrow containing the fertilizers. Beds were immediately thrown up over the fertilizers, and these were not disturbed until the day of planting.

The plot reserved for compost was not bedded till the day of planting, April 14, when the land was marked off, and in this furrow the compost was drilled; beds were immediately formed.

Both plots were then planted. The soil of the compost plot being recently plowed, was loose, while the other plot offered a more compact seed bed, rains in the latter part of March having settled the soil to some extent.

Both the mixture and compost contained per ton 333 lbs.

acid phosphate, $333\frac{1}{3}$ lbs. crushed cotton seed and 1334 lbs. staple manure; 2835 lbs. of mixture and compost per acre were used.

The yields of seed cotton per acre were as follows:

Fertilizers mixed in furrow; firm seed bed - -	1,020 lbs.
Fertilizers composted for 4 weeks; loose seed bed	798 lbs.
Balance in favor of mixing in furrow and planting on settled beds - - - - - - -	222 lbs.

It would be unfair to attribute to composting the large shrinkage in yield on the composted plot. In all probability it was due rather to the loose condition of the soil where compost had just been applied. For two weeks before planting and for two weeks afterwards no rain fell, a circumstance which placed the loose soil of the compost plot at a great disadvantage. It dried out and the seed were later in coming up on this plot than on the more compact soil of the other plot.

This is not the first experiment tending to show that with cotton, and indeed with most plants having a long growing season, it is unprofitable to incur any large expense in repeated handling of bulky manures. During idle seasons regular labor may be advantageously employed in making composts of leaves and manure that is too coarse for hauling at once from stable to field; but one should closely calculate the cost before hiring labor especially for mixing composts. Bulky manures should always be saved and used, but if handled several times the cost of labor may exceed the value of the manure.

The conclusion reached by the Georgia Station relative to composts is quoted from Bulletin 31, which gives results at that Station up to the end of the year 1895. "Composting several weeks before distributing in the soil does not seem to add materially to the effectiveness of the mixture. If the manure is well decomposed it will do just as well to mix all together and deposit in the soil a few days before planting, or separately, one after the other, the same day, as to mix in a heap weeks beforehand, and this will involve considerably less labor of handling."

X. Experiments With Fertilizers.

Plots 1 to 8 of this experiment formed part of a co-operative fertilizer test on cotton, these plots on the Station farm being duplicates of tests conducted for this Station by farmers in a number of localities in this State. Plot 9 was designed to test the effect of lime on a sandy soil, and plot 10 was intended to show how the growth of the cotton plant was affected by an excessive quantity of kainit.

This experiment was conducted on a gray sandy soil containing but few stones. This field bore a crop of wheat in 1895, followed by a crop of sorghum the same year. Unfortunately it was not learned until the experiment had been started that this field had been used for a special fertilizer experiment in 1893 and 1894. During both of these years extremely large quantities of cotton seed meal and nitrate of soda had been used. The slight response to cotton seed meal in 1896, shows that nearly sufficient nitrogen remained in the soil from the previous applications. All plots received equal benefit from previous fertilization, for the reason that the rows ran in a direction perpindicular to that of former years.

The fertilizers used in this experiment cost, delivered in Auburn in less than car load lots, as follows:

	Per ton.
Acid phosphate, (16.26 per cent. available phosphoric acid) - - - -	$15.00
Cotton seed meal - - -	20.20
Kainit (12.3 per cent potash) - -	15.70
Florida soft phosphate (29.26 per cent. total phosphoric acid, 0.78 per cent available) -	13.92
Crushed cotton seed (estimated) - -	8.56
Slaked lime - - - -	5.00

The crop of seed cotton is estimated at $2\frac{1}{2}$ cents per pound, which is equivalent to $6\frac{3}{4}$ cents per pound for lint, and $37\frac{1}{2}$ cents per 100 pounds for seed, in cases where seed cotton affords $33\frac{1}{3}$ per cent. of lint ("thirds itself.")

The following table shows the amount and kind of fertilizers and the cost per acre; the yield of seed cotton, the increased yield on the fertilized plots; the gross value of this increase; and the net value of the increase over and above the cost of fertilizers.

Results of fertilizer experiment.

Plot.	Fertilizers— Amt. per acre.	Fertilizers— Kind.	Fertilizers— Cost per acre.	Seed cotton— Yield per acre.	Seed cotton— Incr'ase over unfertilized plots.	Value of increase at 2½c. per lb.	Profit from fertilizers.
	Lbs.			*Lbs.*	*Lbs.*		
1	200 240	Cotton seed meal..... Acid phosphate......	$ 3 82	759	180	$ 4 50	$ 68
2	00	No fertilizer..........	......	582	....	......	......
3	200 200	Cotton seed meal..... Kainit...............	3 59	958	373	9 33	5 74
4	240 200	Acid phosphate... .. Kainit.........	3 37	907	328	8 20	4 83
5	200 240 200	Cotton seed meal..... Acid phosphate....... Kainit...............	5 39	940	361	9 03	3 64
6	00	No fertilizer...........	......	577	....	......	......
7	200 240 200	Cotton seed meal..... Florida soft phosphate Kainit............ ..	5 27	844	265	6 63	1 36
8	472 240 200	Crushed cotton seed .. Florida soft phosphate Kainit...............	5 27	882	303	7 58	2 31
9	200 240 200 600	Cotton seed meal..... Acid phosphate....... Kainit................ Slaked lime...........	6 89	933	354	8 85	1 96
10	200 240 600	Cotton seed meal..... Acid phosphate....... (3 rations) Kainit	8 53	1138	559	13 98	4 45

In this test acid phosphate proved more effective than an equal weight of Florida soft phosphate. Cotton seed, even at $8.56 per ton, was a more profitable nitrogenous fertilizer than cotton seed meal. The above table shows that in this experiment mixtures containing kainit were the most effective fertilizers. A mixture of kainit and cotton seed meal was most profitable. The increase on all plots where potash was used was large, cotton seed meal was but slightly effective, and acid phosphate almost entirely without effect. This failure of acid phosphate and this favorable result from kainit is somewhat unusual, and probably finds its explanation in the previous fertilization and cropping of the land, and in the unusual character of the season.

The proceeding crops of wheat and sorghum had drawn more heavily on the potash of the soil than on the supply of phosphoric acid, sorghum containing about 2½ times as much of potash as of phosphoric acid, and wheat straw about 4 times as much of potash as of phosphoric acid. This removal of potash by previous crops would naturally leave the soil in a condition to respond freely to applications of potash.

A dry season also favored kainit, since this fertilizer is generally credited with the power of increasing the water-holding capacity of the soil.

The good effect of kainit could not be ascribed to its power to check certain forms of leaf disease, for "rust" was just as apparent on the plots receiving 200 lbs. per acre of kainit as on the plot without kainit. Only when the amount of kainit was excessive, 600 lbs. per acre, was there a noticeable tendency for the foilage to resist disease and remain green late in the season.

Apparently enough phosphoric acid for the needs of the crop remained unused from previous applications. Nearly enough nitrogen also seems to have been left, very little having leached out in the previous winter when the rainfall was light.

As noted above, this experiment was conducted under unusual conditions of soil and season, and hence its results should not be accepted as widely applicable. Other experiments conducted for this Station in a number of localities in this State in 1896, indicate that as a rule cotton seed meal and acid phosphate are much more profitable than they proved to be on this particular field.

Results of a number of fertilizer tests on cotton will be discussed in the next bulletin issued by this Department.

BULLETIN No. 77. JANUARY, 1897.

ALABAMA

Agricultural Experiment Station

OF THE

AGRICULTURAL AND MECHANICAL COLLEGE,

AUBURN.

I. THE SAN JOSE SCALE—A WARNING TO THE FRUIT GROWERS OF ALABAMA.

II. SOME OTHER INSECT PESTS.

a. THE TOMATO WORM.

b. GRAPE LEAF-HOPPERS.

c. CABBAGE WORMS.

C. F. BAKER.

MONTGOMERY, ALA.:
THE BROWN PRINTING COMPANY, PRINTERS.
1897.

☞The Bulletins of this Station will be sent free to any citizen of the State on application to the Agricultural Experiment Station, Auburn, Alabama.

I. THE SAN JOSE SCALE,*

C. F. Baker.

That this terrible pest of the orchard has gained a foothold in Alabama is now an assured fact. Specimens have been examined from orchards and nurseries in the northern, central and eastern portions of the State. It will also probably be found in other sections, as it occurs in several of the Southern States, and no steps have been taken to prevent its free distribution. Not only is the occurrence a matter of vital importance to every orchardist and nurseryman at home, on account of its destructiveness, but late laws (passed and pending) in several States, relative to this insect, will make it impossible to ship from infested localities to those States. This bulletin is published for the purpose of informing fruit-growers regarding the very serious nature of this pest, and warning them that unless its appearance is carefully watched for, and *immediate* steps taken to destroy it, the destruction of infested trees—perhaps whole orchards—*will surely follow.*

Kinds of Trees Attacked.

This scale has been found on most of the fruit trees grown in the United States. It will also attack currant and gooseberry, and even the pecan and English walnut. Some of its most destructive occurrences have been in orchards of apple, peach, pear, plum, and cherry.

* Those desiring a very much fuller descriptive account of this insect should apply to the U. S. Department of Agriculture at Washington for Division of Entomology Bulletin No. 3—new series. Several bulletins on the subject have also been sent out from various State Experiment Stations.

Appearance, and Part of Tree Attacked.

The congregated scales produce a dirty whitish, fly-specked appearance, usually on the bark—in bad cases also on leaves and fruit. Although the scale is a very small one, yet the greyish, scurfy appearance of the bark will call attention to its presence.

How it is Disseminated.

Probably the principal agent in the distribution of the San Jose Scale over the United States has been nursery stock. There should be laws in this State, as there are already in some others, not only compelling owners of orchards to do all possible towards eradicating the pest where it occurs, but prohibiting the transportation or sale of infested nursery stock or fruit in the State. Such a law should certainly be put into effect at once, before the insect has spread beyond all hope of control. Some other States now have abundant cause for extreme regret that they did not enact the necessary laws in time, for as in New Jersey and Ohio the laws come too late to act as a *preventive.* Prevention in this case is comparatively cheap—cure very costly. This matter is most earnestly recommended to the careful attention of orchardists and legislators.

Its Destructiveness.

Relative to the unusual destructiveness of this insect, we cannot do better than quote Mr. L. O. Howard, Government Entomologist, under whose direction it has been carefully investigated. He says: "There is perhaps no insect capable of causing greater damage to fruit interests in the United States, or perhaps the world, than the San Jose, or pernicious, scale. It is not striking in appearance, and might often remain unrecognized, or at least misunderstood, and yet so steadily and relentlessly does it spread over practically all deciduous fruit trees—trunk, limbs, foliage, and fruit—

that it is only a question of two or three years before the death of the plant attached is brought about, and the possibility of injury, which, from experience with other scale enemies of deciduous plants, might be easily ignored or thought insignificant, is soon startlingly demonstrated. Its importance from an economic standpoint, is vastly increased by the ease with which it is distributed over wide districts through the agency of nursery stock and the marketing of fruit, and the extreme difficulty of exterminating it where once introduced, presenting, as it does in the last regard, difficulties not found with any other scale insect. * * *

The Los Angeles Horticultural Commission reported in 1890 that if this pest be not speedily destroyed it will utterly ruin the deciduous fruit interests of the Pacific Coast. Its capacity for evil has been more than demonstrated since its appearance in the east, and it has been, if anything, more disastrous to the peach and pear orchards of Maryland, New Jersey, and other Eastern and Southern States than in California and the West.

We are therefore, justified in the assertion, that no more serious menace to the deciduous fruit interests of this country has ever been known. There is no intention here to arouse unnecessary alarm, but merely to emphasize the importance of taking the utmost precautions to prevent its introduction into new localities, and to point out the extreme necessity of earnest effort to stamp it out where it has already gained a foothold."

What to Do About it.

If scales of any sort whatsoever are found in the orchard, send samples to this office at once (see last page) for identification. There are several scales in the east which very closely resemble the San Jose scale, but which are not so destructive in character. This point should be determined at once. The orchard should be kept free from all scales, but in no case is the necessity for immediate action so urgent as with the San Jose scale.

If a tree is very badly affected, cut it down at once and burn. If the top only is affected, cut off and burn, treat the trunk remaining with whale-oil soap, and retop by grafting (Webster). Otherwise the best and simplest remedy in the east is probably a winter wash of whale-oil soap. This should be *thoroughly* applied at the rate of two pounds dissolved in one gallon water, with a spray pump, brush or swab, once or twice during the winter and again before the buds begin to swell in the spring (Webster and Smith).

The whale-oil soap can be ordered from Leggett & Brother, 301 Pearl St., New York City. "It is sold in barrels of about 450 pounds at 4 cents per pound, in boxes of 100 pounds at 6 cents per pound, and in 50 pound lots at 6½ cents per pound. In each case the material will be delivered free on board of cars or to express."

Mr. Howard gives the following

Summary of Recommendations

which embodies the best advice that can be given fruit growers and which it behooves our orchardists and nurserymen in the east to heed:—

"(1) In all cases of recent or slight attack the affected stock should be promptly uprooted and burned. No measure is so sure as this, and the danger of spread is so great that this course seems fully warranted.

(2) In cases of long standing and wide extent the affected stock should be cut back severely and treated with winter soap wash, stock badly incrusted with scale should be cut out at once and burned. The lessening of the vitality, together with the poisoning of the sapwood already effected by the scale in such cases, will usually prevent the plant from ever again becoming healthy, and generally it is beyond help. We wish particularly to impress upon the minds of

fruitgrowers that as soon as this insect is found to occur in an orchard the most strenuous measures must be taken to stamp it out. No half-way steps will suffice. The individual must remember that not only are his own interests vitally at stake but those of the entire community in which he resides. He may think that he can not bear the loss, but the loss in consequence of the slightest neglect will be much greater. The fact, too, that there is a community of interests among fruit growers in this matter must not be lost sight of. Fruit growers must be mutually helpful in an emergency like this.

(3) As precautionary measures to prevent the introduction of the scale into new districts, the following considerations are important: No orchardist should admit a single young fruit tree or a single cutting from a distance into his orchard without first carefully examining it and satisfying himself conclusively that it does not carry a single specimen of the San Jose scale; he should insist, also, on a guaranty from the nurseryman of such freedom. In addition, no fruit should be brought upon the premises without previous careful inspection. If this course is adopted by everyone interested, without exception, the rate of spread of the species may be limited to the comparatively slight natural extension by crawling, by winds, and by the aid of other insects and birds."

II. SOME OTHER INSECT PESTS.

A. The Tomato Worm.

Probably no other enemy of the tomato can do so much damage in so short a time, as the Tomato Worm. This immense green worm, with a "horn on his tail," is familiar to every grower of tomatoes. Its voraciousness is unequalled. Within a very few days two of them have been known to entirely defoliate a good sized tomato plant. It very closely resembles the Tobacco Worm which works in a similar manner. When the worm becomes full grown it leaves the plant, goes down into the ground and transforms into a large oval dark brown chrysalis, which eventually gives forth one of the large "humming bird" or "hawk moths." After mating the moths lay eggs which produce more worms. In the south there may be several broods in a season.

As the worm and its work are very conspicuous, it is an easy matter to keep the plants clear of them by hand-picking. A sharp-eyed small boy armed with a stick, can knock them off the vines and crush them very rapidly, and is much surer and more economical than any insecticide. Where the worms are abundant this process should be repeated at least once a week. In spite of the ease with which they may be kept under control, several patches of tomatoes were visited last fall in which these worms were working great havoc unmolested, because the owners "didn't know any remedy" for the trouble.

Often individuals are found covered with numerous little white silky bodies. These are the cocoons of beneficial parasites which kill the worms. On this account, they *should never be destroyed.*

b. Grape Leaf-hoppers.

During the summer in almost any vineyard, when the foliage of the vines is disturbed, great numbers of very minute insects are seen flying and jumping about. These insects, though usually occurring in myriads and often doing great damage to the vines, are so inconspicuous that they are rarely noticed. Still more rarely is anything done to remedy the evil. They gain their sustenance by sucking the juice of the vine, thus sapping its life and producing injurious effects, for which the grower can usually see no cause.

The leaf-hoppers hibernate over winter under the leaves and rubbish in the vineyard. Hence the first move indicated is keeping the ground entirely clear of litter of any sort during the winter. During the summer, as soon as they appear on the vines apply kerosene emulsion in a fine spray all over the vines. Apply it very early in the morning, while still cool, for at this time they are most inactive and hence most readily reached with the emulsion.

Kerosene emulsion is made of water, soap and kerosene in the following proportions: one gallon water, one-half pound soap, and two gallons kerosene. Heat the water boiling hot, dissolve in it the soap, add the kerosene and churn the mixture forcibly, or pump back into the same vessel, until it becomes a creamy, white, frothy emulsion, from which the kerosene will not separate. Dilute with nine times the amount of water.

c. Cabbage Worms.

Every one is acquainted with the disgusting green worms in cabbages. They are not only an unmitigated nuisance to those who raise the cabbage for home use, but they often ruin the plant for market purposes. As soon as they appear in the cabbages, the plants should be thoroughly dusted with pyrethrum. The pyrethrum should be a *fresh* article and can be ordered from Leggett & Bro., 301 Pearl St., N. Y. City. Mix one part of this with six parts of wheat or rye flour and allow to stand in a closed vessel over night. It may be dusted into the cabbages by means of a powder-gun made for the purpose, or through cloth bags as is done in the case of Paris green on cotton.

Or two tablespoons of the pyrethrum may be stirred into a gallon of water, and this after standing for a time, sprayed into the plants.

Kerosene emulsion is sometimes used for these worms and for the lice which are so often abundant in cabbages, but it should not be used within several weeks of the time of harvesting as there is a possibility of some odor or taste of kerosene remaining.

There is no danger from the pyrethrum and it leaves no taste, so can be used with impunity. Its active principle is a volatile oil, which escapes rapidly when the powder is left uncovered. A fruit jar with a tight top is a good thing to store it in. It is a very good plan to keep a small supply of it on hand, for it is a very efficient remedy for many troublesome insects, especially some of the household pests like cockroaches, bedbugs, ants, etc. Dusted into the fur of dogs and cats it will kill fleas and lice and can be similarly used on domestic fowls. Small portions melted and made up into little cones, then dried, lit at the top and allowed to smoulder, will rapidly clear a room of flies or mosquitoes.

WHENEVER YOU ARE TROUBLED BY INSECTS

of any kind whatever, in the house or barn, on the farm or garden, in the orchard, in the store, warehouse or mill, or anywhere else, send specimens at once, safely packed in a small wooden box with the facts concerning them, to The Entomologist, Agricultural College, Auburn, Ala. He is stationed here at your service, and will give prompt attention to all communications, furnishing you with information regarding the insects and remedies for them, free of all charge. He is just now engaged in a special study of all insects injuring cotton, and would be very glad to receive notices of any such from all portions of the State.

BULLETIN No. 78. FEBRUARY, 1897.

ALABAMA

Agricultural Experiment Station

OF THE

AGRICULTURAL AND MECHANICAL COLLEGE,

AUBURN.

Co-operative Fertilizer Experiments with Cotton in 1896.

J. F. DUGGAR, Agriculturist.

MONTGOMERY, ALA.:
THE BROWN PRINTING COMPANY, PRINTERS.
1897.

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☞The Bulletins of this Station will be sent free to any citizen of the State on application to the Agricultural Experiment Station, Auburn, Alabama.

CO-OPERATIVE FERTILIZER EXPERIMENTS WITH COTTON IN 1896.

By J. F. DUGGAR.

SUMMARY.

In 1896, in addition to experiments on the Station Farm, there were conducted under the direction of the Agricultural Department of this Experiment Station 27 fertilizer experiments with cotton in as many localities. Reports were received from 21 experimenters; 14 of the most conclusive of these reports constitute the basis for the greater part of the results here presented.

Florida soft phosphate, also known as "Natural Plant Food," proved inferior to high grade acid phosphate, pound for pound. When both phosphates were applied with cotton seed or cotton seed meal the average yield of seed cotton was 43 pounds per acre greater with acid phosphate than with the Florida soft phosphate.

The nitrogen contained in crushed cotton seed and cotton seed meal was equally valuable, pound for pound. The relative prices of cotton seed and cotton seed meal, which fluctuate considerably, must in each particular case determine which is the cheaper source of nitrogen and hence the more profitable fertilizer. On an average one pound of cotton seed meal proved as effective as 2 1-16 pounds of crushed cotton seed. In other words 922 pounds of cotton seed meal proved equal in fertilizing value to 2,000 pounds of crushed cotton seed.

According to these results, which however may have been influenced by the unusual season, a farmer cannot afford to

sell cotton seed and buy cotton seed meal until the ton price of seed is at least 46 per cent. of the ton price of the meal; for example, with cotton seed meal at $20 per ton, crushed seed are worth on the farm $9.20 for fertilizing purposes.

In testing the needs of the cotton plant, 200 pounds per acre of cotton seed meal was used to furnish nitrogen, 240 pounds acid phosphate to supply phosphoric acid, and 200 pounds kainit to afford potash. These fertilizers were not as a rule applied singly, but by twos and threes.

The chief need of the soil was apparently phosphoric acid in three instances, potash in three cases, and nitrogen in five soils; on three of these fourteen soils, phosphoric acid, potash, and nitrogen were all about equally effective. A complete fertilizer, containing all three of the above mentioned fertilizer materials, was more effective on nine out of fourteen soils than was any combination of only two fertilizers.

Averaging the resuls for the fourteen tests, the increase over the yields of unfertilized plots were as follows: With a complete fertilizer, an increase of 454 pounds of seed cotton per acre; with a mixture of cotton seed meal and acid phosphate, an increase of 378 pounds; with a mixture of cotton seed meal and kainit, a gain of 375 pounds; and with a mixture of acid phosphate and kainit, 322 pounds. The average profits per acre from fertilizers were respectively $6.04, $5.63, $5.78, and $4.70.

The work of testing the manurial needs of different soils is being continued with cotton in 1897.

Objects of the Experiments.

The most careless observer cannot fail to notice that there are numerous distinct classes of soil within this State. These differ not only in chemical composition and in physical structure, but also in their ability to utilize for the benefit of crops growing on them the various kinds of commercial fertilizers. Indeed there is no process by which one can positively determine the best fertilizer formula for a given soil until actual tests on it or on similar soils have thrown some light upon its needs. There are general principles, the application of which will usually be highly advantageous in compounding a promising formula, but an actual test is the only final and positive authority.

Hence it is that in fertilizer tests this Station, in 1896 and in previous years, has secured the co-operation of careful and progressive farmers located on the different soil belts of the State.

In the spring of 1896 small lots of carefully weighed and mixed fertilizers were sent to parties in twenty-seven localities. Accompanying the fertilizers were detailed instructions as to how to conduct the experiment. Blank forms for reporting results were furnished. Some of these experiments were visited as time could be spared. The King variety was used in all tests.

The three main objects of the experiment were as follows:

(1) To learn if Florida soft phosphate can be profitably substituted for acid phosphate when used in connection with cotton seed or cotton seed meal.

(2) To ascertain the relative fertilizing values of cotton seed and cotton seed meal.

(3) To obtain information regarding the best combinations of fertilizers for cotton, growing on different classes of soil.

In order to make the work of caring for the experiment as light as possible, only eight plots were used in each test, except in cases where the experimenters volunteered to care for a larger number of plots. The small number of plots in most experiments rendered it impracticable to test each fertilizer separately and alone, which, however, will be done in future tests by discontinuing the use of Florida soft phosphate and cotton seed.

The directions sent to those having eight plots required each plot to be one-eighth of an acre in area, the width being sufficient for eight rows. Rows were $3\frac{1}{2}$ ft. apart and each experimenter was advised to so thin the cotton as to leave the same number of plants on each plot, preferable at distances of 18 inches between plants, a point which was not observed in all cases. However, the reports indicated that in general no wide differences existed in the number of plants growing on the several plots.

The directions stated that land employed for this test should be level and uniform, not manured in recent years, and not newground, or subject to overflow, and that it should be representative of large soil areas in its vicinity. The need of perfect uniformity of treatment for all plots (except as to kinds of fertilizers used) was emphasized.

Fertilizers were applied in the usual manner, that is drilled, ridges afterwards being thrown up above the fertilizers. In the few instances where lime was used, the directions required it to be spread broadcast after forming the beds.

Notes on the weather show that in most localities the season was abnormally dry, a circumstance which materially lessens the value of the results. Many of those who conducted this test made special note of the damage done by unusually hot weather in July and August.

THE FERTILIZERS USED.

The fertilizers used in this experiment cost, delivered in Auburn in less than car load lots, as follows:

	Per ton.
Acid phosphate, - - - -	$15.00
Cotton seed meal, - - - - -	20.20
Kainit, - - - - - - -	15.70
Florida soft phosphate, - - -	13.92
Crushed cotton seed, (estimated) -	8.56
Slaked lime, - - - - - -	5.00

The above prices for acid phosphate and cotton seed meal are considerably higher than the prices paid for the same class of goods in 1897.

The separate fertilizer materials contained the following percentages of essential fertilizer ingredients, that is, nitrogen, phosphoric acid, and potash.

Composition of fertilizers.

	Nitrogen.	Phosphoric acid.	Potash.
	Per cent.	*Per cent.*	*Per cent.*
Acid phosphate	....	16.26*	....
Florida soft phosphate	....	29.26††	....
Kainit	....	....	12.30
Cotton seed meal	6.79†	2.88	1.77
Cotton seed	3.13†	1.27	1.17

*Available; this superphosphate was guaranteed to contain 14% available phosphoric acid, which is more than the percentage in most brands.

† Average of many analyses.

††Chiefly acid-soluble or "insoluble."

All the fertilizers employed are in common use and well known except Florida soft phosphate. This is ground phosphate rock which has not been treated with sulphuric acid, as have the acid phosphates or superphosphates. It contains a much higher percentage of phosphoric acid than acid phosphate because it has not been "diluted" by the addition of sulphuric acid, but this phosphoric acid is nearly all in such a condition that it is not easily dissolved. Other terms applied to Florida soft phosphate are raw phosphate, crude phosphate, and "Natural Plant Food."

In the eight-plot experiments, two plots were left unfertilized, these being plots two and six. The following table shows what kinds and amounts of fertilizers were used on certain plots; the number of pounds of nitrogen, phosphoric acid, and potash supplied per acre by each fertilizer mixture; and the percentage composition and cost per ton of each mixture, the latter being given in order that these mixtures may be readily compared with various brands of prepared guanos:

Pounds per acre of fertilizers, nitrogen, phosphoric acid, and potash used and composition of each mixture.

Fertilizers per acre.	Mixture contains Nitrogen.	Phosphoric acid.	Potash.	Cost of mixture per ton.
Plot 1	*Lbs.*	*Lbs.*	*Lbs.*	
200 lbs. cotton seed meal, 240 lbs. acid phosphate	13.58	44.78	3.54	....
In 100 lbs. of mixture...	3.08	10.18	.80	$17.36
Plot 3				
200 lbs. cotton seed meal, 200 lbs. kainit	13.58	5.76	28.14	
In 100 lbs. of mixture...	3.39	1.44	7.35	$17.95
Plot 4				
240 lbs. acid phosphate, 200 lbs. kainit	....	32.52	28.14	
In 100 lbs. of mixture...	....	8.87	6.39	$15.32
Plot 5				
200 lbs. cotton seed meal, 240 lbs. acid phosphate, 200 lbs. kainit	13.58	44.78	28.14	
In 100 lbs of mixture...	2.12	6.97	4.39	$16.84

The above table shows that the mixture applied to plot 1 was rich in nitrogen and phosphoric acid; that applied to plot 3, in nitrogen and potash; that used on plot 4 was rich in phosphoric acid and potash; and the mixture applied to plot 5 contained considerable quantities of all three of these valuable ingredients, and hence is properly called a complete fertilizer.

Those farmers who are more accustomed to the word ammonia than to the term nitrogen, can change the figures for nitrogen into their ammonia equivalents by multiplying by 1 3-14.

Unless explained, the term "profit from fertilizers" as used in the following table, might be misunderstood.

Profit or loss, as there used, is simply the difference between the value of the increase attributed to the fertilizer and the cost of the latter. To make this more exact, the careful reader may subtract from the apparent profit certain small items, which, because variable, could not be incorporated in the table,—for example, cost of applying fertilizers and cost of picking and ginning the increase.

Again the actual profit per acre from cotton culture may be greater or smaller than the "profit from fertilizer." When on the unfertilized plot cotton is produced at a loss of say $3 per acre, and when the tables show say $10 as the profit from a certain fertilizer mixture, a part of this profit must go towards offsetting the loss that would have occurred without fertilizers, leaving the farmer in this case only $7 in actual profit, although the fertilizer may have been beneficial to the extent of $10 over and above its cost. On the other hand when cotton is produced at a profit on unfertilized land and when fertilizers also show a profit, the sum of these two items is very nearly the farmer's actual profit.

In determining the increase over the unfertilized plots the yield of each fertilized plot is compared with both unfertilized plots lying on either side, giving to each unfertilized plot a weight inversely proportional to its distance from the plot under comparison. When the fertilized plot has an unfertilized plot on only one side of it, this single unfertilized plot is used as a standard. This method of comparison tends to compensate for variations in the fertility of the several plots.

GROUP I. PHOSPHORIC ACID MOST EFFECTIVE.

EXPERIMENT MADE BY MR. D. CARMICHAEL, JR., NEWTON, DALE COUNTY.

Soil for six inches, grey sandy loam; subsoil, red sand.

This piece of upland had been cleared for ten years, the original growth having been pine and scrub oak. In 1895 it was in cotton, in 1894 in watermelons, and in 1893 in sweet potatoes. Mr. Carmichael states that planting was done too late for best results. The rainfall was reported as sufficient up to August 12, after which it was deficient.

"The seasons were unpropitious; heavy rain on August 12 with storm damaged cotton one-third."

The stand was uniform. The height of stalks on the different plots was as follows:

On plot 1 - - -	30 in.	On plot 5 - - -	33 in.
" " 2 - - -	20 in.	" " 6 - - -	19 in.
" " 3 - - -	26 in.	" " 7 - - -	39 in.
" " 4 - - -	26 in.	" " 8 - - -	41 in.

The average yield of the unfertilized plots was 384 pounds per acre.

Newton experiment with cotton; results calculated to one acre.

	FERTILIZERS.		Seed cotton.		Financial results.		
Plot No.	Amount per acre	KIND	Yield per acre	Increase over unfertilized plot.	Value of increase at 2½ c. per lb.	Cost of fertilizers per acre.	Profit from fertilizers.
	Lbs.		*Lbs.*	*Lbs.*			
1	200 240	Cot. seed meal. Acid phosphate.	592	192	4.80	$ 3.82	$ 0.98
2	00	No fertilizer	400				
3	200 200	Cot. seed meal.. Kainit..........	480	88	2.20	3.59	--1.39*
4	240 200	Acid phosphate. Kainit..........	608	224	5.60	3.37	2.23
5	200 240 200	Cot. seed meal.. Acid phosphate. Kainit..........	640	264	6.60	5.39	1.21
6	00	No fertilizer...	368				
7	200 240 200	Cot. seed meal.. Fla. soft phos... Kainit..........	776	408	10.20	5.27	4.93
8	472 240 200	Crushed cot se'd Fla. soft phos... Kainit..........	888	520	13.00	5.27	7.73

* Loss.

Whatever may be the explanation, the figures show for the plot receiving Florida soft phosphate a yield which is 136 pounds greater than that of the plot receiving an equal weight of acid phosphate.

Crushed cotton seed was here a better fertilizer than cotton seed meal to the extent of 112 pounds of seed cotton or $2.80 per acre.

This soil was apparently more responsive to acid phosphate than to either cotton seed meal or kainit. The most profitable mixture appears to have been the one consisting of crushed cotton seed, Florida soft phosphate, and kainit.

Tests had previously been made in three different years by Mr. J. C. Killebrew in the same locality. His results in two of the tests suggest a deficiency of all three valuable fertilizer ingredients, especially nitrogen, while in the third year they indicate that in the soil subjected to the test there is a greater need for phosphoric acid than for nitrogen and potash.

Experiment Made by Mr. A. A. McGregor, Town Creek, Lawrence County.

Soil, red loam upland; subsoil red.

The subsoil is reached at a depth of about five inches. The original forest growth of the neighborhood is reported as hickory and oak, including post oak. Cedars are common and pines spring up on uncultivated land. Directions were carefully followed in thinning the plants so as to leave one about every eighteen inches. When the plants were counted June 30, there were 1004 stalks on each of plots 3, 7, and 8, 996 on plot 5, 973 on plot 1, 945 on plot 4, 944 on plot 2, and 886 on plot 6. The following table gives the actual yields and the yields as corrected for a uniform stand of 1004 plants on each plot, the latter being used in determining the increase.

Even as early as June 8, decided differences in growth on the fertilized plots could be detected, the plot receiving the complete fertilizer (No. 5) being then ahead, a lead which it had lost before July 7, when the plot receiving only acid phosphate and cotton seed meal showed the best growth. At this date all plots which had received kainit had acquired a yellowish cast, which color was especially marked in the case of the plot having only mineral fertilizers.

In Mr. McGregor's judgment the dry hot weather of the first half of August damaged the first four fertilized plots much more than the unfertilized plots, and injured them even more than it did the two plots receiving Florida soft phosphate, etc.

October 22, the height of four typical stalks in each plot was measured, the average height then being as follows: On the plot without kainit 35 inches; with complete fertilizer, including acid phosphate, 33 inches; with raw phosphate, cotton seed, and kainit, 30 inches; without cotton seed meal, 30 inches; with raw phosphate, cotton seed meal, and kainit, 27 inches; without acid phosphate only 24 inches; and without any fertilizer 20 and 18 inches. This crop seems to have had sufficient rain till the middle of July, from which time till August 23 the drought was severe.

The careful and detailed report rendered had been sufficient evidence of the thoroughness and accuracy of Mr. McGregor's test, even though opportunity to make a personal examination of the plots had been wanting.

Town Creek experiment with cotton; results calculated to one acre.

Plot No.	FERTILIZERS. Am't per acre.	KIND.	Seed cotton. Actual yield per acre.	Cor-rect'd yield per acre.	Financial results. In-crease over unfer-tilized plots.	Value of in-crease at 2½ c. per lb.	Cost of ferti-lizers per acre.	Profit from fertili-zers.
	Lbs.		*Lbs.*	*Lbs.*	*Lbs.*			
1	200 240	Cotton seed meal .... Acid phosphate	748	771	368	$ 9.20	$ 3.82	$ 5.35
2	00	No fertilizer	380	403				
3	200 200	Cotton seed meal .... Kainit...............	528	528	125	3.13	3.59	—0.46*
4	240 200	Acid phosphate ...... Kainit...............	512	542	172	4.30	3.37	0.93
5	200 240 200	Cotton seed meal ... Acid phosphate ...... Kainit...............	650	657	319	7.88	5.39	2.49
6	00	No fertilizer	268	305				
7	200 240 200	Cotton seed meal .... Florida soft phosphate Kainit...............	558	558	253	6.32	5.27	1.05
8	472 240 200	Crushed cotton seed . Florida soft phosphate Kainit	636	636	331	8.27	5.27	3.00

* Loss.

The average (corrected) yield of the unfertilized plots was 354 pounds of seed cotton per acre.

Florida soft phosphate was decidedly inferior to acid phosphate.

Crushed cotton seed proved a better manure than did cotton seed meal, for this field which was cleared about 70 years before.

The most profitable mixture consisted of acid phosphate and cotton seed meal, which increased the crop sufficiently to pay for the fertilizers and leave a balance or profit of

$5.35 per acre. When to the above mentioned mixture kainit was added, not only did the latter fail to return a profit, but it also failed to increase the yield.

It is evident that this soil required chiefly phosphoric acid and that it also needed nitrogen, but that no potash was needed in addition to the small amount (about 3½ pounds) contained in 200 pounds of cotton seed meal.

Experiment Made by Mr. J. R. McLendon,

Naftel, Montgomery County.

Soil, sand, 15 inches deep; subsoil, clay.

This piece of upland was cleared about 70 years ago. The original growth was oak and pine. The crop preceding cotton was peanuts.

Naftel experiment with cotton; results calculated to one acre.

Plot No.	Am't per acre.	KIND.	Yield per acre.	Incr'ase over unfertilized plots.	Value of increase at 2½c. per ℔.	Cost of fertilizers per acre.	Profit from fertilizers.
	FERTILIZERS.		Seed cotton.		Financial results.		
	Lbs.		*Lbs.*	*Lbs.*			
1	200 240	Cotton seed meal.... Acid phosphate......	178*	....	....	$ 3 82	....
2	00	No fertilizer..........	140				
3	200 200	Cotton seed meal.... Kainit...............	472	307	$ 7 67	3 59	$ 4 08
4	240 200	Acid phosphate...... Kainit...............	520	330	8 25	3 37	4 88
5	200 240 200	Cotton seed meal..... Acid phosphate...... Kainit...............	560	345	8 62	5 39	2 23
6	00	No fertilizer.........	240				
7	200 240 200	Cotton seed meal..... Fla. soft phosphate... Kainit...............	440	200	5 00	5 27	— 0 27
8	472 240 200	Crushed cotton seed.. Fla. soft phosphate... Kainit...............	472	222	5 55	5 27	0 28

* Plot 1, and possibly plot 2, was injured by a hedge and wood, near which this plot was located.

Where acid phosphate was used the crop was larger than where Florida soft phosphate was substituted.

The difference between the yields of the plots receiving cotton seed meal and crushed cotton seed is slightly in favor of cotton seed.

Both acid phosphate and cotton seed meal increased the yield. The former more than the latter. The effect of kainit cannot be measured on account of the injury to plot 1 from the presence of an adjoining hedge and wood.

GROUP II. POTASH MOST EFFECTIVE.

EXPERIMENT CONDUCTED ON FARM OF MR. F. C. MCDONALD, $\frac{1}{4}$ MILE FROM RUTLEDGE, CRENSHAW COUNTY.

Soil, grey sandy upland; subsoil, yellowish.

The soil is reported as about 10 inches deep.

This field has been in cultivation about 35 years, the original growth being pine.

The land is nearly level and appears uniform, although the yields of the 2 unfertilized plots indicate considerable variation in fertility.

Rutledge experiment with cotton; results calculated to one acre.

Plot No.	FERTILIZERS. Am't per acre.	KIND.	Seed cotton. Yield per acre.	Incr'ase over unfertilized plots.	Financial results. Value of increase at 2½c. per lb.	Cost of fertilizers per acre.	Profit from fertilizers.
	Lbs.		*Lbs.*	*Lbs.*			
1	200 240	Cotton seed meal..... Acid phosphate.......	680	128	$ 3 20	$ 3 82	$—0 42*
2	00	No fertilizer.....	552				
3	200 200	Cotton seed meal..... Kainit................	864	290	7 25	3 59	3 66
4	240 200	Acid phosphate....... Kainit...............	832	236	6 90	3 37	3 53
5	200 240 200	Cotton seed meal..... Acid phosphate...... Kainit...............	1080	462	11 55	5 39	6 16
6	00	No fertilizer..........	640				
7	200 240 200	Cotton seed meal.... Fla. soft phosphate... Kainit..............	1080	440	11 00	5 27	5 73
8	472 240 200	Crushed cotton seed.. Fla. soft phosphate .. Kainit...............	984	344	8 60	5 27	3 33

* Loss.

Florida soft phosphate, in a mixture containing cotton seed meal was almost as effective and economical as acid phosphate, pound for pound.

A mixture containing cotton seed meal afforded a larger crop than one containing crushed cotton seed.

A complete fertilizer was more profitable than any other. The soil responded more freely to kainit than to either phosphate or cotton seed meal, though both of the latter profitably increased the yield.

EXPERIMENT CONDUCTED BY JUDGE T. J. THOMASON, KAYLOR, RANDOLPH COUNTY.

Soil, grey to a depth of 4 to 6 inches, slightly sandy; subsoil, yellow clay, and below this stiff red clay.

The field used is described as a kind of table land nearly level and about 60 feet above river bed, and retentive of fertilizers and moisture. It was in cultivation in 1892, and how much earlier was not known. The original growth was oak and hickory, chiefly white and red oaks.

The figures representing the height of plants indicate that there was a good growth of stalks on the unfertilized as well as on the fertilized plots. Corn occupied the land in 1895 and 1893, (whether with or without cowpeas is not stated), and oats in 1894.

"July and August were very unfavorable for cotton and nearly all the forms of these months were shed. During first of month of August cotton was almost scalded by excessive heat."

Kaylor experiment with cotton; results calculated to one acre.

Plot No.	FERTILIZERS. Am't per acre.	KIND.	Seed cotton. Yield per acre.	Incre'se over unfertilized plot.	Financial results. Value of increase at 2½c. per lb.	Cost of fertilizers per acre.	Profit from fertilizers.
	Lbs.		Lbs.	Lbs.			
1	200 240	Cotton seed meal .... Acid phosphate	1016	216	$ 5.40	$ 3.82	$ 1.58
2	00	No fertilizer.	800				
3	200 200	Cotton seed meal .... Kainit..............	1077	255	6.37	3.59	2.78
4	240 200	Acid phosphate ...... Kainit	1067	223	5.57	3.37	2.20
5	200 240 200	Cotton seed meal .... Acid phosphate ...... Kainit.	1125	259	6.47	5.39	1.08
6	00	No fertilizer.........	888				
7	200 240 200	Cotton seed meal .... Florida soft phosphate Kainit...............	976	108	2.70	5.27	—2.57*
8	472 240 200	Crushed cotton seed.. Florida soft phosphate Kainit..	1117	229	5.72	5.27	0.45

* Loss.

The yield with Florida soft phosphate fell below that with acid phosphate, involving a financial loss when raw phosphate was used.

Crushed cotton seed was more effective and profitable than cotton seed meal.

A mixture of cotton seed meal and kainit was as effective and more profitable than a complete fertilizer, the acid phosphate in the latter being added at a financial loss.

It should be remembered that this soil, which seems to have failed to profit by an application of acid phosphate was already in a fairly fertile condition as shown by an average yield of 844 lbs. of seed cotton on the unfertilized plots.

EXPERIMENT CONDUCTED BY MR. J. N. THOMPSON,

$3\frac{1}{2}$ MILES S. W. OF PRIDE STATION, COLBERT COUNTY.

Soil, dark clay, with red subsoil.

Four or five feet below is flint rock, not solid. This piece of upland has been cleared for 50 years; the original growth was hickory, gum, dogwood, and maple.

It appears that no good rain fell after the land was broken till May 23. "The weather was entirely too dry and hot for very good result from fertilizers." The stand was poor and the plants died early.

The number and arrangement of plots in this experiment is explained in the table.

Pride Station experiment with cotton; results calculated to one acre.

Plot No.	FERTILIZERS. Am't per acre.	FERTILIZERS. KIND.	Seed cotton. Yield per acre	Seed cotton. Incr'ase over unfertilized plot.	Financial results. Value of increase at 2½ c. per lb	Financial results. Cost of fertilizers per acre.	Financial results. Profit from fertilizers.
			Lbs.	*Lbs.*			
1	472	Crushed cotton seed...	570	30	$ 0.75	$2.02	$—1.27
2	200	Cotton seed meal.....	690	150	3.75	2.02	1.73
3	00	No fertilizer..........	540				
4	240	Acid phosphate.......	630	102	2.55	1.80	0.75
5	200	Kainit...............	735	219	5.47	1.57	3.90
6	200 200	Cotton seed meal..... Kainit..............	825	318	7.95	3.59	4.36
7	240 200	Acid phosphate....... Kainit...............	705	213	5.32	3.37	1.95
8	00	No fertilizer..........	480				
9	400 240	Cotton seed meal..... Acid phosphate.......	735	285	7.12	5.84	1.28
10	200 240	Cotton seed meal..... Acid phosphate.......	540	120	3.00	3.82	−0.82
11	200 240 200	Cotton seed meal..... Acid phosphate....... Kainit...............	495	105	2.62	5.39	—2.77
12	200 240 200	Cotton seed meal..... Florida soft phosphate Kainit...............	510	150	3.75	5.27	—1.52
13	00	No fertilizer	330				
14	200 240 200 600	Cotton seed meal..... Acid phosphate. ..... Kainit............... Slaked lime..........	585	255	6.37	6.89	—0.52
15	200 240	Cotton seed meal..... Florida soft phosphate	495	165	4.12	3.70	0.42
16	472 240	Crushed cotton seed.. Florida soft phosphate	495	165	4.12	3.70	0.42

GROUP III. NITROGEN MOST EFFECTIVE.

EXPERIMENT MADE BY MR. J. H. BRASWELL, CASTLEBERRY, CONECUH COUNTY.

Soil, gray sand; subsoil, red sand.

The original growth was pine, which was removed about 25 years ago.

Castleberry experiment with cotton; results calculated to one acre.

Plot No.	FERTILIZERS. Am't per acre	FERTILIZERS. KIND.	Seed cotton. Yield per acre.	Seed cotton. Incre'se over unfertilized plots.	Financial results. Value of increase at 2½c. per lb.	Financial results. Cost of fertilizers per acre.	Financial results. Profit from fertilizers.
	Lbs.		*Lbs.*	*Lbs.*			
1	200 240	Cotton seed meal .... Acid phosphate	744	376	$ 9.40	$ 3.82	$ 5.58
2	00	No fertilizer	368				
3	200 200	Cotton seed meal .... Kainit	624	258	6.45	3.59	2.86
4	240 200	Acid phosphate ...... Kainit	584	220	5.50	3·37	1.13
5	200 240 200	Cotton seed meal .... Acid phosphate ...... Kainit	664	302	7.55	5.39	2.16
6	00	No fertilizer.........	360				
7	200 240 200	Cotton seed meal .... Florida soft phosphate Kainit................	560	200	5.00	5.27	—0.27*
8	472 240 200	Crushed cotton seed . Florida soft phosphate Kainit...............	536	176	4.40	5.27	—0.87*

* Loss.

The average yield was 364 pounds of seed cotton per acre. The land appears to have been remarkably uniform.

Florida soft phosphate was of far less benefit than acid phosphate, the use of the former involving a financial loss.

Cotton seed meal afforded a yield higher by 24 pounds per acre than did crushed cotton seed.

The most effective and profitable fertilizer was a mixture of cotton seed meal and acid phosphate, which returned a profit of $5.58 per acre. When to this mixture kainit was added the yield was reduced, indicating that potash was either useless or harmful.

While both cotton seed meal and acid phosphate were needed, the former was somewhat more effective than the latter, as may be seen by the comparison below: The increase with the complete fertilizer (plot 5) exceeds the increase on the plot having no cotton seed meal (plot 4) to the amount of 82 pounds per acre,—a gain attributable to cotton seed meal.

In the same way the increase on plot 5 exceeds that on plot 3 by 42 pounds per acre, an increase ascribable to acid phosphate. The increase on plot 5 falls short of that on plot 1 by 74 pounds, a loss which appears to be due to the presence of kainit.

Experiment Made by Mr. Jno. P. Watkins, Burnt Corn, Monroe County.

Soil, (4 to 6 inches deep), gray and sandy; subsoil dark red.

This test was made on upland which had been cleared for about 30 years. The original growth was "oak, hickory, etc., with a sprinkling of pines."

The late date of fertilizing and planting, May 7-8, may partly account for the average yield of only 132 pounds of seed cotton per acre on the unfertilized plots. It is also evident from this yield that the land was in a very impoverished condition.

Burnt Corn experiment with cotton; results calculated to one acre.

Plot No.	Fertilizers. Am't per acre.	Fertilizers. Kind.	Cotton seed. Yield per acre.	Cotton seed. Incr'ase over unfertilized plots.	Financial results. Value of increase at 2½c. per lb.	Financial results. Cost of fertilizers per acre.	Financial results. Profit from fertilizers.
	Lbs.		*Lbs.*	*Lbs.*			
1	200 240	Cotton seed meal,.... Acid phosphate.......	768	624	$ 15 60	$ 3 82	$ 11 78
2	00	No fertilizer...........	144				
3	200 200	Cotton seed meal..... Kainit................	688	558	13 95	3 59	10 36
4	240 200	Acid phosphate....... Kainit................	584	452	11 30	3 37	7 93
5	200 240 200	Cotton seed meal..... Acid phosphate...... Kainit................	692	566	14 15	5 39	8 76
6	00	No fertilizer.........	120				
7	200 240 200	Cotton seed meal..... Fla soft phosphate... Kainit................	572	452	11 30	5 27	6 03
8	472 240 200	Crushed cotton seed. Fla. soft phosphate... Kainit,...............	500	380	9 50	5 27	4 23

The land appears to have been fairly uniform. All combinations of fertilizers returned a profit.

Florida soft phosphate proved decidedly inferior to acid phosphate. With cotton seed meal the yield was 72 pounds greater than with crushed cotton seed.

The most profitable mixture consisted of cotton seed meal and acid phosphate.

On the plot receiving kainit in addition to the above named mixture, the yield was reduced.

Analyzing the increase in crop we find that with cotton seed meal added to the other two fertilizers there was a gain of 114 pounds; with acid phosphate added to the other two, an increase of only 8 pounds; with kainit added to the other two, a loss of 58 pounds. The above figures show the effects of the several fertilizers when all used together; the showing made by plot 4 is decidedly more favorable to acid phosphate and kainit for on this plot these two fertilizers without nitrogen afforded a fair profit, which, however, was not equal to the profit obtained on either of the plots receiving cotton seed meal.

Experiment Made by Mr. J. T. Robertson, LeGrand, Montgomery County.

Soil, yellowish, or reddish clay, with a little sand.

The surface had suffered from washing, and the soil was quite shallow. This experiment was conducted on gently sloping upland, which had become much impoverished by about 70 years of cultivation. The original growth was oak, hickory, and pine.

The crop suffered for want of rain after the middle of July. The stand was defective.

Le Grand experiment with cotton; results calculated to one acre.

Fertilizers.		Seed cotton.		Financial results.		
Am't per acre.	Kind.	Yield per acre	Incr'ase over unfertilized plot.	Value of increase at 2½ c per lb.	Cost of fertilizers per acre.	Profit from fertilizers.
Lbs.		*Lbs.*	*Lbs.*			
00	No fertilizer........	112				
200 240	Cotton seed meal... Acid phosphate.....	704	592	$14.80	$3.82	$10.98
200 200	Cotton seed meal... Kainit.............	680	568	14.20	3.59	10.61
240 200	Acid phosphate..... Kainit.............	408	296	7.40	3.37	4.03
200 240 200	Cotton seed meal... Acid phosphate..... Kainit.............	712	600	15.00	5.39	9.69
200 240 200	Cotton seed meal... Fla. soft phosphate. Kainit.............	664	552	13.80	5.27	8.53
472 240 200	Crushed cotton seed Fla. soft phosphate. Kainit	648	536	13.40	5.27	7.13

The yield with Florida soft phosphate fell slightly below that with acid phosphate.

The yields with cotton seed meal and crushed cotton seed were practically identical.

As regards the needs of this soil, the figures speak plainly.

Nitrogen was the element chiefly needed by this soil. Wherever cotton seed meal was used there was a large increase in yield, and this increase occurred whether the other ingredient of the fertilizer mixture was phosphate or kainit.

EXPERIMENT MADE BY MR. C. C. L. DILL, DILLBURGH, PICKENS COUNTY.

Soil, dark sandy loam; subsoil, red clay.

This test was conducted on high table land which had been cleared for 50 or 60 years. The original growth was oak, hickory, and pine.

In regard to rainfall Mr. Dill writes:

"We have had droughts before but none that did so much injury."

Dillburgh experiment with cotton; results calculated to one acre.

	FERTILIZERS.		Seed cotton.		Financial results.		
Plot No.	Am't per acre.	KIND.	Yield per acre.	Incr'ase over unfertilized plots.	Value of increase at 2½c. per lb.	Cost of fertilizers per acre.	Profit from fertilizers.
	Lbs.		*Lbs.*	*Lbs.*			
1	200 240	Cotton seed meal.... Acid phosphate......	600	360	$ 9 00	$ 3 82	$ 5 18
2	00	No fertilizer........	240				
3	200 200	Cotton seed meal.... Kainit..............	592	348	8 70	3 59	5 11
4	240 200	Acid phosphate...... Kainit..............	576	328	8 20	3 37	4 83
5	200 240 200	Cotton seed meal.... Acid phosphate...... Kainit..............	640	388	9 70	5 39	4 31
6	00	No fertilizer........	256				
7	200 240 200	Cotton seed meal.... Fla. soft phosphate... Kainit..............	632	376	9 40	5 27	4 13
8	472 240 200	Crushed cotton seed. Fla. soft phosphate .. Kainit..............	560	304	7 60	5 27	2 33

The land was apparently uniformily poor, the yields of the unfertilized plots being 240 and 256 pounds of seed cotton per acre.

Florida soft phosphate, when combined with cotton seed meal, was practically equal to acid phosphate, pound for pound.

Cotton seed meal afforded a larger yield than did crushed cotton seed.

Cotton seed meal had a greater effect than any of the other fertilizers.

The increased yields obtained by adding each fertilizer in turn to the other two were 60 pounds of seed cotton per acre for cotton seed meal, 40 pounds for acid phosphate, and 28 pounds for kainit.

While the complete fertilizer gave the largest yield, it did not afford the largest profit. A mixture of acid phosphate and cotton seed meal was most profitable.

Experiment Made by Mr. W. T. Webb, Alpine, Talladega County.

Soil, (4-6 inches deep), brown; subsoil, red.

This valley land had been in cultivation 50 years or more. The original growth was pine, oak, and hickory. The preceding crop was corn and cowpeas; it is notable that the crop of cow peas of 1895 did not furnish sufficient nitrogen for the following cotton crop. The most unusual point in the care of the crop was the use of a two-horse harrow in the first cultivation. The smoothing harrow, run obliquely to the rows, and covering a space of eight or ten feet has been elsewhere found useful in the early cultivation of cotton as well as of corn. However, with cotton it should be used with judgment, since under some conditions it may seriously damage the stand.

Plot 1 was more seriously troubled with "rust" than any other plot, although no plot was exempt. The stand was quite uniform.

Alpine experiment with cotton; results calculated to one acre.

Plot No.	FERTILIZERS. Am't per acre.	KIND.	Cotton seed. Yield per acre.	Incre'se over unfertilized plot.	Financial results. Value of increase at 2½c. per lb.	Cost of fertilizers per acre.	Profit from fertilizers.
	Lbs.		*Lbs.*	*Lbs.*			
1	200 240	Cotton seed meal .... Acid phosphate	1720	808	$ 20.20	$ 3.82	$ 16.38
2	00	No fertilizer	912				
3	200 200	Cotton seed meal .... Kainit...............	1616	746	18.65	3.59	15.06
4	240 200	Acid phosphate ..... Kainit	1256	428	10.70	3.37	7.33
5	200 240 200	Cotton seed meal .... Acid phosphate ...... Kainit	1400	614	15.35	5.39	9.96
6	00	No fertilizer.........	744				
7	200 240 200	Cotton seed meal .... Florida soft phosphate Kainit...............	1248	504	12.60	5.27	7.33
8	472 240 200	Crushed cotton seed . Florida soft phosphate Kainit...............	1312	568	14.20	5.27	8 93

Irregularities in the soil render a part of the results of this test inconclusive, though the figures suggest the need of nitrogenous fertilizers.

About one-eighth of the area of plot 6 was struck by lightning which probably accounts for part of the difference between the yields of the 2 unfertilized plots.

The heavy shrinkage in yield where cotton seed meal was omitted (plot 4) indicates a need of nitrogen.

GROUP IV.—PHOSPHORIC ACID, POTASH, AND COTTON SEED MEAL ABOUT EQUALLY EFFECTIVE.

EXPERIMENT MADE BY DR. JOHN GORDON, HEALING SPRINGS, WASHINGTON COUNTY.

Soil, gray sandy loam ; subsoil yellow sandy clay.

The soil is 4 to 6 inches deep and very porous. The test was made on pine land cleared 10 years before. This is the only report in which we find that the crop was injured by excessive rains.

Healing Springs experiment with cotton ; results calculated to one acre.

	FERTILIZERS.		Seed cotton.		Financial results.		
Plot No.	Am't per acre.	KIND.	Yield per acre.	Incr'ase over unfertilized plots.	Value of increase at 2½c. per lb.	Cost of fertilizers per acre.	Profit from fertilizers.
	Lbs.		*Lbs.*	*Lbs.*			
1	200 240	Cotton seed meal.... Acid phosphate.......	316*	88	$ 2 20	$ 3 82	$—1 62†
2	00	No fertilizer.........	224*				
3	200 200	Cotton seed meal.... Kainit...............	660*	434	10 85	3 59	7 26
4	240 200	Acid phosphate...... Kainit...............	704	476	11 90	3 37	8 53
5	200 240 200	Cotton seed meal.... Acid phosphate...... Kainit...............	952	722	18 05	5 39	12 66
6	00	No fertilizer.........	232*				
7	200 240 200	Cotton seed meal.... Fla. soft phosphate... Kainit...............	1160	932	23 30	5 27	18 03
8	472 240 200	Crushed cotton seed. Fla soft phosphate... Kainit...............	1320	1092	27 30	5 27	22 03

* Defective stand. † Loss.

The two unfertilized plots agree very closely in yield, the average being 228 pounds of seed cotton per acre. After the second plowing many plants died on the unfertilized plots and on plots 1 and 3.

Raw phosphate when applied along with cotton seed meal and kainit, appeared to be more effective and profitable than acid phosphate. Crushed cotton seed afforded a larger yield than did cotton seed meal. The soil responded freely to all fertilizing materials, whether applied in groups of two or three together.

A deficient stand on two fertilized plots and the unfavorable season render it impossible to determine which element was most deficient in the soil.

This is Dr. Gordon's fourth test of fertilizers on cotton. Previous results were either inconclusive or suggestive of a deficiency of all three essential fertilizer ingredients.

Experiment Made by Prof. J. B. Espy,

Abbeville, Henry County.

Soil, red clay, eight inches deep; subsoil, loam.

This piece of upland had been in cultivation about 20 years, yielding in 1895 22 bushels of corn per acre. The original forest growth was oak and hickory.

On each plot the same number of plants was left. The crop was injured by drought. Prof. Espy writes in regard to the effect of fertilizers on leaf diseases: "The plots on which kainit was used rusted less than the rest."

Abbeville experiment with cotton; results calculated to one acre.

Plot No.	FERTILIZERS. Am't per acre.	FERTILIZERS. KIND.	Seed cotton. Yield per acre.	Seed cotton. Incre'se over unfertilized plots.	Financial results. Value of increase at $2\frac{1}{2}$c. per lb.	Financial results. Cost of fertilizers per acre	Financial results. Profit from fertilizers.
	Lbs.		*Lbs.*	*Lbs.*			
1	472	Crushed cotton seed .	900	288	$ 7.20	$ 2.02	$ 5.18
2	200	Cotton seed meal.....	1140	534	13.35	2.02	11.33
3	00	No fertilizer..........	600				
4	240	Acid phosphate	1230	624	15.60	1.80	13.80
5	200	Kainit................	1080	468	11.70	1.57	10.13
6	200 200	Cotton seed meal .... Kainit...............	1380	762	19.05	3.59	15.46
7	240 200	Acid phosphate ...... Kainit	1350	726	18.15	3.37	14.78
8	00	No fertilizer..........	630				
9	400 240	Cotton seed meal .... Acid phosphate	1530	912	22.80	5.84	16.96
10	200 240	Cotton seed meal..... Acid phosphate	1440	834	20.85	3.82	17.03
11	200 240 200	Cotton seed meal .... Acid phosphate ...... Kainit	1620	1026	25.65	5.39	20.26
12	200 240 200	Cotton seed meal..... Florida soft phosphate Kainit................	1410	828	20.70	5.27	15.43
13	00	No fertilizer.	570				
14	200 240 200 600	Cotton seed meal. ... Acid phosphate ...... Kainit............... Slaked lime..........	1725	1119	27.97	6.89	21.08
15	200 240	Cotton seed meal .... Florida soft phosphate	1260	648	16.20	3.70	12.50
16	472 240	Crushed cotton seed.. Florida soft phosphate	1320	702	17.55	3.70	13.85

The yields on the three unfertilized plots indicate that the land was of uniform quality. This soil, which averaged 600 pounds of seed cotton per acre without fertilizers, responded generously to every fertilizer, whether applied singly, two by two, or all together. A complete fertilizer carried the yield to more than a bale per acre, an increase of more than 250 per cent. over the yield of the unfertilized plots, and returned a profit of $20.26 per acre.

The following analysis of results of plots 2 to 11, inclusive, shows the relative increase in yield of seed cotton per acre attributable to the different fertilizers:

Cotton seed meal increased the yield when added—

To the unfertilized plot,	by	534	lbs.
To kainit plot,	"	294	"
To acid phosphate plot,	"	210	"
To kainit and acid phosphate plot,	"	300	"
Average increase for cotton seed meal,		334	lbs.

Acid phosphate increased the yield when added—

To the unfertilized plot,	by	624	lbs.
To kainit plot,	"	258	"
To cotton seed meal plot,	"	300	"
To kainit and cotton seed meal plot,	"	264	"
Average gain for acid phosphate,		361	lbs.

Kainit increased the yield when added—

To the unfertilized plot,	by	468	lbs.
To acid phosphate plot,	"	102	"
To cotton seed meal plot,	"	228	"
To acid phos. and cotton seed meal plot,	"	192	"
Average increase for kainit,		247	lbs.

All fertilizer materials were effective, acid phosphate being slightly more important than cotton seed meal and kainit and decidedly more useful than Florida soft phosphate. The latter appears to have been more effective when employed with crushed cotton seed than when used with the meal.

Crushed cotton seed was decidedly less valuable than cotton seed meal when both were used singly, but when with each Florida soft phosphate was applied, cotton seed exerted a greater effect than did the meal. In the latter case it is probable that the phosphate hastened the decomposition of the seed and was in turn made more soluble by the large amount of decomposing organic material afforded by the seed.

Slaked lime was employed at a slight profit. When to a mixture of 200 lbs. of cotton seed meal and 240 lbs. of acid phosphate there was added an additional 200 lbs. of cotton seed meal, an increase in yield occurred, but this was no more than sufficient to pay the cost of the extra fertilizer.

The result of this experiment is in perfect accord with those of tests conducted at Abbeville in 1890, 1891 and 1892. The evidence seems quite sufficient to justify a positive statement that the cotton crop on the farm of the South East Alabama Agricultural School is increased by all three of the essential fertilizer constituents and that their order of effectiveness is (1) phosporic acid, (2) nitrogen, and (3) potash.

Experiment Made by Messrs. McQueen Smith and B. W. Gresham, on the Farm of the Former Near Prattville, Autauga County.

Soil red clayey loam.

This test was made on nearly level upland which had been in cultivation for perhaps 50 years, having been in cotton during most of the past 20 years. The original growth was pine, oak, and hickory.

On most plots the number of stalks was 980, and on no plot did the number greatly differ from this. The rainfall was decidedly deficient.

A notable point in the cultivation of this crop was that it was grown with less hoeing than usual, a saving in this respect being effected by running a 14-inch scrape across the rows immediately after barring off.

Prattville experiment with cotton; results calculated to one acre.

Plot No.	Fertilizers. Am't per acre.	Fertilizers. Kind.	Seed cotton. Yield per acre.	Seed cotton. Cost of fertilizers per acre.	Financial results. Value of increase at 2½ c. per lb.	Financial results. Incr'ase over unfertilized plots.	Financial results. Profit from fertili-
	Lbs.		Lbs.	Lbs.			
1	200 240	Cotton seed meal..... Acid phosphate	552	208	$5.20	$3.82	$1.42
2	00	No fertilizer..........	344				
3	200 200	Cotton seed meal .... Kainit................	512	196	4.90	3.59	1.41
4	240 200	Acid phosphate....... Kainit................	472	184	4.60	3.37	1.23
5	200 240 200	Cotton seed meal..... Acid phosphate....... Kainit................	640	380	9.50	5.39	4.11
6	00	No fertilizer..........	232				
7	200 240 200	Cotton seed meal..... Fla. soft phosphate... Kainit................	432	200	5.00	5 27	—0.27*
8	472 240 200	Crushed cotton seed . Fla. soft phosphate. . Kainit.	440	208	5.20	5.27	—0 07*

*Loss.

In this test raw phosphate was decidedly inferior to acid phosphate. Crushed cotton seed and cotton seed meal afforded practically the same yields.

A complete fertilizer, containing cotton seed meal, acid phosphate, and kainit was the most effective and profitable fertilizer used. Whenever any ingredient of this mixture was omitted there was a large shrinkage in yield.

Cotton seed meal and acid phosphate were somewhat more effective than kainit, although the last fertilizer made a better show in the dry season of 1896 than it did in previous tests on other Autauga County soils which were apparently quite similar to Mr. Smith's. The difference is probably due in large part to the unusual weather condition in 1896.

The following experiments are regarded as inconclusive, although some of them convey suggestions which are doubtless valuable :

Experiment made by Mr. E. J. Beasley, Red Level, Monroe County.

Experiment made by Mr. J. J. Blackstock, agent for Hirsch Bros., at Hirsch Crossing, Russell County.

Experiment made by Prof. Geo. P. Bondurant on farm of North Ala. Agrl. School, Athens, Limestone County.

Experiment made by Mr. T. M. Roundtree, or farm of S. W. Ala. Agrl. School, Evergreen, Conecuh County.

Experiment made by Mr. G. W. Freeman, on the farm of the N. E. Ala. Agricultural School, Albertville, Marshall County.

Experiment made by Mr. M. W. Borum, Harpersville, Shelby County.

Experiment made by the Tuskegee Normal and Industrial Institute, Tuskegee, Macon County.

The following tables give the yields of seed cotton per acre in the seven experiments just enumerated.

Red Level and Hirsch Crossing experiments with cotton; results calculated to one acre.

Plot No.	Fertilizers. Am't per acre.	Fertilizers. Kind.	Red Level. Yield of seed cotton.	Red Level. Increase over unfertilized plots.	Hirsch Crossing. Yield of seed cotton.	Hirsch Crossing. Increase over unfertilized plots.
	Lbs.		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
1	200 240	Cotton seed meal.... Acid phosphate......	784	208	712	40
2	00	No fertilizer.........	576		672	......
3	200 200	Cotton seed meal.... Kainit	632	95	952	280
4	240 200	Acid phosphate...... Kainit	576	76	736	24
5	200 240 200	Cotton seed meal.... Acid phosphate...... Kainit..............	616	154	720	—12*
6	00	No fertilizer.........	424		752	....
7	200 240 200	Cotton seed meal.... Fla. soft phosphate... Kainit	536	112	472	—280*
8	472 240 200	Crushed cotton seed.. Fla. soft phosphate... Kainit	560	136	784	32

*Loss.

Yields of seed cotton in experiments made at Athens, Evergreen, Albertville, Harpersville, and Tuskegee.

Plot No.	FERTILIZERS. Am't per acre.	FERTILIZERS. KIND.	Athens. Seed cotton per acre	Evergreen. Seed cotton per acre	Albertville. Seed cotton per acre	Harpersville. Seed cotton per acre.	Tuskegee. Seed cotton per acre.
	Lbs.		Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
1	472	Crushed cotton seed .	750	870	667	915	
2	200	Cotton seed meal	825	1065	791	675	1230
3	00	No fertilizer.	765	750	600	495	828*
4	240	Acid phosphate.	810	900	652	540	945
5	200	Kainit	615	900	682	495	915
6	200 200	Cotton seed meal. . . . . Kainit.	615	1110	731	480	907
7	240 200	Acid phosphate . . . . . . Kainit.	1350	945	836	705	1050
8	00	No fertilizer	1260	675	296	585	
8	400 240	otton seed meal . . . . Acid phosphate	1350	810	701	630	
10	200 240	Cotton seed meal . . . . Acid phosphate	1275	1440	521	825	960
11	200 240 200	Cotton seed meal . . . Acid phosphate . . . . Kainit	1335	930	806	780	667†
12	200 240 200	Cotton seed meal. . . . Florida soft phosphate Kainit.	885	945	1140	870	
13	00	No fertilizer.	765	720	697	630	
14	200 240 200 600	Cotton seed meal . . . . Acid phosphate . . . . . Kainit . . . . Slaked lime.	1065	900	1080	780	
15	200 240	Cotton seed meal. . . . Florida soft phosphate	975	645	1125	690	
16	472 240	Crushed cotton seed. Florida soft phosphate	825	705	1057	705	

* Average of two plots; arrangement of plots slightly different from that in other experiments.

† Injured by trees standing near.

In the experiment at Red Level a mixture of cotton seed meal and acid phosphate was decidedly advantageous, but variations in fertility as shown by the yields of the two unfertilized plots were too great to justify any further conclusions.

The wide variation in the yields of plots 3 and 8 at Athens was due to the fact that the first five or six plots were located on higher land than were any of the others.

In the experiment at Evergreen we should conclude that nitrogen was chiefly needed, were it not for the figures opposite plots 9 and 10, and for the small yield on plots 15 and 16.

At Albertville, manures applied in previous years obscured the results. In spite of this disadvantage, the results of Mr. Freeman's careful work suggest that the soil was deficient in all three essential fertilizer ingredients, especially in nitrogen.

Florida Soft Phosphate versus Acid Phosphate.

By averaging the results of the 14 experiments which afford definite indications, we find that the complete fertilizer that contained acid phosphate was more effective than the one in which Florida soft phosphate was used. The average difference in favor of the acid phosphate was 43 pounds of seed cotton per acre.

Viewed from another standpoint, there were 11 experiments in which acid phosphate afforded larger yields, and three tests in which the crude phosphate stood ahead of its competitor. In this comparison it should be remembered that equal quantities of the two phosphates were used and that the Florida soft phosphate contained at least 60 per cent. more phosphoric acid than did the high grade acid phosphate employed.

It may be claimed that the raw phosphate will have a greater effect in the second year after application than will acid phosphate. However, few farmers would be willing to wait so long for a large part of their returns from feritlizers. Crude phosphate has been found to be most effective when used in combination with some organic fertilizer, a condition which has been afforded in these tests by employing cotton seed meal or cotton seed in connection with it.

Relative Fertilizer Values of Cotton Seed and Cotton Seed Meal.

Frequent letters of inquiry reach the Alabama Experiment Station asking on what terms a farmer can afford to sell his cotton seed and buy cotton seed meal as a fertilizer. One of the objects of the co-operative fertilizer experiment described in this bulletin was to get answers to this question from all of the soils used in the test.

In deciding on the amounts of cotton seed and meal to be compared, quantities of each were employed which would afford equal amounts of nitrogen, as indicated by the analyses then available. A more nearly complete compilation of analyses published since this experiment was planned indicates that it would have been more strictly accurate to have used 434 pounds of cotton seed per acre instead of 472.

Disregarding the tests classed as inconclusive, we find that of the remaining experiments 7 give larger yields with cotton seed and 7 afford heavier crops with cotton seed meal. Combining the results of these 14 experiments we find that crushed cotton seed afforded an average of 10 pounds per acre of seed cotton more than did the meal. This difference in yield in favor of the seed is amply sufficient to counterbalance the fact that there was used as fertilizer 38 pounds per acre of crushed cotton seed in excess of what was necessary to supply the required amount of nitrogen. After making this allowance, we find that cotton seed and cotton seed meal were on an average equally effective when such quantities of each were compared as contained equal amounts of nitrogen. A pound of nitrogen was just as valuable in one as in the other.

But the market prices of cotton seed and meal are not governed wholly by the relative amounts of essential fertilizer ingredients in each. Whether it is more profitable to sell seed and buy meal, or apply seed to the land, depends on the relative prices of these two materials. The average figures for 14 experiments in 1896 showed that one ton of seed was equal to an amount of meal containing a like quantity of nitrogen, which we find to be 922 pounds of meal; from this it follows that 1 pound of meal was equal to 2.06 pounds of seed. Hence we get the price per ton of seed at which the farmer could afford to swap seed for meal by dividing the price of meal by 2.06 (2[1-16]). For example, assuming a price of $20 per ton for cotton seed meal and dividing this by 2.06 we have $9.22 per ton as the relative fertilizer value of seed. Of course, to this price of seed should be added the cost of getting the seed to the oil mill. To put the average results of fourteen tests made in 1896 into still another form, we may say that a ton of crushed cotton seed was worth on the farm as fertilizer 46 per cent. of the cost of a ton of cotton seed meal.

The preceding are only average results, and individual soils and crops may be more responsive to the one or to the other source of nitrogen. For example, on certain compact clay or prairie soils deficient in vegetable matter, cotton seed may be the more valuable because of its effect on the mechanical condition of the soil. On the other hand we can scarcely doubt that cotton seed meal has some advantage under conditions when it is necessary that the fertilizer should exert its effect quickly. In this connection attention is called to the fact that the fertilizers for this test were applied later than is customary, the great majority of them being put in the ground in April, while in a few cases they were not applied till May. This may have been a greater disadvantage to the cotton seed than to the meal.

A discussion of this subject necessarily turns largely on the chemical composition of the materials compared. Hence, the following figures calculated from many analyses compiled in Bulletin No. 33 of the Office of Experiment Station, U. S. Department of Agriculture, are added:

	Nitrogen. Lbs.	Phosphoric Acid. Lbs.	Potash. Lbs.
2,000 lbs. of cotton seed contains	62.6	25.4	23.4
922 lbs. of c. s. meal contains	62.6	26.5	16.3

AVERAGE RESULTS WITH COTTON SEED MEAL, ACID PHOSPHATE, AND KAINIT.

In the table below the results of the 14 experiments which give fairly conclusive results are summarized and averaged. The figures in the table represent the increase in seed cotton over the unfertilized plots.

Increased yield in pounds of seed cotton per acre resulting from different fertilizer mixtures.

LOCALITY.	INCREASE OVER UNFERTILIZED PLOT WITH			
	C. S. meal Acid phos.	C. S. meal Kainit	Acid phos. Kainit	C. S. meal Acid phos. Kainit
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*
Newton............	192	88	224	264
Town Creek........	368	125	172	319
Rutledge...........	128	290	236	462
Kaylor.............	216	255	223	259
Tuscumbia..........	120†	318	213	105
Castleberry.........	376	258	220	302
Burnt Corn........	624	558	452	566
LeGrand...........	592	568	296	600
Dillburgh	360	348	328	388
Alpine..............	808	746	428	614
Healing Springs ...	88	434	476	722
Abbeville..........	834†	762	726	1026
Naftel...........	....	307	330	345
Prattville	208	196	184	380
Average........	378*	375	322	454

*Average of 13 tests.
†Plot 10.

The average amounts of seed cotton by wnich the fertilized plots exceeded the unfertilized were: 378 lbs. per acre with a mixture of cotton seed meal and acid phosphate; 375 lbs. per acre with a mixture of cotton seed meal and kainit; 322 lbs. per acre with a mixture of acid phosphate and kainit; and 454 lbs. with a complete fertilizer.

Crediting the respective fertilizer mixtures with these increments at $2\frac{1}{2}$ cents per pound, and deducting the cost of the fertilizers, there remains an average profit of $5.63 for the first mixture, $5.78 for the second, $4.70 for the third, and $6.04 for the complete fertilizer. The largest profit came from the heaviest application of fertilizers, 640 lbs. per acre.

By subtracting in turn from the average gain of the complete fertilizer the gain of each plot receiving its fertilizers in pairs, we find that the average relative increase attributable to cotton seed meal is 132 lbs., to acid phosphate 79 lbs., and to kainit 76 lbs. of seed cotton per acre.

List of Publications of the Alabama Agricultural Experiment Station.

1. Bulletins Nos. 1–10, 1883–1885.
2. Bulletins Nos. 1–9, 1885–1887.
3. Bulletins Nos. 1–8, for 1887.
4. Bulletins Nos. 1–5, for 1888.

The above bulletins were issued in the early formative period of the Experiment Station partly in conjunction with the Commissioner of Agriculture, whose office was then located at Auburn.

5. Bulletins Nos. 1–77 of the current series. These represent the regular bulletins of the Station since the formation under the Hatch fund.

6. Annual Reports of the Agricultural Experiment Station, 1-8, 1888-1896.

By recent action of the Station Council the above bulletins have been arranged in volumes as follows:

Vol. I. To include all bulletins issued in the first four series and before the foundation under the Hatch Act.

Vol. II. To include bulletins 1-21 of the current series, 1888-1890.

Vol. III. To include bulletins Nos. 22-58 of the current series, 1891-1894.

Vol. IV. To include bulletins Nos. 59-75 of the current series.

Indices of these bulletins have been published and will be sent to parties applying for them until the issues are exhausted.

In addition to the early bulletins grouped under Vol. I, the following bulletins and annual reports are out of print and cannot be furnished: Nos. 3, 4, 5, 7, 8, 9, 20, 22, 24, 35, 36, 37, 40, 41, 42, 43, 44, 45, 47, 48, 49, 50, 51, 54, 57, 60, 61, 62, 63, 67, 72, 73, 74.

The following annual reports are exhausted: 1, 3, 5, 6, 7.

Anyone having copies of the bulletins which are exhausted will confer a favor by returning them to Librarian Alabama Experiment Station.

BULLETIN No. 79. MARCH, 1897.

ALABAMA

Agricultural Experiment Station

OF THE

AGRICULTURAL AND MECHANICAL COLLEGE,

AUBURN.

Some Horticultural Suggestions.

F. S. EARLE, Horticulturist.

MONTGOMERY, ALA.:
THE BROWN PRINTING COMPANY, PRINTERS.
1897.

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☞The Bulletins of this Station will be sent free to any citizen of the State on application to the Agricultural Experiment Station, Auburn, Alabama.

SOME HORTICULTURAL SUGGESTIONS:

By F. S. Earle.

Commercial horticulture is an established business at comparatively few points in Alabama. Vegetables have been grown and shipped in large quantities from the neighborhood of Mobile for many years; and Huntsville, in Madison County, at the extreme northern end of the State, has a national reputation as a nursery centre. In recent years there has been some planting of grapes and other fruits in Baldwin county, across the bay from Mobile; and there is a constantly increasing interest in fruit and truck growing at various points north of Mobile along the Mobile and Ohio Rail Road, in Mobile and Washington counties. Another fruit growing centre is at Fruithurst, in Cleburne county, on the Southern Railway, where the colony established by the Alabama Fruit Growing and Winery Association, is actively at work planting grapes and other fruits. Evergreen, Cullman and a few other points on the Louisville & Nashville Rail Road make some shipments of fruits and vegetables.

Why this State should be behind its neighbors in horticultural development is not apparent. Conditions of soil and climate are quite similar to those found in Georgia and Mississippi; and transportation facilities seem to be equally good; but the total shipments of fruits and vegetables from Alabama are very may times less than from either of its neighbors. Whatever the causes that have led to this condition, the present state of the markets does not justify the Experiment Station in urging the indiscriminate planting of fruits and vegetables for shipment to northern markets. It is very desirable to have a more diversified agriculture; but it is far better and safer to continue growing cotton as at present than to rush into a new and untried business without first carefully considering those fundamental conditions on which success or failure will so largely depend.

The growing of fruits and vegetables for distant shipment is at best an uncertain and hazardous business. It depends for success on many factors, some of the most important of which, are entirely beyond the control of the grower. When everything is favorable the profits are larger than in other lines of farming; but as is the case in all lines of business in which the possible profits are large, the risks are correspondingly great. In our uncertain climate an entire crop, representing much labor and expense, may be destroyed by frost in a single night. If this danger is happily passed, vegetable crops are likely to be injured by the frequently occurring spring drouths; and both fruits and vegetables often suffer heavy loss from untimely floods of rain during the harvest. Then there are the numerous fungous diseases and insect pests to be reckoned with. Perhaps the losses from untoward climatic conditions would be no greater than with other farm crops, were it not for the imperative necessity for earliness in order to escape the competition of points further north. This frequently compels truckers to plant so early as to take heavy extra risks. Even with an abundant crop safely matured the troubles and risks of the fruit and vegetable grower are by no means ended. There are probably ten men who grow fairly good crops, where there is one who handles and markets his crop in such a way as to get the best possible profit from it. These products are all perishable. They can not, as a rule, be held for better prices, but must be marketed as fast as they mature. On account of this very perishability dealers seldom care to purchase these products at the farm but compel the grower to ship on commission thus assuming himself the heavy transportation charges, and the dauger of damage in transit. The further risk of loss through dishonest dealers has also to be considered; but these points will be discussed more in detail on an other page.

It is not intended by these remarks to discourage the growing of fruits and vegetables for shipment at those points where the business is established; or where the conditions of soil, and transportation facilities are especially favorable. In fact, these unfavorable factors are already too well known to all who have had practical experience, for a restatement of them to have such an effect. They are, however, factors that must be reckoned with, and it is to warn beginners in the business that they are mentioned here.

On the other hand, the rapid increase in horticultural production during the past few decades has been fully equaled by the wonderfully rapid increase in the consumption of such products. This leads to the belief, that as the general business depression of the past three years passes away, prices for horticultural products will advance, and the business will become more generally profitable. Then, too, these years of depression will cause many people to drop out who have gone into the business unadvisedly or as a temporary makeshift, thus leaving the field to those who make commercial horticulture their chief business.

There is something about this business that makes it very attractive to many people. Its very uncertainty adds an element of interest. Parts of the work are so light that they can be taken part in by all the members of the family. Children quickly become interested; and the boys are more likely to follow in their fathers' footsteps and stay on the farm than in other lines of agriculture. The strenuous activities of the shipping season, when every faculty is strained to the uttermost to get off the perishable crop without loss, leaves its imprint on the individual, making his mind more active and alert. Fruit growing communities, are proverbially more intelligent and progressive than those engaged in other rural occupations.

In the nature of the case, however, it is a business that will never be engaged in by more than a small part of the people of the State. There is another phase of horticultural production, however, in which all are nearly equally interested; and that is the growing of a better and more abundant supply for home use and for the local markets. While apples, potatoes and cabbage are shipped into Alabama by the car load, and turnips and ruta-bagas by the barrel, there is certainly room for continued horticultural agitation and instruction. In our climate it is possible, with a very small outlay of time and money, to have an abundant supply of fresh vegetables on the table every day in the year; but how many are there, who avail themselves of this opportunity? Most people plant something of a variety in the early spring; but with this their gardening energy for the season is exhausted. The okra and butter beans, and perhaps a few tomatoes will continue to bear throughout the season; and these, with collards, cow peas and field corn must be the reliance during the hot months, to be supplemented in the fall by a small patch of turnip greens. In the small towns the supply of even these standbys is irregular and uncertain.

In view of these facts the issuance would seem timely of a series of bulletins giving short practical directions for the cultivation and marketing of the principal fruit and vegetable crops, under the conditions prevailing in this State. In the present bulletin some suggestions are offered on such general topics as soils, fertilizers and marketing, leaving the different special crops to be discussed at some future time, taking up with each the problems connected with its growth and marketing; but paying particular attention to its uses in the home garden, and the means by which a better and more continuous supply can be secured at a minimum cost of money and labor.

Soils for Horticultural Crops.

In selecting a location for truck farming, or commercial fruit growing, the character of the soil should be carefully considered ; for, next to suitable transportation facilities, it is a question of the greatest importance. The kind of soil to be selected will naturally depend on the crop to be grown. For the home garden almost any of the soils of the State can be made to answer a very good purpose. An essential requirement for both fruits and vegetables is good drainage, either natural or artificial. This is especially necessary where earliness is a question of importance, for wet sodden soils are always cold and backward in the spring. Soils with a certain amount of sand are easier to cultivate, and will be more suitable for most vegetables than heavy clay soils. They can be planted earlier in the spring and will mature crops earlier. Most fruits on the other hand will, in this latitude, thrive better and be freer from disease on rather stiff clay land than on very sandy soils. Perhaps the most notable exception to this statement is the case of the Oriental pears (LeConte, Keiffer, &c.,) which seem especially adapted to the moist sandy soils of the coast region. The ideal truck soil is a moist but not wet, black sandy loam, containing abundant vegetable matter; and preferably resting on a not too impervious red clay subsoil. It should be nearly level or with a gentle southern exposure. Of course the greater the natural fertility the better, but after all this is not a vital question, for there are no soils so rich that they will stand continuous trucking without frequent and heavy applications of fertilizing material. The mechanical condition, and moisture holding capacity of the soil is really of greater importance to the truck farmer, than its chemical composition; and these must be maintained by continually adding to its supply of vegetable matter, either by applications of stable manure, or by plowing under green crops. Only comparatively level lands should be planted to truck crops. On steep broken hillsides too much fertility is lost by washing and there is too much extra labor in cultivation. All stumps, rocks or other obstructions should be carefully removed in order to admit the use of modern cultivating machinery.

Very broken hillsides are sometimes utilized by planting them to fruit trees and especially to grape vines. Fine fruit can be grown in such locations, and in some cases it may be the best way of using such lands. It is however usually unwise to plant commercial orchards on land so rolling as to prevent rowing the trees and cultivating both ways, on account of the added labor in cultivating and harvesting where the rows have to circle the hillsides. Only high lying lands should be selected for orchards, especially of the stone fruits, not only on account of the better drainage, but because of the greater freedom from spring frost, and a less liability to loss from rot. High land fruit is finer colored and more attractive than that grown on low lands. A flat topped hill with the land sloping away in all directions is an ideal location for an orchard, especially if there is a good red clay subsoil. The character of the top soil is not so important. It may be a little sandy, in which case the fruit will be a few days earlier; but a stiff red clay throughout, with only a small amount of vegetable matter, will give fruit of the highest flavor, best color and best shipping quality. As stated before these remarks do not apply to the Oriental pears and only partially to apples. Parts of the mountain country of north Alabama are admirably adapted to apples; but in the central and southern parts of the State they are a little out of their latitude and the trees are likely to be short lived in dry and exposed locations. They will be longer lived and more fruitful in lower and moister lands, though in such locations the fruit is always duller in color and more liable to rot.

IRRIGATION.

Next to good drainage, an abundant water supply is one of the most important factors in producing vegetable crops. Our annual rainfall would be ample for the needs of all crops, if it were equally distributed, but this is not always the case. Our drouths are never as prolonged and destructive as those sometimes occurring in the States further west; but there is seldom a season when the ability to apply water to his crops at will, would not be of great benefit to the truck farmer. The deeper rooted orchard trees seldom suffer seriously for water, but young vegetable plants are often pinched quite severely during April and May; and during our long dry falls most gardening operations are impossible, except on the moistest lands, without artificial watering.

In many parts of State the streams are fed by springs so that they continue to run, even in the dryest weather. It would be a very simple and inexpensive matter to turn this running water onto the adjoining bottom lands if they were devoted to trucking purposes; and in other parts of the State storage reservoirs could be built at small expense which would be filled by the winter rains. Of course a much less quantity of water would be required here per acre than in the arid regions of the West, for a single irrigation would usually be sufficient to carry a crop through a period of drouth.

Along the larger water courses, water can be profitably lifted onto the land by steam pumps. This is not an untried theory, but is in practical use by some of our most progressive truck farmers. In those parts of the State where artesian water can be obtained this furnishes an admirable source of supply for irrigation purposes.

This question is one that is destined to attract much more attention in the future than it has in the past; and those who are studying a location with reference to its suitability for the truck business would do well to examine its capabilities for irrigation.

Manures and Fertilizers.

Many questions reach the Experiment Station as to the best fertilizer for the different fruits and vegetables. Such questions are hard to answer unless something is known of the local soil conditions; yet there are certain general considerations that are nearly always applicable.

In the first place see that the soil is in the best possible mechanical condition ; for it is useless to buy expensive fertilizers to throw among clods ; and equally useless to buy fertilizers to feed weeds and grass, for they will choke the crop all the more rapidly when the ground is enriched, if they are allowed to grow unchecked. In other words, thorough cultivation should always accompany heavy fertilization.

The important ingredients of all fertilizers are nitrogen, phosphoric acid and potash. The other mineral foods of plants are usually sufficiently abundant in all soils. A complete fertilizer is one in which all of these substances are present. An incomplete fertilizer is one in which some one or two of them are wanting. Just what the roll of each of these substances is in the economy of the plant cannot be exactly stated ; yet it is known that an abundant supply of nitrogen and potash promotes the growth of the wood and leaves, giving the foliage a dark green luxuriant appearance, but at the same time it usually somewhat retards maturity. The phosphates, on the other hand, promote fruitfulness and tend to hasten development and maturity. Different kinds of plants draw on these different fertilizing elements in varying proportion, some taking up more of one substance and some more of another. Numerous attempts have been made to construct fertilizer formulas* to fit the exact requirements of each crop. These special formulas are sometimes useful, but on our poorer Southern soils the chief requirement is a good complete fertilizer abundantly applied ;

*Some of the best of these formulas are given by the North Carolina Experiment Station. See Bull. 112, pp. 92-95.

and so far as practical results are concerned it will usually answer about as well to take this fertilizer, for the different vegetable crops usually grown, all from the same pile, as it will to mix special lots to try and hit the special wants of each. The needs of fruit trees will be discussed further on ; but for vegetables the best one fertilizer is undoubtedly stable manure. Where it can be obtained in sufficient quantity it may be used almost to the exclusion of anything else. It is a complete fertilizer, containing all three of the necessary elements in about the right proportions ; and besides greatly improves the mechanical condition of the soil by increasing the vegetable matter it contains. The only exceptions to its beneficial effects are where a drouth immediately follows its application in a raw or unfermented state, or before it is thoroughly incorporated with the soil ; or in the case of a few diseases, like potato scab, that seem to be worse where the soil has been dressed with stable manure. For quick growing crops it should be well rotted or it should be incorporated with the soil some time in advance of planting. If the quantity is limited, apply in the row, opening out a deep furrow and bedding on it in advance of planting ; but in the case of heavy applications it is better to broadcast and plow in during the winter. On lands naturally deficient in phosphoric acid, like all those of the pine belt, or when continued applications of stable manure have been made year after year, it will usually pay to add two or three hundred pounds per acre of acid phosphate in the drill, even where heavy applications of manure are made. The effect of cotton seed is much like that of stable manure. Experiments conducted by this station (see Bull. 78) go to confirm the high manurial value of the whole or crushed cotton seed.

Many truck farmers are so situated that they cannot obtain a sufficient supply of either stable manure or cotton seed. In such cases commercial fertilizers must be depended on, supplemented by green manuring. Any good brand of high grade, complete fertilizer, will give good results if used in sufficient quantity ; but it will generally be found cheaper to buy the ingredients and mix them at home. Nitrogen is much the most expensive element in commercial fertilizers. It is supplied by the trade in the form of cotton seed meal, castor bean meal, fish scrap, slaughter house refuse, nitrate of soda and sulphate of ammonia. In this State cotton seed meal will usually be the cheapest and most available source of supply, though nitrate of soda is useful where a very quick acting fertilizer is required. The supply of phosphoric acid comes from Carolina and Florida phosphate rock, and from bones. Thomas slag is a residue from iron works that is sometimes used for the phosphate it contains. Here our most economical form of phosphate comes from the ground phosphate rock that has been treated with sulphuric acid to render it soluble. This is commercially known as acid phosphate. It should analyze from twelve to fifteen per cent. of available phosphoric acid. The supply of potash comes from hard wood ashes and from certain salts that are mostly mined in Germany. Cotton seed hull ashes where they can still be obtained make an excellent source of potash. It is usually used in this state in the form of kainit; but sometimes the muriate of potash is used. These are both products of the German mines. Kainit is the crude salt. A good quality will show about twelve and a half per cent. of potash, the remainder being common salt, magnesium chloride, and other impurities. The muriate is a refined product and should contain fifty to fifty-five per cent. of potash. The sulphate of potash is preferred for some purposes, especially for tobacco, where it is supposed to give better burning qualities than the muriate ; but it is more expensive and is probably no better for most crops. The proportion in which to mix the different ingredients should, of course, vary with the character of the soil, and to some extent with the crop to be raised. Each large grower should experiment for himself until he finds what is best suited to his particular needs. In the majority of cases the following formula will perhaps be as useful as any other:

Cotton seed meal 3 parts (by weight.)
Acid phosphate 3 parts.
Kainit 1 part.

This will give about 3 % of nitrogen, 7 % of phosphoric acid and $2\frac{1}{2}$ % of potash. This is a smaller per cent. of potash than is sometimes recommended, and quite likely on some soils or with certain crops a larger proportion would be useful.

In mixing the fertilizer select a place on the barn floor or on smooth hard ground. Spread down a layer two or three inches deep of one of the ingredients, then another layer of another, and so on until the required amount of each is spread down. Then begin on one side with hoes or shovels and chop it down and pull it over so as to thoroughly mix the different layers. When it is all worked over to one side begin again and work it back, and continue working it back and forth until the color blends and becomes uniform to the eye.

When very large quantities are used a part may be broadcasted to advantage; but it is usually best to apply in the drill from two to three weeks before planting. The row can be opened with a single shovel plow and the fertilizer scattered as evenly as possible in the furrow. Before covering run another furrow in the bottom of this one with a narrow bull tongue or scooter, to mix the fertilizer with the soil; then bed on it, using either a single shovel or light turning plow. Just before planting knock off the beds by running over two rows at a time with the back of the harrow or with a plank drag. This will leave a bed of fine slightly compacted, fresh earth to receive the seed; and it will destroy such weeds as have sprouted. The amount of fertilizer to use per acre will depend on the richness of the soil; and on the crop to be grown. Eight hundred to a thousand pounds of the above mixture will usually be sufficient for beans, tomatoes and sweet potatoes; while Irish potatoes, cabbage and onions will use twice that quantity, or even more, to advantage.

As soon as early crops are harvested the land should be planted to cow peas. After such heavy fertilizing they will make an enormous growth, which can be turned under for green manuring; or better still, be made into hay, and be fed to stock in order to make more stable manure. The roots and stubble will be left in either case to enrich the soil. The cow pea like many other leguminous plants, is able, by means of the tubercles on its roots, to draw on the store of atmospheric nitrogen, which most plants can not do. It is this that makes this plant so useful in building up the soil. It is a nitrogen gatherer and, as has been stated, nitrogen is the most expensive element of soil fertility. If the land is not to be used for a winter crop, it will be best to allow the pea vines to lie on the ground as a mulch till toward spring before turning them under, as bare plowed land leaches badly in our heavy winter rains. On lands infested with "root knot," which is often so troublesome to vegetables and to some fruit trees, it is not advisable to plant cow peas since, unfortunately, they serve as a nurse plant for the nematode worms that cause the knots. On such soils a crop of millet, sorghum or broadcast field corn may be grown and turned under. This will supply vegetable matter to the soil, but it will not increase the supply of nitrogen, as is the case with the cow peas.

The importance of rotation of vegetable crops should be mentioned in this connection. Different crops draw differently on the elements of soil fertility, so that while it may be partially exhausted for one crop, or class of crops, others may grow on it luxurantly. It is, however, on account of the greater liability to disease, when one crop is grown continuously year after year, that the necessity for rotation is more particularly urged. There are a few crops, like onions, that can often be grown with good results year after year on the same land, when heavy fertilization is practiced; but in most cases it is far better and safer to follow a systematic rotation.

It is hard to get the soil too rich, or too full of vegetable matter for the best production of vegetables. With fruits the case is different. To secure the best results on thin lands orchards must be fertilized, but it must be done with care and judgment. Excessive applications of stable manure, or other nitrogenous fertilizer, should always be avoided, especially after tress reach bearing age. Such applications induce a rank, sappy growth that makes pear trees much more liable to blight, and will surely cause destructive rotting of the stone fruits. With apples there is less danger, and they may safely be fertilized quite heavily. Excessive wood growth is, however, never desirable in a bearing orchard of any kind. The trees should be carefully watched, and be given such treatment as will give a crop of well developed fruit; and, at the same time, a moderate growth of well matured wood. The leaves should always be of a dark rich green, for pinched yellow foliage indicates starvation.

It is usually best to use the available stable manure for the garden, and depend on commercial fertilizers for the orchard. While the trees are young, the mixture recommended for vegetables can be safely used; but a much smaller quantity will be required. If the land is to be used for orchard purposes alone, two to four pounds to the tree or vine will be ample. It is a common practice to plant some truck crop in a young orchard. In such cases the trees will need no fertilizer, other than that given to the vegetable crop. Another common practice is to plant a young orchard to cotton; and, everything considered, this is perhaps the best treatment, as the long season of cultivation required by the cotton is just what is needed by the trees. In this case an added amount of fertilizer will be useful, as cotton is given so little, compared to what is required for vegetables.

It is always advisable to sow oats or rye in the orchard in the fall to prevent washing and leaching during the winter; but this crop should always be plowed under early in the spring, and in no case be allowed to mature. Nothing is harder on young trees than a small grain crop. In sections where crimson clover can be successfully grown, it makes the best of winter cover crops for an orchard; since, like the cow pea, it is a nitrogen gatherer, and constantly adds to the fertility of the soil. If no other crop is grown in the orchard cow peas may be sown late in the season, say from the middle of July to first of August. They can be allowed to lie on the ground for a winter mulch, or they can be turned under in the fall, and the ground be reseeded to some winter growing cover crop, as recommended above. They should not be planted early in the season, for nothing should be allowed to interfere with the thorough cultivation of a young orchard from March to July.

After about the second summer it will not pay to attempt to grow vegetable or cotton crops in the orchard, as the trees will begin to draw too heavily on the soil; but the crops for winter cover should be continued.

As the trees reach bearing age, the proportion of cotton seed meal, or other nitrogenous material, in the fertilizer ahould be materially reduced, and more acid phosphate be substituted. The formula may now be:

cotton seed meal,	1 part	(by weight)	
acid phosphate,	4 parts	"	"
kainit,	2 parts	"	"

This will give approximately 1% of nitrogen, $7\frac{1}{2}$% of phosphoric acid and 4% of potash. When the soil is naturally rich and the trees are very vigorous, or when cow peas or crimson clover are grown and plowed in, the cotton seed meal may be omitted entirely, until such time as the lessened growth and yellow color of the foliage, indicate its need. In fact an orchard can not be fertilized by rule, but should be treated each season according to its needs, as indicated by growth and condition; always remembering that a heavy crop greatly exhausts the vitality of the trees, and that it should always be followed by increased fertilization.

Bone meal makes an admirable fertilizer for fruits and especially for grapes. High freight rates make it rather expensive in this State, and the same temporary effect can be had at less cost from the mixture of cotton seed meal and acid phosphate recommended above; but it must be admitted that the effect of the bone meal is more lasting.

Hot Beds and Cold Frames.

Hot beds and cold frames are indispensable to the truck farmer and market gardener for starting tender plants in the spring, and they should be much more generally used in private gardens. The more elaborate forcing houses for growing vegetables under glass, and the hot beds heated by flues with fire heat, so much used further North, will not be discussed here. Hot beds heated with manure, and glass or canvass covered cold frames are all that are necessary in this climate for starting such plants as tomatoes, egg plant, peppers, cucumbers and cantelopes in the Spring ; or for growing lettuce and radishes, or carrying cabbage plants through the winter. The regular 3x6 ft. glazed hot bed sash are, of course, the best cover for such beds, and every extensive grower should have at least a partial supply of them ; but they are expensive, and almost equally good results can be obtained with ordinary unbleached domestic, or sheeting, if supplemented by an abundant supply of hay, corn stalks or pine straw, to use for extra covering during very cold nights. Indeed this extra covering will be needed almost as much with the glass.

To make a hot bed, select a well drained spot with southern exposure, and dig a pit two feet deep the size of the proposed bed. Fill this with fresh horse manure from the stable and tramp it down well. If the manure is trashy or old, add some cotton seed meal to insure active fermentation. Pour on water enough to dampen the mass thoroughly without soaking it, and cover with six inches of rich soil. Now build a frame of rough boards a foot high on the south side, or front, and two feet high on the back. The frame is usually built six feet wide, on account of the length of the sash. The double width, or ten-fourths sheeting, is also just right to cover a six foot bed. One by three inch strips are put across every three feet, for rafters to support the sash or cloth. When cloth is used it is sometimes tacked onto light frames, the size of sash ; but it is much more convenient to leave it in one piece, about two feet longer than the bed. Bring one edge even with the back side of the bed, and nail fast, using strips or lath on top of the cloth, to prevent the nails tearing out. Bring the free edge of the cloth down to the front of the bed, and nail it fast between two 1x2 in. strips, so as to form a roller. If the bed is long, place the upper and lower strips so as break joints, and thus make a continuous roller the entire length of the bed. The roller should hang down half way on the front side of the bed. Its weight will then help hold the cover in place. Such a cover can be rolled up by one man in a moment's time, on a bed sixty or even a hundred feet long, and the bed can be covered again as quickly ; but the shifting of that amount of sash is a matter of considerable labor. The sides and ends of the bed should be banked with earth, and the cover closed. In three or four days the manure will get pretty hot. Sink a thermometer into the soil, and do not plant seed till the temperature gets down to 90°, or a little below. After planting, water slightly, if necessary, and cover the bed tightly, till the seed is well up ; then give ventilation whenever the weather will permit.

The construction of a cold frame is the same as that of a hot bed, except that no pit is dug and no fresh manure is used. The soil for both hot bed and cold frame should be plentifully enriched with compost, or well rotted stable manure. When growing plants on a large scale, the cold frame is generally made double width, with a ridge pole of 2x4 in. scantling supported on light posts about two feet high. Two curtains ten-fourths wide, or two lengths of sash, are necessary to cover such a twelve foot bed ; but it requires less lumber than a six foot bed, as the sides need be only one foot high. The single bed is built running east and west, so as to face the sun ; but the double bed should run north and south, so that the morning sun will shine under the ridge from one side, and the afternoon sun on the other, thus leaving no part in continuous shade.

Such plants as tomatoes, peppers and egg plants should be started in a hot bed ; but as they can be grown very close together when young, a small bed will answer for starting a very large number of plants. When about two or three inches high, they should be shifted to the cold frames, and be planted in regular rows four to six inches apart each way. A bed 12x60 ft. planted in this way, will hold plants enough for about an acre of land. A marker is a convenience in transplanting, made by putting pins, the required distance apart, into a light strip, an inch or so shorter than the width of the bed. The pins pressed into the soil mark the entire row across the bed at once, and by always placing the end of the marking stick against the same side of the bed, the plants will be made to row both ways quite accurately. This is an important point when taking the plants up to move to the field.

Plants can usually be held in such cold frames from four to five weeks, according to the weather. Tomatoes will require from four to six weeks in the hot bed, and egg plants and peppers six to eight weeks, so seed should be sown from two to three months before it is expected to move the plants to the open ground. The hot bed is usually located near the house or barn, where it can be easily cared for, but each cold frame should be located near the center of the land it is expected to plant from it, even if water has to be hauled to the beds in barrels. About two weeks before planting time open furrows, scatter in the fertilizer, and bed on it as previously described. When just ready to plant, if the land is level enough for cross cultivation, mark it off with deep furrows running across the beds. If the land has to be circled, the beds must be split by a deep furrow, and the plants spaced by guess in the row. Planting should follow the marking off as closely as possible, so as to have moist soil to draw about the plants. The bed should be well wet down a few hours before planting, so that the dirt will stick together, and not crumble. Now take down the frame, and haul away the lumber. Then take a long bladed knife, and slice down deeply midway between the plants, running the knife in both directions, so as to cut the soil in the bed into squares, with a plant in the center of each square. Now lift the squares of earth carefully on a spade, and place them on hand barrows or stretchers. When the stretcher is full two men take it and carry it along the rows. It is set on the ground, and the carriers lift the plants, one by one, with a flat paddle or trowel, and place them in the freshly opened furrows. Other hands follow immediately with hoes and draw the dirt about the plants, firming it with their feet. Large plants can be handled in this way without wilting or checking their growth, and with no danger of loss, even in quite dry weather.

Another class of plants, like cantaloups and cucumbers, will not bear handling in this way. These must be planted in boxes or "dirt bands" in the cold frames. These bands are furnished very cheaply by the fruit box factories, as they are made from sap wood, and other poor material. They consist of thin veniers, three or four inches wide, and grooved so as to fold into a four or five inch square, with a lap on one side. The prepared dirt is shoveled back from one end of the bed, the bottom is leveled down, and the bands are folded into shape, and are packed closely together in rows running across the bed. When the cleared space is filled by them, the dirt is shoveled back into them, and another space is cleared, and so on till the bed is completed. The dirt should be well packed in the boxes by using a stick for a rammer; and seed should be planted in each box, about four weeks before it is expected to put the plants in the field. It used to be thought necessary to tack these bands together before placing them in the beds, but it is found that the mould that forms on the wood when it is buried in the ground, serves to hold the bands together, till carried to the field. The boxes are lifted on a spade, and carried to the field in hand barrows, exactly as the squares of earth are with the tomato plants. Plants in dirt bands dry out much more rapidly, and require more frequent watering, than those in solid beds. Some growers cut the corner of the dirt band, and remove it before hilling up the plants in the field; but this is not necessary, as the roots pass freely out at the bottom and the band soon rots away. Such hardy seeds as onions and cabbages can be sown in cold frames in the fall, and the plants will be ready to set in the field in late winter, or early spring, so soon as the heaviest freezing is past, in time to use the same frames for some of the tenderer crops in the spring.

Marketing and Transportation.

As has been previously stated, there are many who succeed in growing good fruits and vegetables, who fail to market them, so as to get the best results. The price of these goods depends so much on the condition in which they reach the market, and in their presenting an attractive appearance to the eye of the customer, that no pains or expense should be spared in securing the best possible results in this direction. No old or dirty barrels, or other packages, should be used. Let everything be as neat, clean and attractive as possible. Above all, grade the goods with great care, and throw out everything that is unsound or unsightly. The culls may be of some use at home for stock feed; but it is worse than useless to load up the markets with such stuff. Avoid all attempts at false packing. Do not put all the choice specimens on top of the package, and the culls in the middle. The buyer is just as smart as you are, and is constantly on the lookout for such deceptions. Be careful however that the package is smoothly and evenly filled, with the contents just high enough, so that the cover presses it all firmly, so as to prevent jostling about and bruising in transit. Stamp your name and address plainly on every package, as a guarantee of good packing; and as a trade mark that will come to have great value, when it becomes known that your goods are always carefully and honestly packed.

These suggestions apply equally well, whether your market is in the next town, or a thousand miles away; but as most southern growers depend on distant shipment, for marketing their crops, the question of transportation becomes a most vital one. In the early days of the business, nearly all horticultural products were shipped by express. This has never been a satisfactory method, on account of the high charges, and the frequent damage from rough handling; and in the present state of the market, except for near by points, or for a few high priced articles, the rates are absolutely prohibitory. It is certainly not advisable to undertake growing any of these crops, for distant shipment, except at those points where the business is being carried on extensively enough to secure car load freight rates, and fast freight transportation.

The bulkier products, like cabbage, watermelons and potatoes; and in some cases pears and apples, can be safely handled in ordinary open or ventilated fruit cars, such as are provided by all the roads. For the more delicate fruits and vegetables, refrigerator transportation is indispensable. The added expense is considerable; but it is more than repaid by the greater safety in transit, and the better condition on arrival. In fact, many of these products cannot be shipped by freight in open cars at all; but must either go by express, or in refrigerators. In such cases, both cost and condition greatly favor the refrigerator car.

Many difficulties, and much prejudice were formerly encountered in shipping fruits under refrigeration. Dealers and buyers were afraid to handle fruits that had been on ice, claiming that they would melt down and spoil, as soon as they were removed to the warmer air. This belief was wide spread, and deeply seated, and it has taken much time, and many practical demonstrations to fully convince the trade of its falsity. It probably originated in attempts to save fruit that was already overripe, and on the verge of spoiling, by placing it in the ice box. Such fruit will be preserved for some time if kept cold enough; for cold arrests the growth of the organisms of decay. The decay is only arrested, however, for these organisms are not killed by the cold, and as soon as such fruit is again brought into a warm atmosphere, they rapidly complete its destruction. If, however, the fruit is taken from the field at the proper stage of maturity, and is placed at once in a refrigerator car, the cold prevents the beginning of incipient decay; and the fruit will arrive at its destination in a condition to keep almost as long, after taking it from the car, as it would have kept in the open air at the time it was picked. Strawberries must be in the best possible condition, and the weather not too hot, for them to stand thirty-six hours transportation by express; or in other words for them to reach market, in good condition, on the second morning after picking. In the writers experience strawberries have been repeatedly sent from southern Illinois to Detroit, a three days run by refrigerator freight, and have been successfully reshipped by express, to Canadian points, that were not reached till the second morning after leaving Detroit.

Again, no fruit is more perishable than a fully ripened peach; but peaches fully mellow, and ready to eat, have been put in refrigerator cars in California, and, after a six days run to Chicago, have been reshipped by express to New York, reaching there in condition to bring good prices. Of course, to endure such severe tests, it is necessary to have the fruit very carefully assorted and packed. A very few specked peaches, or rotting strawberries, would spoil an entire package before reaching so distant a market. Good judgment, too, is necessary in picking fruit at the proper stage of maturity for refrigerator shipment. Of course it should not be too ripe, but the mistake is much more often made of picking it too green. In shipping by freight in open cars, it is often necessary to pick pretty green, but with most fruits this is done at great sacrifice of quality. Under refrigeration fully matured ripe fruit will keep better, than that which is grass green. This is an important point in favor of refrigeration; and one that many growers do not understand, for it enables fruit to be put on the market after its full flavor and quality has been developed. The flat, insipid quality, and lack of flavor so often noticed in California fruits on the eastern markets, comes very largely from the pernicious habit of green picking. A peach that is ripe enough to be fully mellow, is hard to handle without bruising; but they should hang on the tree till fully grown and colored. A peach that would be mellow, if left on the tree till to-morrow, is in just the right condition to pick to-day. Pears, on the other hand, should be picked green, at least ten days to two weeks before softening; and should be ripened in a close dark place. For this reason, they can be safely shipped in tight boxes or barrels in open cars, unless it is intended to place them in cold storage on arrival. In this case they should be shipped under refrigeration, to retard the ripening process as much as possible.

Refrigerator cars were first built for the meat trade. The meat was hung in cold storage houses; and was loaded into the cars at, or near, the freezing point. In a tight, well built car such a cold load would warm up very slowly; and a small amount of ice served to carry it safely to its destination. When it was attempted to use these cars for fruit, the hot load, fresh from the fields, soon melted the limited ice supply; and the cars invariably arrived heated, and in bad order. To use these cars successfully, it was found necessary to build cooling houses at the shipping points, in which the fruit could be cooled off before loading, as in the case of the meat. This caused delay in getting the fruit on the market; and made much additional expense. It, however, demonstrated the success of refrigeration for the transportation of fruits; and soon cars were built especially for the fruit trade, with sufficient ice capacity to cool off a load of hot fruit in transit, and to keep it cool. At the present time there are a number of refrigerator car lines, with specially built fruit cars, that are actively competing for the fruit and vegetable carrying trade; so that any point, having sufficient business to offer, can secure efficient car service, with competent men to look after the proper loading and icing of the cars. Each line, of course, claims to have the best cars; and for difficult service there would certainly be considerable choice between them, but with the numerous re-icing stations that are now available, any of them will give satisfactory service, if properly loaded and handled.

The main points to consider in selecting a refrigerator car, for transporting produce, are first, its ice capacity, and second, its insulation. The ice tanks should hold at least five tons of ice, and six tons is even better. The position of the tanks, whether overhead or at the ends, is a question of minor importance. The car should be tightly built, with double walls and roof, with the space between them filled in with some non-conducting material, or by numerous linings of building paper, with dead air spaces between them. The doors should be built like the walls and be of the same thickness; and they should fit as nearly air tight as possible. Of course the car should be sweet and clean.

It is usual for the refrigerator companies to furnish their own men for loading the cars, for proper loading is a point of so much importance, that they do not care to trust the reputation of their cars to inexperienced men. The important points to secure in loading are first, that the packages be so spaced, that the cold air has immediate access to all sides of them, and, second, that they be so secured, that the load cannot shift by the bumping of the cars while in transit. These points are usually secured by piling the crates, or other packages, one above another in tiers or ranks, from three to six inches apart; and with lath or strips between each layer. Strips are placed upright against the end of the car, and a row of packages is placed on the floor, with the ends set snugly against these strips, and carefully spaced. Light half inch strips, as long as the width of the car, are placed across the ends of the packages; and the front one is nailed down, with a light nail, to the head of each package to prevent side shifting. Another row of packages is placed on these strips, each one directly above one in the lower row. These are again stripped and nailed, and so on to the top. The next course is placed with the ends snugly against the ends of the first course, so that the air spaces are continuous. When the center of the car is reached, begin in the other end and load in the same way. A space will usually be left at the last, too narrow to admit another course of packages; and the car must now be braced, to prevent the courses trom shifting endwise. Pieces of 1 x 6 in. board are set up against the ends of each rank of packages; and other strips are nailed across these uprights, near the bottom and the top of the car. The distance between these opposite cross-pieces is now carefully measured, and pieces of board are cut for braces about an inch longer than this space, so that they will have to be driven home with considerable force. The braces are toe-nailed in place, to prevent their falling, if they should chance to loosen in the bumping of the car. When thus loaded and braced, the contents are absolutely immovable, yet each package is separated from its neighbors, on all sides, by a layer of cold air, which, when it becomes warmed by the hot fruit, rises, and is carried by the currents thus generated to the ice, where it is quickly cooled again, and where it deposits the moisture that may have been taken up from the fruit. This rapid circulation of the air is very important, and the ice, instead of making the fruit damp, as might at first be thought, really serves to dry it very effectually.

In conclusion, a few words in regard to commission merchants may not be out of place. As has been stated, nearly all fruits and vegetables from the South are consigned to dealers, who sell them on commission for the account of the shipper. The markets are so variable, and these perishable goods suffer such frequent losses in transit, that this system adds seriously to the other risks of the grower. It is usually advisable to sell at the shipping point whenever a good cash offer can be obtained, even if the price offered is something below current quotations. It is only occasionally that this can be done, and shipping on consignment is often a necessity.

The merchant now has the game so completely in his own hands that shippers are naturally suspicious; and, if poor returns are made, they are very likely to conclude that "commission men are all thieves." It is unfortunately true that dishonest men are found in this line of business, as in all others; and southern shippers have often been mercilessly swindled. It is equally true, however, that in every market of importance, there are as honorable men engaged in the produce commission business as can be found in any other line of trade; and it should be the first care of the shipper to post himself fully as to the character and reliability of the man who seeks his trade. Every shipper should investigate in advance of the shipping season, and decide on one or two good houses in each of the markets he expects to use. He should correspond with these houses, posting them on the character and quality of his expected crops, and he should ship to them regularly throughout the season. In this way the dealer and his customers become acquainted with the quality of the goods, and, if they come regularly, it is often possible to sell them in advance of arrival. A dealer takes an interest in a regular shipper, and will look out for his interests. It is never good policy to ship to one man to-day, and another to-morrow, acting on the whim of the moment, or yielding to the persuasions of the last solicitor who asks for your shipments. It is equally bad policy to scatter a small shipment among half a dozen houses in the same market. Make your trade of some importance to the commission man, by sending good goods regularly, and it will be to his interest to see that you are given satisfaction. The men who abuse the commission men most are usually those who ship the poorest and most dishonestly packed goods.

Another point: keep your dealer posted, in advance, of the amount and character of your shipments ; and of the total shipments that are going to his market from your locality. Insist on his keeping you posted as to his market, and on his making you prompt returns. Do not let him send you weekly or monthly statements, but demand account sales and check for each lot sent, on the day that it is sold. Do not be afraid to spend a few dollars in telegraphing. Send a night rate message notifying the dealer of the amount and quality of each shipment made him, and require a daily wire from each market you are using, giving quotations from actual sales. This will cost something, but no produce shipper can afford to consign his goods without this necessary information.

[SCIENCE CONTRIBUTIONS.]

BULLETIN No. 80. APRIL, 1897.

ALABAMA

Agricultural Experiment Station

OF THE

AGRICULTURAL AND MECHANICAL COLLEGE,

AUBURN.

A Preliminary List of Alabama Fungi.

L. M. UNDERWOOD and F. S. EARLE.

MONTGOMERY, ALA.:
THE BROWN PRINTING COMPANY, PRINTERS.
1897.

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The Bulletins of this Station will be sent free to any citizen of the State on application to the Agricultural Experiment Station, Auburn, Alabama.

* Dr. L. M. Underwood was Biologist of the Station from September 1, 1895, to August 1, 1896.

HISTORICAL SKETCH OF THE STUDY OF FUNGI IN ALABAMA.

LUCIEN M. UNDERWOOD.

Our present knowledge of the extent and distribution of the higher plants of the state of Alabama, while far from complete, is still considerable, due to the efforts of several botanists who have devoted much time to their study. Chief among these to whom we are thus indebted are the late Judge Peters of Moulton, Prof. E. A. Smith of Tuscaloosa, and especially, Dr. Charles Mohr of Mobile, who has studied Alabama plants ever since his arrival in the country in 1848. It is expected that the results of these long continued studies will soon be made public, and that we shall soon have, for the first time, a published Flora of Alabama. While the higher plants are thus likely to be well cared for, the study of the less conspicuous but no less interesting and important lower plants has not been so carefully nor so systematically conducted. Both Judge Peters and Dr. Mohr collected a number of mosses and liverworts, and several new species in these groups have been described with Alabama as a type locality, but this field has not been worked with any degree of thoroughness. Judge Peters also collected a considerable number of lichens which are preserved with his collections at Tuscaloosa. So far as we are aware the large group of filamentous fresh water Algae has received no attention whatever, there being not a single recorded species from the entire state, tho members of the group are very commonly distributed throughout the waters of the state. A most inviting and important virgin field is still open for students in this direction. Our knowledge of Alabama

Diatoms is due entirely to the labors of Mr. K. M. Cunningham, of Mobile, who has done much careful work on this interesting group.

The study of the Fungi of the state of Alabama commenced with the collections of Judge Thomas M. Peters, whose name will be linked inseparably with the future study of these organisms, because of the new and interesting things he brought to light, some of which have contributed not a little to the present knowledge of the relations of these difficult and interesting organisms. His field work was prosecuted largely in the vicinity of his home in Lawrence county, and on his farm property at "The Roost" * on a fork of the Sipsey river in Winston county adjoining Lawrence on the south. His collections were largely made during the years 1854–1864 † and in the main were sent to Rev. Moses A. Curtis, who was engaged (1835-1872) in studying the mycologic flora of North Carolina. These, with others collected in various parts of the eastern and southern United States, were sent to Rev. M. J. Berkeley of England, by whom the new species were described in his "Notices of North America Fungi" which were published chiefly in Grevillea, 1872-1876, conjointly with Cur-

* This interesting locality takes its name from the fact that in former years the passenger pigeon (*Ectopistes migratorius*) used the trees in the vicinity as a roosting place and accumulated there in vast numbers. No traces of their former abode are left, but the entire region is one of the most interesting botanically in the entire state. The exact location is in Township 8, Range 9, section 10, Winston county.

† With Judge Peters' collection at Tuscaloosa, there is a MSS list bearing this inscription:

"A list of Alabama Fungi with genera arranged according to Dr. John Lindley but species under each order are set down alphabetically. Collected from 1854–1864 in the counties of Lawrence, Walker and Winston and adjacent counties in Alabama, dried specimens of most of which will be found in the "Peters collection" in the University of Alabama."

The list of species numbers some five hundred, but a large part of these are not in the collection which is preserved in three quarto volumes after the usual manner of exsiccatæ.

tis. These species are frequently alluded to as the "B. & C." species and have been the source of much difficulty to later mycologists from the very brief and often too general descriptions. The types of these fungi will be found at Kew, England, which contains Berkeley's herbarium among its collections. Specimens of many of them may doubtless be found in the Curtis collection, now owned by Harvard University, when that collection shall become as accessible to botanists as the one at Kew. The ultimate decision in regard to the status of these species, however, will necessarily depend on the examination of the types at Kew, since these are the ones on which Berkeley based his descriptions, and probably, tho not certainly, represent the same material that Curtis divided with him.

Some of Judge Peters' earlier collections were sent to H. W. Ravenel, of Aiken, S. C., and were distributed by him in his "Fungi Caroliniani Exsiccati" of which five fascicles (five hundred specimens) were issued, 1852-1860.

Judge Peters' own collection of fungi was presented with his botanical library and other collections to his alma mater, the State University of Alabama, and through the kindness of Dr. Eugene A. Smith, we have been permitted to examine the collections and include numerous notes of its contents. The State University also possesses a copy of Ravenel's work above noted which is now very rare and is especially valuable for the student of mycology in any portion of the south. The Peters' collection is in a very good state of preservation considering its age, but does not contain all the species included in the "B. & C." descriptions of Alabama fungi above noted.

The second Alabama botanist to give attention to these plants was John F. Beaumont, concerning whom comparatively little is now known. He lived for a time in Lawrence county, but afterwards removed to southeastern Alabama, and is said to have died at Troy, Pike county.*

* A brief sketch of Beaumont from which we have drawn facts concerning his work, appeared in the Journal of Mycology, 2: 81-83, 1886, written by his associate. It is desirable to place on record a more complete statement of his life and work, and if any persons reading this know anything further concerning him, they will confer a favor by communicating with either of the writers.

Beaumont, like Peters, sent numerous specimens of fungi to Curtis, and these are included in the emmeration in the "Notices" above alluded to. It is uncertain in what part of the state Beaumont's specimens were collected, but it is more than likely that it was in southeastern Alabama, where he is known to have resided during the latter part of his life.

Nothing more was accomplished toward making known the cryptogamic flora of Alabama until 1889, when Dr. George F. Atkinson assumed control of the department of biology in the Alabama Polytechnic Institute. He was an indefatigable collector and added especially to the knowledge of parasitic forms, publishing several papers on the economic, systematic and biological relations of various groups of species, during his residence in the state and since his removal. These contributions which added greatly to our exact knowledge of Alabama Fungi are enumerated below. In collecting, Dr. Atkinson was assisted by graduate students, notably B. M. Duggar, 1890–1, and C. L. Newman, 1889–92. A considerable portion of the fungi collected during this period (1889–1892) are preserved in the collection of the Alabama Polytechnic Institute. These include a large number of types (or duplicate types) of the new species described by him in his various publications. A fuller set is contained in his private collection † which we have not examined.

During the years 1893–5 the department of biology was under the control of Professor J. M. Stedman, who was primarily a zoologist, so that naturally little attention was given to the advancement of our knowledge of the Alabama flora. Some two or three specimens collected during this period may be found in the A. P. I. collection.

During the past year, 1895–6, the writer (since January, 1896, associated with Professor F. S. Earle) has devoted as much time as could be spared from other duties in active field work for the collection and study of the fungous flora. Since July 1896, Professor Earle has continued the field

† Now in Cornell University, Ithaca, New York.

work with such assistance as could be utilized. Naturally the collecting has been done within a distance of a few miles from Auburn, and so far as the parasitic forms are concerned, to a considerable extent it duplicates that done by Dr. Atkinson and his assistants; some interesting parasitic species, however, have been added from this section, and a considerable number of saprophytic forms (Pyrenos, Gastros and other fleshy fungi, have been added to the collection. In this connection, however, it should be stated that the season of 1895–6 was specially unfavorable for the extensive growth of fungi, being very dry during the fall of 1895 and during the spring of 1896. In fact not until July 1896, was the rainfall sufficient to bring out anything of the normal productiveness of this region.

A few trips were made to various parts of the state, largely for the purpose of gaining information as to the character of the country with the expectation of making more extended excursions later. During these trips a considerable amount of material was collected in various parts of the state and valuable data accumulated regarding distribution and desirable regions for prosecuting field work in the future. Professor Earle has twice visited Mobile county. The writer has also been once in the same county (December, 1895); one trip was made to Tuscaloosa, Hale and Dallas counties (May 1896) and one to DeKalb, Madison, Lawrence and Winston counties (June 1896).

It is thought best to publish this preliminary list of the species of fungi now known to exist in Alabama, as a basis for further work, as well as a stimulus to bring to light some of the species early described from the state that are now known only through their type specimens. For this purpose, and as some of the descriptions are not easily accessible, we have collated the original descriptions of all species which were described with Alabama as a type locality, and have further designated with a star those species of which specimens have not been seen by the writers. The material collected during the present year has been deposited in the collection of the Alabama Polytechnic Institute, and so far as material would permit in the collections of the writers. It must be borne in mind that this list represents only a small part of the flora of the state, since only limited areas have been examined for a limited time. It will be many years before the fungi will be as fully known as the higher plants, for with only a single institution in the state that maintains a course in Botany, the task of field exploration and laboratory determination and investigation falls heavily on two or three workers.

The state of Alabama presents a very diversified flora, including many of the plants of the Appalachian mountain chain which extends through the highlands of the state beyond its centre, and many of the Gulf coast plants towards the southern limits. The differences of elevation are also considerable and furnish another element for the production of a diversified flora. As stated above, we have a good working knowledge of the higher plants of the state, so soon as it shall be made available to students by publication.* The state will probably be found to contain more spermaphytes than any state east of the Mississippi river, owing to its range of latitude, altitude, and its peculiar position. It is natural to infer that the fungous fiora, when it shall be made known, will be proportionally large since the parasitic portion of it at least is directly dependent on the higher plants as the source of nutrition and sustenance. The fungous flora of the vicinity of Auburn has impressed neither of the writers as exceptionally rich. The generally poor quality of the soil may perhaps account for part of this condition,

*It should not be understood that even the higher plants are all enumerated. As an instance of what can be done in fairly well worked localities, we may cite the instance that of about two hundred Spermaphytes collected by Professor Earle and myself in the vicinity of Auburn during the Spring of 1896, at least a dozen were not known to Dr. Mohr as members of the Alabama flora, and two or three were new to science. And these were incidental gatherings in our search for fungi, having in view the establishment of a host herbarium of Alabama plants for reference, a great desideratum for the Biological Laboratory.

coupled with the fact that the timber is more largely pine than otherwise, a host that supports in this climate few fungi as compared with many deciduous trees.

The observations made on the various brief excursions through the state may properly be mentioned here as indicating some of the regions where exploration will yield good results in the future. There are doubtless many others perhaps equally advantageous. A few of these already noted are :—

(1) The spurs of the Appalachian system reaching our state, notably the Lookout range extending through DeKalb, Etowah and Cherokee counties.

This region can be reached from any point on the Alabama Great Southern between Chattanooga and Attalla. The basin of the Coosawattie, from Rome to Gadsden, will doubtless be well worth the exploration. The range parallel to Lookout, known as Sand mountain, will likewise repay careful exploration; one very promising portion of this is accessible from the railroad leading from Attalla to Guntersville, and other portions are accessible between Huntsville and Chattanooga.

(2) The river drainage of the northern portion of the State. This will form an interesting and peculiar region by itself, and can be reached from the various towns on the Tennessee river from Chattanooga to Florence.

(3) The river region of Tuscaloosa and Hale counties bordering on the Black Warrior, accessible by the Alabama Great Southern from Birmingham to Meridian. Parts of this region visited during May 1896, and at an unfavorable time because of the dry season—showed a rich and diversified flora.

(4) The coast region of Southern Alabama, comprised in Mobile and Baldwin counties. The peculiar parasitic flora developed by the labors of Professors Tracy and Earle in their account of Mississippi fungi, and collected largely at points on the Gulf coast only a few miles to the west of our state, would argue a like development in corresponding

areas in our own state, and the brief visits made by the writers to this region amply confirm the above statement.

(5) The highland counties of northwestern Alabama. From a single visit to this region we would predict for it the indication of being the region of the state most prolific in furnishing additions to the flora. This prediction is based on the fact that the higher fiora, and especially the timber, is the most diversified of any portion of the state visited, and on the additional fact that a large part of the area is still covered with the original forest and has not suffered from the modifications induced by cultivation and civilization. The writer made a single trip from Decatur to Moulton, thence by the mountain road to the northern portion of Winston county, and thence to Haleysville on the railroad leading from Sheffield to Birmingham. The region throughout showed evidence of an exceedingly rich field for exploration. On account of the few settlements in this area it would be desirable to visit this region with a party provided with tent and supplies, allowing for delays in river crossings if the trip is to be taken during the period of heavy rains. Even a fortnight's trip taken either in early spring, in midsummer, or in early autumn, or even in November, would repay a rich reward, each season of course furnishing its own characteristic flora. The region may be reached either from Cullman or Decatur, or from Haleysville as above noted. It should be remembered that it was in this region that the greater part of Judge Peters' collections were made.

In a recent article in Garden and Forest* the writer has called attention to the fact that while the study of mycology in America commenced in the South (North Carolina) the later development of the mycologic flora of the Southern States has not been extensive. In only two of these states, in fact, is there a mycologist connected with the experiment station, and in several there is not even a botanist. Ala-

*Issue of 1 July, 1996 (9:263, 264).

bama, Mississippi and Texas are the three states of the southern tier that have contributed anything to a knowledge of the fungous flora from their experiment stations, and still it seems that it must be to these institutions mainly that we are to look for work in this direction.

The following are the more important local lists that have appeared from the Southern States:

North Carolina.—CURTIS, M. A. Geological and Natural History Survey of North Carolina. Part 3 Botany; containing a catalogue of the indigenous and naturalized plants of the state. 1867.

Contains a list of 2,392 species of fungi.

South Carolina.—RAVENEL, H. W. Contributions to the Cryptogamic Botany of South Carolina. Med. Jour. & Rev., Charleston, 4:428-433, J. 1849; 5:324-327, My. 1850; 6:190-199, Mh. 1851.*

The third part contains a list of 169 hymenomycetous fungi.

Georgia.—Nothing is known of the fungous flora except a few scattering species reported by Mr. Ravenel in his exsiccatæ.

Florida.—ELLIS, J. B. and MARTIN G. New Florida Fungi. Jour. Myc., 1:97-101. Au., 1885.

Descriptions of 16 species.

CALKINS, W. W. Notes on Florida Fungi. Jour. Myc., 2:6, 7; 23; 42; 53, 54; 70; 80, 81; 89-91; 104-106; 126-128. 1886; 3:7; 33, 34; 46; 58, 59; 70; 82. 1887.

List of some 300 species of fungi collected by the writer.

Mississippi.—TRACY, S. M., and EARLE, F. S. Mississippi Fungi. Bull. Miss. Agric. Exper. Sta., 34: 1895.

List of 353 species, largely parasitic.

—Mississippi Fungi. Bull. Miss. Agric. Exper. Sta., 38: 1896.

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* In addition, the Fungi Caroliniani exsiccati, above cited, and the later issue of Fungi Americani exsiccati, were quite largely supplied with specimens from this state.

An additional list of 85 species, mostly parasitic. Both this and the preceding paper contain descriptions of species of Mississippi fungi, first published from that state.

Louisiana.—FEATHERMAN, A. Report of Botanical Survey of Southern and Central Louisiana, 1871.

Contains among other plants, a list of 21 species of fungi.

—Third Annual Report of the Botanical Survey of Southwest Louisiana, 1872.

Contains among other plants, a list of 68 species of fungi.

LANGLOIS, A. B. Catalogue provisoire de Plantes Phanerogames et Cryptogames de la Basse Louisiane. 1887.

A list of some 644 fungi collected by Father Langlois.

ELLIS, J. B., and LANGLOIS, A. B. New species of Louisiana fungi. Jour. Myc., 6:35-37, Mh., 1890.

Descriptions of 16 species from the state.

Texas.—RAVENEL, H. W. Report on the Fungi of Texas. Rep. Comm. Agric. on Diseases of Cattle, 171-174. 1871.

COOKE, M. C. The Fungi of Texas. Annals New York Acad. Sci., 1:177-187. 1878.

List of 149 species from the state, largely collected by Ravenel.

JENNINGS, H. S. Some Parasitic Fungi of Texas. Bull. Texas Agric. Exper. Sta., 9:23-29. 1890.

List of 95 species from the state.

Arkansas.—We know nothing of its fungous flora.

Tennessee.—Any knowledge of the fungus flora of this state is likewise lacking.

The above includes, of course, only the more important papers. Scattered descriptions of species from several of the Southern States are also to be found in descriptive literature, periodical or otherwise. We now give in conclusion the complete list, as we know it, of papers relating to the mycologic flora of our own state.

LIST OF WORKS AND PAPERS TREATING OF ALABAMA FUNGI.

(Authors chronologically arranged.)

RAVENEL, H. W. Fungi Caroliniani Exsiccati. Fasc. 1-5, 1852-1860.

Contains numerous Alabama species, contributed chiefly by T. M. Peters.

BERKELEY, M. J. Notices of North American Fungi. Grevillea, 1:33-39, 49-55, 65-71, 97-102, 145-150, 161-166, 177-180. 1872-3; 2:3-7, 17-20, 33-35, 49-53, 65-69, 81-84, 97-101, 153-157, 177-181. 1873-4; 3:1-17, 49-64, 97-112, 145-160. 1874-5; 4:1-16, 45-52, 93-108, 141-162. 1875-6.

Contains references to some 227 species of Fungi collected in Alabama by Peters and Beaumont. Many of these were new to science and are briefly described in both Latin and English by Berkeley and Curtis.

BERKELEY, M. J., and CURTIS, M. A. Fungi Cubenses. Jour. Linn. Soc., 10:280-392. 1869.

Describes a large number of Cuban fungi, some of which also occurred in various parts of the United States. Among these are five species of which the type is reported from Alabama. It is probable that the material was collected by Peters, but the fact is not stated.

FARLOW, W. G. The Synchitria of the United States. Bot. Gazette, 10:235-245. Pl. 1885.

Mentions and describes *Synchitrium pluriannulatum* collected by Peters in Alabama.

COOKE, M. C. Precursores ad Monographiam Polypororum. Grevillea, 15:19-27. 1886.

Describes *Poria Beaumontii* B. & C., from the Berkeley collection, originally sent from Alabama by Beaumont.

ATKINSON, G. F. A New Ramularia on Cotton. Bot. Gazette, 15:166-168. J. 1890.

Describes *R. areola* from Auburn, Alabama.

—Some Erysiphei from Alabama and Carolina. Jour. Elisha Mitchell Sci. Soc., 7:61-74. 1890.

Describes sixteen species of mildews from Alabama stations.

—Black rust of cotton. Bulletin Ala. Exper. Sta. 27: May, 1891.

General account of the "rust" of cotton, with account of *Cercospora gossypina*, *Colletotrichum gossypii*, and *Macrosporium nigricantium.*

—Sphaerella gossypina n. sp. the perfect stage of Cercospora gossypina Cke. Bull. Torr. Bot. Club, 18: 300, 301. *Pl. 122. October, 1891.*

Species described from material collected at Auburn, Eutaw, and Alberta Station, Alabama.

—On the structure and dimorphism of Hypocrea tuberiformis. Bot. Gazette, 16: 282-285. *Pl. 25*, October, 1891.

Results of study based on material collected at Auburn, Alabama.

A new Ravenelia from Alabama. Bot. Gazette, 16: 313-314. November, 1891.

Describes *R. cassiaecola on C. nictitans* from Auburn, Alabama.

—Some Cercosporae from Alabama. Jour. Elisha Mitchell Sci. Soc., 8: 33-66. 1891. (Separate pp. 1-36).

Describes some 79 species collected in Alabama, of which 27 are new.

—Some leaf blights of cotton. Bull. Alabama Agric. Exp. Sta. 36. March, 1892.

Discusses the economic relations of several of the diseases of cotton, some of which are produced by various fungi.

—The Genus Frankia in the United States. Bull. Torr. Bot. Club, 19: 171-177. Pl. 128. June, 1892.

Account of *F. alni* and *F. ceanothi* n. sp. based on material collected at Auburn, Alabama.

—Some diseases of cotton. Bull. Alabama Agric. Exp. Sta. 41. D, 1892.

General summary of cotton diseases, including those produced by species of *Cercospora, Colletotricium, Macrosporium* and *Sphaerella.*

—Additions to the Erysiphei of Alabama. Jour. Elisha Mitchell Sci. Soc. 10: 74-76. 1893.

Notes on twelve additional species of this group.

—Some Septoriae from Alabama. Jour. Elisha Mitchell Sci. Soc. 10: 76-78. 1893.

Notes on fifteen species observed in the State, including *S. Alabamensis* n. sp. parasitic on *Nepeta glechoma.*

—Germination of the spores of Cerebella paspali. Bull. Torr. Bot. Club, 21: 127-128. *Pl. 183.* March, 1894.

Based on material collected at Auburn, Alabama.

—Steps towards a revision of the linosporous species of North American graminicolous Hypocreaceae. Bull. Torr. Bot. Club, 21: 222-225. May, 1894.

Establishes three genera with two new species based on material collected in Alabama.

—Notes on some Exoasceæ of the United States. Bull. Torr. Bot. Club, 21: 372-380. August, 1894.

Describes among other new species, *E. mirabilis, E. rhizipes, E. varius* and *E. australis,* on material collected at Auburn, Alabama.

—Leaf-curl and Plum-pockets. Bull. Cornell University Agric. Exper. Sta. 73. S, 1894.

Gives general account and illustrations of three of the species described in the above paper.

Ellis, J. B., and Everhart. B. M., North American Fungi. Centuries 25 (1890), 28 (1892) and 35 (1896).

Includes four species of Alabama fungi.

Seymour A. B. and Earle, F. S., Economic Fungi. Fasc 2-9. 1891—1895.

Contains several species of Alabama fungi contributed chiefly by G. F. Atkinson.

Duggar, B. M. Germination of the teleutospores of Ravenelia cassiaecola. Bot Gazette, 17: 144-148, *Pl. 9, 10,* May, 1892.

Study made at the Alabama Polytechnic Institute, with illustrations of the germinating teleutospores.

Morgan A. P. North American Fungi. IV. Gastromycetes. Cincinnati Soc. Nat. Hist., 13: 5-21. *Pl. 1, 2.* April, 1891.

Mentions *Lycoperdon pedicellatum, L. Peckii*, and *L. cepaeforme* as occurring in Alabama collected by G. F. Atkinson.

—New North American Fungi. Jour. Cincinnati Soc. Nat. Hist. 18: 36-45. *Pl. 1-3.* 1895.

Describes and illustrates among other species, *Hydnum atroviride* collected in Alabama by G. F. Atkinson.

UNDERWOOD, L. M., and EARLE, F. S. Treatment of some fungous diseases. Bull. Alabama Agric. Exper. Sta. 69. F 1896.

General account of fungi and their habits, and treatment of the principal diseases of the leading cultivated crops occurring in the State.

—The distribution of the species of Gymnosporangium in the South. Bot. Gazette, 22: 255-258. S 1896.

Notes on the six species of the Eastern United States parasitic on Juniperus Virginiana, five of which occur in Alabama.

—Notes on the Pine-inhabiting species of Peridermium. Bull. Torr. Bot. Club, 23: 400-405. O 1896.

Describes the three species of the Eastern United States, two of which are common in Alabama.

TRACY, S. M., and EARLE, F. S. New Species of Fungi from Mississippi. Bull. Torr. Bot. Club, 23: 205-211. 1896.

Mentions *Glonium macrosporium* from Auburn, Alabama.

UNDERWOOD, L. M. Mycology in the Southern States. Garden and Forest, 9:263, 264. Jy, 1896.

Alludes to the mycologic work done in Alabama,

—Edible Fungi; a wasted food product. Bull. Agric. Exper. Sta., 73: 337-346, O 1896.

General account of Fungi as food; alludes to certain edible and poisonous species occurring in Alabama with figures of *Amanita caesarea A. muscaria* and *Agaricus campestris.*

—Some new Fungi, chiefly from Alabama. Bull. Torr. Bot. Club, 24: 81-86. 28 F, 1897.

Describes ten species of Fungi from Alabama, together with two others also collected in this state, but not originally described from Alabama material.

PECK, C. H. New species of Fungi. Bull. Torr. Bot. Club, 23: 411-420. O, 1896.

Describes *Lentinus Underwoodii*, *L. ventricosus*, *Pholiota sabulosa*, *Flammula Underwoodii* and *Boletus tabacinus* from material sent from Alabama by the writer.

—New species of Fungi. Bull. Torr. Bot. Club, 24:137-147. March, 1897.

Describes, with others, ten new species of fungi from Alabama material.

EARLE, F. S. New species of Fungi imperfecti from Alabama. Bull. Torr. Bot. Club, 24:28-32. 1897.

Describes twelve new species of fungi from Alabama belonging to the group of imperfect fungi.

PRELIMINARY LIST OF THE KNOWN SPECIES OF ALABAMA FUNGI.

L. M. UNDERWOOD AND F. S. EARLE.

The following list includes the species of Fungi at present known to inhabit the State of Alabama. In the case of those species described by Berkeley all have been included in the list whether they have been collected recently or not. In the case of those whose type locality is Alabama, Berkeley's descriptions in both Latin and English are given, since the two are usually more or less supplementary to each other. Those which have not been collected since their publication are marked with a star. All the species not so marked are represented by specimens in some American collection and their location can be determined from the following statement of the basis on which the list rests. It is founded on the following material:

1. The species reported by Berkeley in his notices, and, presumably, to be found in the Berkeley collection at Kew, England.

2. Species preserved in the Peters collection, now owned by the State University of Alabama.

3. Species collected by Judge Peters in Alabama and distributed in Ravenel's Fungi Caroliniani exsiccati.

4. Species collected by Professor G. F. Atkinson or his assistants and deposited in the herbarium of the Alabama Polytechnic Institute. * Also species described by this author in recent papers.

5. Material collected by the writers, 1895-1896.

Whenever possible, the location is noted by counties, and the time of collection by months. That from Lee county, which naturally includes the greater part of the list, was collected by the writers jointly from January to July 1896; that collected before that time (October- December 1895,) was collected by L. M. Underwood, and that since July 1896, by F. S. Earle.

6. Material collected by G. W. Carver, of the Tuskegee Normal and Industrial Institute, in Macon County.

Much of the material collected by Professor Atkinson has been again collected by the writers in the vicinity of Auburn, Lee county, but no mention of this appears in the list, the original collector alone being indicated for each county. The herbarium of the Polytechnic Institute therefore contains, in addition to general material, considerably more Alabama material than the present list would indicate, especially in parasitic forms. The recent collections outside of Lee county, unless otherwise noted, were made by L. M. Underwood, except those collected in Mobile county, 1896, which were collected by F. S. Earle. Specimens of the material collected by the writers, if in quantity sufficient for division, were also deposited in their private collections. It is the intention of the list to include no species that cannot be verified by subsequent examina-

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* Besides this material, Professor Atkinson left a record containing collector's numbers of quite a number of fungi collected in Alabama; some of these give localities, a few give names, many neither; also a host index of Alabama parasitic species; although these contain references to some species not mentioned in the following list, no use has been made of these notes, since we have had access to no specimens to represent them.

tion. The material, therefore, reported in the manuscript list of Judge Peters, unless represented in some of his collections above noted, has been omitted from the text.

The classification followed is a slight modification of that proposed by Schroeter, * with the adaptation of ordinal and family names to a uniform system. The genera and species are arranged alphabetically, under each family or order, as the simplest method of citation, and with a few exceptions follow Saccardo's limitations. In the case of parasitic species, reference is made to all the hosts on which the species has been collected in the state. For the use of those who will continue to study the fungi of the state, a generic index and a host index are added as a matter of convenience. In the citation of hosts the reformed nomenclature is used with generic citation of such synonymy as appears necessary to render the reference clear.

The list, of course, makes no pretense at completeness, for it represents only a beginning, mostly confined to two or three counties of the state. Probably three times the number of fungi it mentions will ultimately be found in the state. It has been found by experience that when attention is called to any certain group of plants and the imperfectly known and limited number from a given area is noted, that a stimulus is thereby given to further search and exploration. It is hoped that the citation of the unknown "B. & C." species, with their limited descriptions, will lead to their rediscovery, and that the list will in other ways stimulate the study of these plants in the state until its flora becomes reasonably well known.

For the benefit of those who are not conversant with the lower plants, it may be desirable to indicate briefly some of the characteristics of the Fungi and to outline, as far as possible by common names, the various groups into which this

* In Engler-Prantl: Die naturalichen Pflanzenfamilien.

series of plants is divided. It will thus serve to interpret to such persons what might otherwise appear to be a mere list of unpronounceable names.

The Fungi, known under various names, like moulds, mildews, toadstools (or in this state frogstools) and mushrooms, are plants that are (1) Of simple structure and organization; (2) Contain no chlorophyl (the green coloring matter of ordinary vegetation) and are therefore unable to live on inorganic matter like other plants, and (3) Reproduce by means of microscopic spores instead of seeds. Since they are unable to live on inorganic food they must draw their nourishment from other living plants or animals and thus act as parasites, or else draw their food supply from decaying organic matter. Of the former type a considerable number are directly injurious to cultivated plants and play an important part in agriculture. These have already served as the subject of a general bulletin from this station (No. 69) and several special bulletins (Nos. 26, 36, 41, 50 and 55). Much yet remains to be done in the direction of learning the life histories of these parasitic species and determining the best means of checking their ravages; in fact, we have only made a beginning in this direction. Some of the species living on decaying organic matter form valuable articles of food, and attention has been called to a few of these in a preliminary bulletin from this station (No. 73). Many species are not at present known to have any economic character. It is, however, desirable to know them all, and we therefore present a classified arrangement that will serve as a sort of synopsis of the list that follows.

Fungi are variously classified by different botanists but it is convenient here to separate them primarily into five classes, two of which are often not regarded as true fungi, but nevertheless share with them many of their characters. These classes are again divided into orders and these again into families. These various groups with such common names as have been applied to them may be arranged as follows:

I. Class Schizomycetes.—Includes the bacteria, many of which are exceedingly useful to man; many produce disastrous diseases of men and animals; some are of considerable economic importance to horticulturists in our state, viz: the *Bacillus amylovorous* producing pear blight; and *Bacillus solanacearum* causing blight of tomatoes and blight and rotting of potatoes. The bacteria are not usually regarded as true fungi; at least they have no place in a flora.

II. Class Myxomycetes (slime moulds).—Represented with us by two orders, one of which (*Plasmodiophorales*) contains root parasites, some of which attack cultivated plants. The other order (*Myxogastrales*) contains a series of organisms that are among the most remarkable in existence. They grow on rotten wood, possess no economic importance, and on account of their characters while in the growing condition, are, by some botanists, regarded as animals. The zoologists, however, do not claim them and they are here retained. In their later or spore-bearing stages some of them bear considerable superficial resemblance to the puff-balls and were, indeed, classified with them by the early mycologists. As a matter of fact, no two groups could be more different from each other, and they here appear at opposite ends of the list.

Class III. Phycomycetes.—(The lower or algal fungi).

Order *Chytridiales.* (Simple parasites, a few affecting higher plants.)

Order *Mucorales.* (Moulds, including ordinary well known forms, the common green mould excepted.)

Order *Entomophthorales.* (Insect parasites; mostly beneficial.)

Order *Saprolegniales.* (Aquatic moulds, sometimes parastitic on fish. (This group, often of economic importances in fish hatcheries, has not been studied in the state.)

Order *Peronosporales.* (White rusts and downy mildews; an important parasitic group.)

Class IV. Ascomycetes. (The spore-sac fungi.)

Order *Gymnoascales.* (Leaf-curl and "plum-pockets;" an important economic group.)

Order *Perisporiales.* (Powdery mildews; some are of considerable economic importance.)

Order *Hypocreales.* (A few like the ergot of grain are economic; the majority are saprophytic.)

Order *Sphaeriales.*
Order *Dothideales.* (The black fungi. A very few like the "black knot" of the plum are parasitic; the greater number are saprophytes.)

Order *Hysteriales.* (Of little economic importance.)

Order *Phacidiales.* (Mainly leaf parasites, a few of economic importance.)

Order *Pezizales.* (Cup fungi; mostly fleshy.)

Order *Helvellales.* (Fleshy fungi; a few edible.)

(As so-called inperfect forms (*Fungi imperfecti*) we have three orders that in the list are placed between this class and the preceeding; some of them are stages of ascomycetous fungi; others probably are not related to ascomycetous forms, and are probably complete in themselves; many members of these three orders are parasitic and of economic importance.)

Class V. Basidiomycetes.

Order *Ustilaginales.* (Smuts; parasitic on corn, cereals and grasses.)

Order *Uredinales.* (Rusts; parasitic on various plants; a highly economic group.)

Order *Tremellales.* (Jelly-like fungi.)

Order *Hymeniales.* (Mushrooms, toadstools, woody or bracket-fungi; many fleshy forms are edible)

Order *Gastrales.* (Puff-balls; many species edible.)

As far as it is possible to arrange the diverse forms in a lineal series these groups are arranged in the order of complexity of structure, the simplest forms coming first; no lineal arrangement, however, can satisfactorily express affinities.

CLASS MYXOMYCETES.

ORDER PLASMODIOPHORALES.

Frankia Alni (Wor.) Atk.

On roots of Alnus sp. Lee, 7, 1896.

Frankia Ceanothi Atk.

On roots of Ceanothus Americanus, Lee, 5, 7, 1895.

Described by Professor Atkinson in Bull. Torr. Bot. Club, 19 : 171-177, *pl. 128, f. 2-4.* 1892, from Alabama material, but the description is not sufficiently compact to be readily quoted.

ORDER MYXOGASTRALES.

Arcyria ferruginea Sauter.

Lee, 2, 1896.

Arcyria punicea Pers.

Lee, 12, 1895 ; 2, 1896.

Badhamia decipiens (Curt.) Berk. *

"Alabama (Peters)."

Described from Alabama specimens under the name of *Physarum chrysotrichum* B. & C. from Alabama, in Grevillea, 2 : 66 as follows :

"Sessile, subglobosum, peridio floccisque fulvis."

"Sessile, globose; somewhat depressed; tawny; the upper part soon breaking off; flocci springing from the base, tawny like the peridium."

Calonema aureum Morg.

Lee, 12, 1895.

Ceratiomyxa mucida (Pers.) Schroet. (*Ceratium hydnoides.*)

"Alabama (Peters, Beaumont)"; Lee, 4, 1896.

Clathroptychium rugulosum (Wallr.) Rost.

On Quercus 1873. (Peters). Peters coll.

Comatricha Friesiana (DeBy.) Rost. *

"Alabama (Peters)."

Comatricha typhina (Roth.) Rost. (*Stemonitis typhoides* Bull.)

Alabama (Peters). Peters coll.

Cribraria argillacea Pers. *

"Alabama (Beaumont)." Described in Grevillea, 2: 68, as *Licea spermoides* B. & C. from Alabama material.

Dictydium cernuum (Pers.) Nees.

Alabama (Peters). In the Peters coll. as *D.umbilicatum.*

Didymium clavus (A. & S.) Rost.

Alabama, 8, 1855 (Peters). Peters' coll.

Enteridion olivaceum Ehrh.

Alabama (Peters). Peters' coll., No. 125a, under the name of *Licea applanata.*

Fuligo septica (Link.) Gmel.

Alabama (Peters). Peters' coll., No. 107; Lee, 4, 1896.

Hemiarcyria clavata (Pers.) Rost.

On Pinus. Alabama (Peters). Peters' coll.

Hemiarcyria funalis Morg.

Lee, 12, 1895.

Hemiarcyria rubiformis (Pers.) Rost.

Lee, 11, 1895; 2, 1896.

Hemiarcyria serpula (Scop.) Rost.

Alabama (Peters). Peters' coll., No. 105; Lee, 12, 1895.

Lycogala epidendron (L.) Buxb.

Lee, 2, 3, 1896.

Perichaena corticalis (Batsch.) Rost. (*P. populina*).

Alabama (Peters). Peters' coll., No. 106.

Physarum cinereum (Batsch.) Pers.

Lee, 3, 1896.

Physarum flavicomum B. & Br. (*P. cupripes* B. & C.)

Alabama, 1855 (Peters). Peters' coll.

Physarum Petersii B. & C.

Alabama (Peters). Peters' coll., No. 104. In poor condition. Described in Grevillea, 2: 66, from Alabama specimens as follows: "Stipi aequali lateritio, peridio globoso luteo; floccis sub-flavis; sporis atris."

"Stem equal, brick-red; head globose, delicate yellow when free from the dark spores; flocci yellowish."

Physarum pulchripes Pk.

Lee, 3, 1896.

Reticularia atra (A. & S.) Fr.
Lee, 3, 1896.
Spumaria alba (Bull.) D. C. (*Didymium spumarioides* Fr.)
Alabama, 1865. (Peters). Peters' coll.
Stemonitis fusca Roth.
Lee, 2, 1896.
Stemonitis microspora Lister.
Lee, 2, 3, 1896.
Stemonitis tenerrima B. & C.
Lee, 11, 1895.
Trichia affinis DeBary.
Lee, 2, 1896.
Trichia chrysosperma (Bull.) D. C.
Lee, 11, 12, 1895.
Trichia varia Pers.
Lee, 12, 1895.
Tubulina cylindrica (Bull.) D. C.
Lee, 3, 1896.

CLASS PHYCOMYCETES.

ORDER CHYTRIDIALES.

Synchytrium decipiens Farlow.
On Falcata comosa (Amphicarpaea), DeKalb, 5, 1896.
Synchytrium fulgens Schroet.
On Œnothera laciniata (Œ sinuata), Lee, 4, 1896.
Synchytrium puriannulatum (B. & C.) Farlow.
On Sanicula sp. (Peters).
Described as *Uromyces pluriannulata* in Grevillea, 3: 57, as follows:

"Maculis nullis; soris cuticula arcte inclusis; sporis magnis nucleatis, globosis, episporio concentrice membranaceo."

"Spots none, sori closely imprisoned in the cuticle; spores globose, .0024 in diameter, the epispore consisting of many concentric membranes; outer membrane splitting off."

ORDER MUCORALES.*

Mucor Beaumontii B. & C.
On Brassica oleracea (Beaumont).
Described in Grevillea, 3:148, as follows :
"Floccis curtis hyalinis; sporis oblongis vel ellipticis obtusissimus atropurpureis."
"Flocci short, hyaline ; spores elliptic or oblong, very obtuse, .008 long, about half as wide, dark purple."
Sporodinia Aspergillus (Scop.) Schroet.
On decaying Boletus sp., Lee, 7, 10, 1896.
The zygosporous stage of this fungus has been called *Syzygites megalocarpus* Ehr.

ORDER ENTOMOPHTHORALES.

Empusa Muscae (Fr.) Cohn.
On dead flies, Lee, 5, 1896.

ORDER PERONOSPORALES.

Albugo Amaranthi (Schw.) O. Kuntze.
On Amaranthus sp. Hale, 5, 1896; Lee, 7, 1896.
Albugo candidus (Pers.) O. Kuntze.
On Arabis Virginica (Cardamine Ludoviciana), Lee, 4, 1896.
On Lepidium Virginicum, Lee, 3, 1890 (R. S. Edwards).
On Senebiera sp. Lee, 5, 1896.
Albugo Ipomoeæ-panduranae (Schw.) Swingle.
On Ipomoea Batatas, Lee, 7, 1890 (Atkinson).
On Ipomoea pandurata, Lee, 7, 1896.
On Ipomoea purpurea, Lee, 6, 1890 (Atkinson).
On Ipomoea tamnifolia, Lee, 7, 1896.
Albugo Portulacae (D. C.) O. Kuntze.
On Portulaca oleracea, Lee, 7, 1890, (Atkinson).
Albugo Tragopogonis (Pers.) S. F. Gray.

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*A number of the common moulds belonging here have been noted from time to time, but no attempt has been made to include them in the list.

On Ambrosia artemisiæfolia, "Pike Roads," 6, 1891, (Atkinson).

On Tragopogon porrifolius, Lee, 5, 1890, (Atkinson).

Peronospora Arthuri, Farlow.

On Enothera laciniata, Lee (Œ sinuata) (Atkinson).

Peronospora Lamii (Al. Braun) DeBary.

On Lamium amplexicaule, Lee, 1, 1890 (R. S. Edwards).

Peronospora parasitica (Pers.) Fr.

On Brassica oleracea (young plants from seed-bed), Mobile, 3, 1896 (Reese).

On Lepidium Virginicum, Lee (Atkinson).

Peronospora Seymourii Burrill.

On Houstonia patens, Lee, 3, 1896.

Peronospora plantaginis Underw.

On Plantago aristata, Lee, 5, 1896. Described from Alabama material in Bull. Torr., Bot. Club, 24 : 83, as follows :

"Mycelium parasitic in well-defined yellow areas of the leaf, occupying the entire width and a length of 1–3 cm.; conidiophores usually solitary, long exserted, irregularly 5-6 times dichotomous; ultimate ramulae short, unequal, recurved, 4–12 μ long; conidia narrowly oval or lemon-shaped, pointed at each end, dark, almost black by reflected light, brownish violet by transmitted light, 40–44x16–18 μ. Oospore unknown.

On leaves of *Plantago aristata,* Auburn, Alabama, May, 1896. F. S. Earle."

Peronospora Violae DeBary.

On Viola tenella, Lee, 2, 1890 (Atkinson).

Plasmopara Geranii (Peck) Berl. & DeTon.

On Geranium Carolinianum, Lee, 3, 1896.

Plasmopara Halstedii (Farl.) Berl. & DeTon.

On Bidens frondosa, Lee, 8, 1890 (Atkinson).

On Gnaphalium purpureum, Lee, 6, 1890 (Atkinson in Economic Fungi, 314).

Plasmopara obducens Schroet.

On Impatiens aurea (I. pallida) Lee, 4, 1896.

Plasmopara viticola (B. & C.) Berl. & DeTon.

On Parthenocissus quinquefolius (Ampelopsis), Dallas, 5, 1896.

On Vitis sp. (various cultivated varieties), Lee (Atkinson).

On Vitis rotundifolia, Lee, 10, 1890 (Atkinson).

(FUNGI IMPERFECTI.)

ORDER HYPHALES.

FAMILY MUCEDINACEÆ.

Botrytis curta (B. & C.) Sacc. *

On Magnolia sp. (Beaumont).

Described under *Polyactis curta*, in Grevillea, 3:110, as follows:

"Minuta curta e maculis orbicularibus brunneis oriunda; floccis simplicibus vel apice lobatis; sporis subglobosis."

"Growing on orbicular brown spots; stems very short, with from one to two septa, simple or slightly divided at apex; spores subglobose, .0008 in diameter."

Cercosporella persica Sacc.

On Amygdalus persica, Lee, 9, 1890 (Atkinson); Macon, 8, 1896 (Carver).

Chromosporium fulvum (B. & C.) Sacc.*

On Peziza psammophila (Peters).

Described in Jour. Linn. Soc., 10:355, in part from Alabama material, under *Gymnosporium*, as follows:

"Effusum, tenue, sporis obovatis peroxydatis stratum pallidius membranaceum insidentibus (494)."

"On dead twigs. Hab. Alabama, No. 5,224. On Peziza psammophila B. & C., Car. Inf. on dead wood. Resembles Oidium fulvum. Spores .001 inch long, shortly pedicellate."

Microstroma Juglandis (Bereng.) Sacc.

On Hicoria alba, Lee. 4, 1890 (Atkinson in Economic Fungi, 162).

On Hicoria glabra, Lee, 4, 1896.

Monilia fructigena Pers.

On Amygdalus persica, Lee, 7, 1892 (Richards).

Monilia megalosporum (B. & C.) Sacc.

Described in Jour. Linn. Soc., 10:363, in part from Alabama material, under *Oidium*, as follows:

"Soris pulvinatis melleis, articulis ellipticis subglobosisque maximus lævibus (431)."

"On dead bark. Hab. Alabama, No. 6,094. Spores with three distinct membranes, the intermediate ones with short cylindrical connecting processes .002-.0028 inch long. Habit like that of Bactridium. The Alabama specimens are on some Polyporus."

Ovularia obliqua (Cooke) Oud.

On Rumex sp., Lee, 7, 1891 (Duggar).

Piricularia grisea (Cooke) Sacc.

On Panicum sanguinale, Lee, 7, 1891 (Newman).

On Panicum sp., Lee, 7, 1891 (Atkinson).

On Paspalum undulatum, Lee, 8, 1891 (Atkinson).

On Paspalum sp., Lee, 7, 1891 (Newman).

On Chaeticloa Italica (Setaria Germanica), Lee, 8, 1890 (Atkinson in Economic Fungi, 61).

Ramularia areola Atks.

On Gossypium herbaceum, Lee, 9, 1890 (Atkinson in Economic Fungi, 407); Macon, 8, 1896 (Carver).

Described in Bot. Gazette, 15:168, as follows: "Spots hypophyllous, rarely amphigenous, pale at first, becoming darker, 1-10mm. (mostly 3-4mm.), angular, irregular in shape, limited by the veins of the leaf, conidia in profusion giving a frosted appearance to the spots. Hyphæ hypophyllous, rarely amphigenous, fasciculate in small clusters over the spots, subnodose, older ones frequently branched below, more rarely above where they are toothed, teeth frequently unilateral when the hyphæ are curved instead of zigzag, several times septate, stouter below, hyaline, 25-75 x $4\frac{1}{2}$-7 μ. Conidia oblong, usually abruptly pointed at the ends, sometimes rounded, 1-3 septate, concatenate in the early developement of the hyphæ, hyaline, 14-30 x 4-5 μ."

Ramularia Liriodendri E. & E.
On Liriodendron, Lee, 10, 1895.
Ramularia macrospora Asteris Trelease.
On Aster sp., Lee, 5, 1896.
Ramularia Virgaureæ Thuem.
On Solidago sp., Lee, 7, 1891 (Duggar).
Rhinotrichum bellum B. & C. *
On dead wood (Beaumont).
Described in Grevillea, 3:108, as follows: "Vivide aurantiacum; effusum; sporis oblongo-ellipticis."
"Bright orange, forming a thin stratum; spores oblong, elliptic, .0006 long."
Rhinotrichum macrosporum Farlow.
On Gossypium herbaceum, Lee, 1891 (Atkinson).
Rhinotrichum tenellum B. & C.
On Gossypium herbaceum, Lee, 1890 (Atkinson).
Sepedonium Americanum B. & C.
On rotten wood, Peters Coll., 1:123.
This is probably only an herbarium name, as it does not appear in Notices of North American Fungi in Grevillea, and cannot be traced in Sacc. Syll. Fung. The specimen consists of a mass of sulphur-yellow spores on very rotten wood. No hyphæ are observable. The spores are light yellow, orbicular, roughened, 8-10 μ.
Sepedonium subochraceum B. & C.
On rotten wood (Peters); Lee, 7, 1896.
Described in Grevillea, 3:147, as follows: "Effusum alutaceum; sporis globosis granulatis.
"Forming a continuous tan-colored stratum; spores globose, studded with little papillæ, .0004 in diameter."
Trichothecium roseum (Pers) Link.
On Ficus carica, Lee, 10, 1891 (Atkinson).
On Amygdalus persica, Lee, 11, 1890 (Atkinson).

Family Dematiaceæ.

Cercospora Acalyphae Peck.

On Acalypha Ostryaefolia (A Caroliniana,) Lee, 8, 1891, (Newman).

Cercospora Agrostidis Atks.*

On Agrostis sp. Lee, 7, 1891, (Duggar & Newman.

Described in Jour. Elisha Mitchell Sci. Soc. 8: (Separate: 12) as follows:

"Spots amphigenous, broadly elliptical, very light brown center with broad border of dull red brown, 3-5mm. long. Hyphae amphigenous, loosely fasciculate, tufts irregularly scattered and few in a spot, bright reddish brown, septate, nearly straight to subflexuous and sparingly toothed near apex, 40-65x31-24. Conidia hyaline, 1-7-septate, terete, straight or little curved, 10-60x2½."

Cercospora Alabamensis Atks.

On Ipomoea purpurea, Lee, 8, 1891, (Newman), Macon, 8, 1896, (Carver).

Described from Alabama specimens (l. c. 19) as follows:

"Spots amphigenous, dirty white definitely limited by dark purple or black with raised margin, 2-3mm. Hyphae amphigenous, loosely fasciculate, fascicles numerous, faintly septate, dilutely reddish brown, nearly straight, denticulate, or abruptly shouldered and promptly scarred at the angles, 50-100x4½. Conidia long, slender, straight or curved, hyaline, closely multiseptate, terete, 70-250x3-4."

Cercospora althaeina Sacc.*

On Althaea rosea, Perry, 7, 1890, (Atkinson, l. c. 28).

Cercospora althaeina Modiolae Atks.*

On Modiola multifida, Lee, 1890, (Atkinson).

Described (l. c. 28) as follows: "Spots same [as in type] but little smaller, with narrow raised margin. Hyphae amphigenous, fasciculate, fuscidulous, continuous, cylindrical, 30-70x4½. Conidia hyaline, slender and tapering to the very narrow apical portion, multiseptate, 50-100x3-4."

Cercospora anthelmintica Atks.

On Chenopodium anthelminticum, Lee, 8, 1891, (Duggar).

Described (l. c. 16) as follows: "Spots small, amphigenous, 1-3mm., white with narrow raised margin surrounded by a dark border. Hyphae epiphyllous, fasciculate, spreading, subflexuous, subnodose and profusely toothed, septate, fuliginous with faint reddish tinge, 30-100 x4½. Conidia hyaline, terete 4-10 septate, 25-100x4-4½."

Cercospora asterata Atks.*

On Aster sp. Lee, 11, 1891, (Atkinson).

Described (l. c. 18) as follows: "Spots amphigenous, about 6mm. in diameter, generally in edge of leaf, dirty grey bordered by black, exterior to this effused with reddish purple. Hyphae amphigenous, fasciculate, dull reddish brown, subhyaline at the tips, septate, geniculate, subflexuous, torulose to denticulate, minutely guttate, 70-120x4-5. Conidia hyaline, nearly cylindrical, tapering gradually to each end, septate, 30-50x3."

Cercospora atromaculans E & E.

On Cassia occidentalis, Lee, 10, 1895.

On Cassia Tora, Lee, 9, 1891, (Atkinson).

***Cercospora atramarginalis** Atks.

On Solanum nigrum (?), Lee, 1890, (Atkinson).

Described (l. c. 27) as follows: "Spots amphigenous, orbicular, 4-6mm., light brown or dirty grey with black border above. Hyphae hyphophyllous, fasciculate from stroma, short, flexuous or denticulate, continuous, faintly fuliginous, 10-30x4-4½. Conidia obclavate or cylindrical, 1-10 septate, guttulate, yellowish, 10-70x4-5."

Cercospora avicularis Wint.

On Polygonum punctatum (P acre) (?), Lee, 8, 1891, (Atkinson).

Cercospora avicularis sagittati Atks.

On Polygonum sagittatum, Lee, 10, 1891, (Duggar).

Described (l. c. 16) as follows; "Spots amphigenous, light brown with narrow elevated margin frequently bordered by reddish brown, 2-3mm. Hyphae olive brown, frequently with reddish tinge, fasciculate, septate, sometimes subgeniculate to denticulate, 70-170x4. Conidia faintly colored, septate, 100-300x3-5."

Cercospora beticola Sacc.*

On Beta vulgaris (Sugar beet), Lee, 11, 1890, (Atkinson 1, c. 14).

Cercospora Bolleanea (Thuem.) Speg.

On Ficus carica, Lee, 11, 1895 ; 10, 1896.

Cercospora Boehmeriae Peck.

On Boehmeria cylindrica, Lee, 11, 1891, (Atkinson).

Cercospora canescens E. & M.

On Phaseolus vulgaris, Lee, 7, 1891, (Newman).

Cercospora catenospora Atks.

On Sambucus Canadensis, Lee, 8, 10, 1891, (Atkinson).

Described (1. c. 34) as follows: "Diffused in irregular patches or over large surface of under side of leaves, giving dirty green color. Hyphæ fasciculate from stomata of leaf, divergent, 20-30 up to 75x5-6, septate, nearly cylindrical, often toothed, bearing conidia laterally as well as at the apex, olive yellowish, rarely darker and inclined to faint reddish tinge. Conidia lateral and acrogenous, concatenate or single, cylindrical when concatenate and then abruptly tapering each way to small truncate end, terete when single, more rarely somewhat clavate, dilutely olive yellowish, often guttulate, 1-6 septate, 20-100x4-5."

Cercospora Cephalanthi E. & K.*

On Cephalanthus occidentalis, (Atkinson, l. c. 35).

Cercospora ceracella Sacc.

On Prunus avium, Lee, 7, 1891 (Newman).

Cercospora cercidicola Ell.

On Cercis Canadensis, Hale, 5, 1896, Lee, 8, 1892, (Newman & Duggar).

Cercospora citrulina Cke.*

On Citrullus vulgaris (watermelon), 9, 1890, (Atkinson, l. c. 13).

Cercospora Clitoriæ Atks.*

On Clitoria mariana, Lee, 8, 1891, (Atkinson).

Described (l. c. 30) as follows: "Spots angular, rather large, 3-6mm., black or nearly black above, brown below.

Hyphae epiphyllous, fuliginous, short, projecting but little above the tuberculate stroma, 5-10 long. Conidia long, slender, terete, faintly colored, straight or curved, several times septate, 50-70x3."

Cercospora consociata Wint.

On Ruellia ciliosa, Lee, 7, 1896.

Cercospora crinospora Atks.*

On Rhyncospora glomerata, Lee, 8, 1891, (Atkinson).

Described (l. c. 26) as follows: "Hyphae fasciculate, 3-6 in a tuft, undulate, sparingly toothed and nearly hyaline at apex, dark brown for nearly the entire length. Conidia very slender, straight, terete, hyaline, 4-6 septate, 20-60x1½-2."

Cercospora cruenta Sacc. (*C. Dolichi E. & E.*)

On Dolichos sinensis, Lee, 7, 1891, (Duggar), Macon, 10, 1896, (Carver), Perry, 7, 1881, (Atkinson).

Cercospora Cucurbitae E. & E.

On Cucurbita sp. (dish-rag squash), Lee, 1890, (Atkinson).

On Lagenaria vulgaris, Lee, 9, 1891, (Duggar).

Cercospora Davisii E. & E.

On Melilotus alba, Macon, 8, 1896, (Carver); Perry, 7, 1890, (Atkinson, l. c. 28).

Cercospora depazeoides (Desm.) Sacc.

On Sambucus Canadensis, Lee, 9, 1890, (Atkinson).

Cercospora Desmodii E. & K.*

On Meibomia mollis, (Desmodium), Lee, 1890, (Atkinson l. c. 21).

On Meibomia sp., Perry, 7, 1890, (Atkinson l. c. 21).

Cercospora Diodiæ Cke.

On Diodia teres, Lee, 7, 1891, (Newman & Duggar).

Cercospora Diodiæ-virginianæ Atks.

On Diodia Virginiana, Lee, 9, 1891, (Duggar).

Described (l. c. 26) as follows: "Spots amphigenous, brown or dirty white with a broad, ill-defined purple border above, 2-5mm. Hyphae amphigenous, fasciculate, tufts numerous, fuliginous, nearly straight, denticulate, 40-250x4-5. Conidia hyaline, stout at base, tapering to a long, slender apical portion, multiseptate, 80-350x4."

Cercospora Diospyri Thuem.

On Diospyros Virginiana, Lee, 9, 1891, (Duggar).

The variety C. Diospyri ferruginosa Atks. seems to be only the fully matured form of the fungus. See Miss. Agr. Exp. Sta. Bull. 38 : 151.

Cercospora effusa (B. & C.) Ell.

On Lobelia amoena, Lee, 10, 11, 1891, (Atkinson).

Cercospora Elephantopodis E. & E.

On Elephantopus tomentosus, Lee, 6, 1890, (Atkinson l. c. 23).

On Elephantopus sp. Lee, 10, 1896.

Cercospora Erechtitis Atks.*

On Erechtites hieracifolia, Lee, 11, 1891, (Duggar).

Described (l. c. 34) as follows: "On dead parts of the leaf. Hyphae epiphyllous, fasciculate, reddish brown, geniculate or scarred, in which case hyphae are cylindrical, frequently guttute, 50-240x4. Conidia hyaline, septate and guttulate, 70-230x3-4."

Cercospora erythrogena Atks.

On Rhexia mariana, Lee, 7, 1890, (Atkinson).

On Rhexia Virginica, Lee, 10, 1890, (Atkinson).

Described (l. c. 33) as follows: "Hypophyllous, spots indefinite, usually reddening the leaf above, giving dirty appearance to large part of under surface of leaves. Hyphae scattered, frequently creeping, often branched, septate, dull reddish brown, flexuous, denticulate, 50-70x4-5. Conidia slender, usually curved, longer ones terete, faintly olive brown, multiseptate and usually guttulate, 30-100x3½-4."

Cercospora flagellaris E. & M.

On Phytolacca decandra, Lee, 7, 1891, (Newman & Duggar).

Cercospora flagellifera Atks.

On Galactia pilosa, Lee, 9, 1891, (Atkinson).

Described (l. c. 19) as follows: "Spots amphigenous, suborbicular to angular, 3-4mm. or large and indefinitely limited (this may be due to the presence of other fungus), dark brown above, lighter below. Hyphae amphigenous, rather compactly fasciculate or spreading, reddish brown, prominently scarred and flexuous and denticulate toward tips, or cylindrical, 40-150x4-5. Conidia hyaline, very long and slender, multiseptate, 70-250x2½-3 at base."

Cercospora fuscovirens Sacc.

On Passiflora incarnata, Lee, 10, 1891, (Duggar).

Cercospora fusimaculans Atks,

On Panicum dichotomum, Lee, 8, 1891, (Duggar).

Described (l. c. 18) as follows: "Spots amphigenous, light brown bordered by dark brown, broadly fusoid or elliptical, 3-4mm. long, frequently confluent. Hyphae epiphyllous, fasciculate, olive reddish brown, straight, subgeniculate or nodulose, sparingly denticulate toward apex, septate, 50-100x4-4½. Conidia small, hyaline, 3-4 septate, tapering little toward each end, 25-40x2."

Cercospora Galii E. & Hol.*

On Galium pilosum punctulosum, Lee, 7, 1890, (Atkinson l. c. 21).

Cercospora gossypina Cke.

On Gossypium herbaceum, Lee, 10, 1890, (Atkinson).

Cercospora Hydrangeae E. & E.*

On Hydrangea sp. (cult.), Lee, 1890, (Atkinson).

Herbarium name given by Ellis to Alabama specimens. Described by Atkinson (l. c. 20) as follows: " Spots large, angular, limited by veins, blackish above, frequently becoming whitish in center, light brown below. Hyphae amphigenous, fasciculate from tuberculate base, olive brown with dull reddish tinge in age, subgeniculate and denticulate, 40-70x[illegible]-4½. Conidia hyaline, long, slender, terete, curved, multiseptate, 70-150x3-4."

Cercospora Hydrocotyles E. & E.

On Hydrocotyle umbellata, Lee, 8, 1891, (Duggar).

Cercospora Jatrophae Atks.*

On Jatropha stimulosa, Lee, 7, 1890, (Atkinson).

Described (l. c. 32) as follows: "Spots indefinite, at first yellowish above and dirty yellow below from hyphae first developing below; when badly attacked and old, hyphae are amphigenous and then the spots dirty grey with indefinite yellow border. Hyphae fasciculate from yellowish brown stroma, dilutely yellowish brown, short, subflexuous, 10–20x3. Conidia long and slender, hyaline or subhyaline, 5–12 septate, tapering little to distal end, 50-100x1½–2."

Cercospora Jussiaeae Atks.

On Jussiaea decurrens, Lee, 9, 1891, (Atkinson).

On Jussiaea leptocarpa, Lee, 9, 1891, (Duggar).

Described (l. c. 18) as follows: "Epiphyllous, small white spots surrounded by indefinite reddish purple border. Hyphae fasciculate, reddish, septate, geniculate and denticulate toward the apex, 40–120x4–4½. Conidia hyaline, obclavate, 3-10 septate, 100-150x4."

Cercospora leucosticta E. & E.

On Melia Azederach, Lee, 11, 1895.

Cercospora Liquidambaris C. & E.

On Liquidambar styraciflua, Lee, 10, 1891, (Atkinson); Macon, 10, 1896; (Carver).

Cercospora Liriodendri E. & Hark.

On Liriodendron tulipifera, Lee, 7, 1891, (Newman).

Cercospora Lobeliae K. & S.

On Lobelia sp. Lee, 10, 1891, (Atkinson).

Cercospora Ludwigiae Atks.

On Ludwigia alternifolia, Lee, 9, 1891, (Atkinson).

Described (l. c. 26) as follows: "Spots amphigenous, subcircular, irregular, reddish brown or purple, sometimes with white in center, 1-3 mm. Hyphae epiphyllous, densely fasciculate from tuberculate base, short, olive brown or faintly fuliginous, straight or flexuous, 20-30x4-5. Conidia slender, terete, straight or curved, sometimes guttulate, 3-10 septate, faintly colored, 25-100x2½-3."

Cercospora macroguttata Atks.

On Chrysopsis graminifolia, Lee, 8, 1891, (Atkinson).

Described (l. c. 32) as follows: "Hypophyllous forming small oval or larger narrowly oblong patches, olive brown in color, from the profusion of the development of the fungus. Hyphae long, flexuous, geniculate, sparingly toothed near apex, multiseptate and multiguttulate with large guttulae, dark brown in age with olive tinge, growing tips and young ones decided olive green tinge, 100-250x5-6. Conidia nearly cylindrical, very narrowly terete-fusoid, dilutely olive green, 3-8 septate, 10-80x4½-5."

Cercospora Mali E. & E.*

On Pirus malus, Lee, 9, 1890, (Atkinson, l. c. 23.)

Cercospora moricola Cke.*

On Morus sp. Lee, (Atkinson. l. c. 11.)

Cercospora Nymphaeae E. & E.

On Castalia odorata (Nymphaea), Lee, 9, 1891, (Duggar).

Cercospora occidentalis Cke.

On Cassia occidentalis, Lee, 9, 1891, (Duggar); Macon, 10, 1896, (Carver).

Cercospora omphakodes E. & Hol.*

On Phlox Floridana, Lee, 6, 1890, (Atkinson, l. c. 10).

Cercospora pachyspora E. & E.

On Peltandra sagittaefolia (P. alba), Lee, 7, 1890, (Atkinson).

Cercospora papillosa Atks.*

On Verbena sp. (cult.), Lee, 12, 1891, (Atkinson).

Described (l. c. 20) as follows: "Spots orbicular or irregular, sometimes in edge of leaf, dirty white, 2-5mm. Hyphae amphigenous, fasciculate, nearly straight, denticulate to papillate, the scars sometimes being on minute protuberances. In some cases I have seen them several in a whorl, reminding one of the appearance of some sexual shoots of some algae of the family Lemaneaceae, fuliginous with very faint brick red tinge, 50-70x4-5. Conidia hyaline, long, rather stout at base, usually tapering rather abruptly into slender, thread-like apical portion, multiseptate, sometimes faintly so, 80-200x4-4½ at base.

Cercospora Penstemonis E. & K.

On Penstemon pubescens, Lee, 4, 1892, (Atkinson).

Cercospora personata (B. & C.) Ell.

On Arachis hypogea, (Beaumont) in Rav. F. Car. Exs. 3:85, (under Cladosporium).

On Arachis hypogea, Lee, 9, 1891, (Atkinson).

Cercospora Petersii (B. & C.) Atks.

On Smilax glauca, Lee, 12, 1891, (Atkinson).

On Smilax laurifolia, Lee, 3, 1896.

In *Helminthosporium Petersii* B. & C. (Grevillea 3:102) Berkley evidently confused two very different fungi, and it may be a question which is entitled to the specific name. Under the description, he cites first specimens on Smilax from So. Car., and, second, specimens on Laurus Benzoin from Ala.; but in naming the species after the collector of the Alabama specimens he seems to imply that he considers that the type of the species. Unfortunately the brief description does not help us to decide the question. As priority on the page favors the other supposition, we concur with Atkinson in writing the name for the form on Smilax as above. A single fragment on a leaf preserved in the Peters Collection (1:142) under this name seems without question to be the well known *Isariopsis Linderae* (E. & E.) Sacc., but unfortunately the hyphae and spores are entirely worn away so that positive identification is impossible.

Cercospora pinnulaecola Atks.

On Cassia nictitans, Lee, 10, 1891, (Duggar).

Described (l. c. 32) as follows: "Diffuse, hypophyllous, giving dirty appearance to under surface of the pinnules, which are usually paled above. Hyphae in loose tufts distributed over the affected area, reddish brown, septate, minutely guttulate, irregularly flexuous, geniculate and profusely denticulate, 100-200x4½. Conidia, obclavate, hyaline, multiseptate and multiguttulate, 50-150x4-5."

Cercospora polygonacea E. & E.

On Polygonum scandens, Lee, 10, 1891, (Duggar).

Cercospora purpurea Cke.

On Persea palustris, Lee, 4, 1896.

Cercospora rhuina C. & E.

On Rhus copallina, Lee, 11, 1895.

On Rhus glabra, Lee, 8, 1891, (Newman & Duggar).

On Rhus toxicodendron, Lee, 6, 1890, (Atks).
On Rhus vernix (R. venenata), Macon, (Atks).

Cercospora richardiæcola Atks.

On Richardia Africana, Lee, 9, 1891, (Atkinson).

Described (l. c. 19) as follows: "Spots amphigenous, black with small white center and concentric lines, suborbicular, 2-6mm. Hyphae epiphyllous, fasciculate, faintly fuliginous when young with reddish tinge, reddish brown with age, usually straight but sometimes geniculate or subflexuous to denticulate toward apex, 10-80x5. Conidia hyaline, obclavate, 4-10 or more septate, 50-100x3-4."

Cercospora rigospora Atks.

On Solanum nigrum, Lee, 7, 1890, (Atkinson).

Described (l. c. 33) as follows: "Spots indefinite or absent, but parts of leaf affected usually obscurely yellowish above. Hyphae hypophyllous, fasciculate, divergent, in sooty patches sometimes very indistinct, or distributed over large areas, fuliginous with olive tinge, subflexuous, denticulate or torulose, longer ones faintly septate and multiguttulate, 50-60x$3\frac{1}{2}$-4. Conidia straight or curved, subcylindrical, abruptly tapering at each end or terete, 3-10-septate, multiguttulate, dilutely olive yellow, 50-70x3-4."

Cercospora Rubi Sacc.

On Rubus cuneifolius, Lee, 8, 1890, (Atkinson).

Cercospora Sagittariae E. & K.*

On Sagittaria latifolia (S. variabilis), 7, 1891, (Duggar & Newman, l. c. 29).

Cercospora Saururi E. & E.*

On Saururus cernuus, Montgomery, 7, 1890, (Atkinson, l. c. 22).

Cercospora seriata Atks.

On Sporobolus asper, Lee, 7, 8, 1891, (Newman & Duggar),

Described (l. c. 27) as follows: "Spots amphigenous. cinereous with definite brown border margined by indefinite yellow, irregularly oblong, sometimes confluent. Hyphae epiphyllous, fasciculate, faint reddish brown, in age darker, flexuous and toothed, 20-50x4, tufts in parallel rows. Conidia hyaline, nearly cylindrical, straight or curved, faintly 2-6 septate, 30-70x3-3½."

Cercospora Setariae Atks.

On Chaetochloa glauca, Lee, 9, 1891, (Duggar).

Described (l. c. 18) as follows: "Spots amphigenous, dark with indefinite pale border, elliptical. Hyphae epiphyllous, dull reddish brown, fasciculate, sometimes very dense, others divergent, sometimes branched from near the base, septate, with a few small guttulae, scars small, giving denticulate appearance near apex, 50-100x4½-5. Conidia hyaline, 1-pluriseptate, cylrindical or obclavate, straight or curved, 20-150x4-5."

Cercospora Silphii E. & E.*

On Silphium compositum, Lee, 6, 1890, (Atkinson, l. c. 28).

Cercospora smilacina Sacc.?

On Smilax sp. Lee, 5, 1896.

There seems to be much confusion as to the forms of Cercospora on Smilax leaves and these specimens are determined as above with considerable doubt.

Cercospora solanicola Atks.*

On Solanum tuberosum, Lee, 6, 1890, (Atkinson).

Described (l. c. 21) as follows: "Spots small, dark border, or indeterminate on dead areas of the leaf. Hyphae fasciculate, olive brown with faint reddish tinge, straight to flexuous or geniculate toward apex, 3-5 septate, 40-120x5. Conidia hyaline, terete, obtuse, 10-30 septate, 100-230x4-5."

Cercospora sordida Sacc.

On Tecoma radicans, Lee, 9, 1891, (Atkinson).

Cercospora Sorghi E. & E.

On Sorghum halapense, Macon, 8, 1896, (Carver).

Cercospora Stylismae Tracy & Earle.

On Breweria humistrata (Stylisma), Lee, 7, 1896.

Cercospora Tephrosiae Atks.

On Cracca hispidula (Tephrosia), Lee, 9, 1891, (Atkinson).

Described (l. c. 12) as follows: "Spots amphigenous, small, angular or suborbicular, 1-2mm., elevated, blackish brown. Hyphae epiphyllous, fasciculate, fascicles crowded, reddish, flexuous or dentate, 50-100x4½-5. Conidia obclavate, subhyaline and tinge of same color as hyphae, 5-8-septate, usually straight, 70-130x4-4½."

Cercospora tessellata Atks.*

On Eleusine Aegyptiaca, Lee, 11, 1891, (Atkinson).

Described (l. c. 27) as follows: "Spots indefinite above, usually narrowly oblong, nearly black below with bluish tinge caused by numerous black tufts and bluish cast of tissue affected. Hyphae hypophyllous, densely fasciculate, fuliginous, short, 10-12x2½-3, denticulate, tufts in longitudinal and usually transverse rows, giving a checkered appearance to the group. Conidia slender, hyaline, terete, curved, septate, 50-90x2-2½."

Cercospora Thaspii E. & E.

On Angelica villosa (A. hirsuta), Lee, 7, 1890, (Atkinson).

Cercospora Tropaeoli Atks.

On Tropaeolum sp. (cult.), Lee, 9, 1891, (Atkinson).

Described (l. c. 27) as follows: "Spots amphigenous, very light brown with narrow elevated margin above, suborbicular, 2-4mm. Hyphae epiphyllous, few in a cluster, stout, short, faintly fuliginous, 20-40x5, dentate. Conidia hyaline, rather stout at base and quickly tapering into long, slender apical portion, reminding one of *C. flagellaris*, multiseptate, 50-100x3½-4½ at base."

Cercospora truncatella Atks.*

On Passiflora incarnata, Lee, 8, 1891, (Atkinson).

Described (l. c. 12) as follows: "Spots amphigenous, suborbicular, whitish with narrow light brown border, 2-4mm. Hyphae amphigenous, fasciculate, reddish brown, septate, geniculate or nearly straight, conidial scars distributed along at geniculations, 70-250x4-5. Conidia hyaline, faintly septate, tapering very gradually from truncated base to obtuse apex, rarely rounded at base, 50-150x3½-4."

Cercospora tuberosa E. & K.

On Apios Apios (A. tuberosa), Macon, 8, 1896, (Carver).

Cercospora Vernoniae E. & K. (?)

On Vernonia noveboracensis, Lee, 8, 1891, (Atkinson).

Cercospora Violae Sacc.
On Viola odorata, Lee, 7, 1891, (Atkinson).
On Viola villosa, Lee, 5, 1892, (Duggar).
Cercospora viticola (Ces.) Sacc.
On Vitis sp. (cult), Lee, 1891, (Newman).
Cercospora Zinniae E. & M.
On Zinnia multiflora, Lee, 1890, (Atkinson).
Cladosporium fulvum Cooke.
On Lycopersicum esculentum (tomato), Lee, 10, 1896; Macon, 8, 1896, (Carver).
Cladosporium graminum Corda.
On Chrysopogon nutans, Lee, 9, 1891, (Duggar).
On Avena sativa, Lee, 1, 1891, (Newman).
Cladosporium herbarum (Pers.) Link.
On Ficus carica (mummied fruits still hanging on tree), Lee, 2, 1896.
On Zea mays, Lee, 6, 1891, (Newman).
Cladotrichum scyphophorum Corda. (?)
Peters Coll. 1:124.
This seems to be a good *Cladotrichum*, but the specific determination is very doubtful. There is nothing to indicate who made the determination. The enlarged ends of the hyphal cells at length collapse and become goblet-shaped, but the fungus forms a dark purplish black confluent mass, and the spores are dark fuscous, very obtuse, flattened at the ends, formed concatenately, about 12x8u.
Coniosporium Arundinellae Ell. & Tracy.
On Arundinaria tecta, Lee, 12, 1888, (Newman).
Coniosporium Arundinis (Corda) Sacc.
On Saccharum officinarum, Macon, 8, 1896, (Carver).
Coniosporium gramineum (E. & E.) Sacc.
On Arundinaria tecta, Lee, 1891, (Atkinson).
Fusicladium pirinum pyracanthae Thuem.
On Crataegus pyracantha, Lee, 9, 1891, (Atkinson in Ellis, N. A. F. 2792).
Glenospora Curtisii Berk & Desm.
On Nyssa (living bark), Lee, 1, 2, 1896.

Helicosporium pulvinatum (Nees) Fr.

On rotten wood, Lee, 3, 1896.

Tentatively determined as above by Mr. A. P. Morgan.

Helminthosporium Beaumonti Sacc.* (*H. dubium, B. & C.*)

On Viburnum, (Beaumont).

Described in Grevillea, 3:104, as follows: "Molle; floccis brevibus obtusis basi divaricato-divisis; sporis oblongis, 7-septatis."

"Flocci short, divided in a divaricate manner at the base, obtuse; spores oblong, with about seven septa, .0016 long. There is occasionally a single vertical septum."

Helminthosporium interseminatum B. & Br.

On Sambucus Canadensis, Lee, 11, 1891, (Atkinson).

On Solidago sp. Lee, 9, 1891, (Atkinson).

Helminthosporium Leersiae Atks.

On Homalocenchrus Virginicus (Leersia Virginica), Lee, 9, 1891, (Atkinson).

No description has been found of this species. It may be only an herbarium name.

Helminthosporium macrocarpum Grev.

On dead twigs, 2, 1896.

Helminthosporium macrocarpum caudatum B. & Br.

On dead twigs, Lee, 1, 1896.

Helminthosporium Ravenelii B. & C.

On Sporobolus Indicus, Lee, 6, 1890, (Atkinson); Macon, 10, 1896, (Carver).

Helminthosporium turcicum Pass.

On Sorghum halapense, Lee, 7, 1890, (Atkinson).

Heterosporium Sambuci Earle.

On Sambucus Canadensis, (dead stems), Lee, 3, 1896.

Described in Bull. Torr. Bot. Clbb, 23:30, as follows: "Effused, covering considerable areas with a black, velvety tomentum; hyphae long, 100-200 μ, dark fuscous, erect, often fascicled, branching, septate, nodular, bearing spores pleurogenously at the enlarged nodes; spores oblong, dark fuscous, 3-septate, surface conspicuously roughened by minute tubercles, about 20-30x5 μ."

Macrosporium antennaeforme B. & C.*

On leaves of Celtis sp. (Peters).

Described in Grevillea, 3:105, as follows: "Floccis brevibus, sporis torulosis elongatis deorsum attenuatis pluriseptatis."

"Threads short, sometimes acute, sometimes dilated at the apex and fertile; spores attenuated below, elongated above, 12-18 septate torulose; occasionally they are shorter, more obtuse, with a few vertical septa. Two spores are sometimes formed at the two angles of the wedge-shaped terminal joint."

Macrosporium Brassicae Berk.

On Brassica oleracea (cabbage), Washington, 7, 1896.

Macrosporium Catalpae E. & M.

On Catalpa Catalpa (C. bignonoides), Macon, 10, 1896, (Carver).

Macrosporium Cheiranthi (Lib.) Fr.

On Rosa sp. (Beaumont), in Grevillea, 3:105.

Macrosporium Cookei Sacc.

On Datura Stramonium, Lee, 8, 1891, (Duggar).

Macrosporium Iridis C. & E.

On Iris sp., Lee, 8, 1891, (Duggar).

Macrosporium leguminum Cooke.

On pods of Dolichos sinensis, Macon, 8, 1896, (Carver).

Macrosporium nigricantium Atks.

On Gossypium herbaceum, Lee, 1891, (Atkinson); Macon, 8, 1896, (Carver).

Described in Bot. Gazette, 16:62, as follows: "The hyphae are amphigenous, subfasciculate or scattered, .050-.140mm. long x .006-.007mm. in diameter, nodulose, septate, olive brown. Conidia .018-.022mm. x .036-.050mm. strongly constricted about the middle, stoutly rostrate at one side of the apex, smooth, transversely, longitudinally and obliquely septate, olive brown. The nodulose hyphae resemble those of such species as M. parasiticum Thuem."

Macrosporium Ravenelii Thuem. (?).

On Meibomia mollis, (Desmodium), Lee, 3, 1896.

Macrosporium stilbosporoideum B. & C.

On leaves of Crataegus sp. (Beaumont).

Described in Grevillea, 3:105, as follows: "Floccis brevissimis, quandoque obsoletis; sporis obvatis fenestratis."

"Mycelium creeping; fertile branches very short or obsolete; spores obovate, with about three transverse and several vertical divisions, resembling those of Stegonospora, Cd., .001-.0013 long, about two-thirds as much broad, with a short pedicel."

Periconia pycnospora Fr.

On Dolichos sinensis, Lee, 12, 1890, (Atkinson).

Polythrincium Trifolii Kunze.

On Trifolium reflexum, Lee, 5, 1896.

Scolecotrichum Euphorbiae Tracy & Earle.

On Euphorbia nutans, Lee, 9, 1896; Macon, 8, 1896, (Carver).

Scolecotrichum Graminis Fckl.

On Arundinaria tecta, Lee, 10, 1891, (Duggar).

Septonema spilomeum Berk.

On Quercus, (Beaumont), Rav. Fung. Car. Exsce. 4:87.

Streptothrix atra B. & C.

On Juniper, (Peters).

On dead wood, Lee, 11, 1895.

Described in part from Alabama specimens in Grevillea, 3:107, as follows: "Floccis parce articulatis sursum ramosis crenulato-flexuosis; sporis globosis vel subellipticis inquinantibus."

"Threads branched above, repeatedly undulated, with short constrictions; spores globose or subelliptic, abundant, falling off as a black powder."

Zygodesmus fuscus Corda.

Peters Coll. 3:67.

Family Stilbaceæ.

Isaria radiata B. & C.*

On pine wood, (Peters). This species is not given by Saccardo.

Described in Grevillea, 3:62, as follows: "Prostrata radians albida receptaculis filiformibus obtusiusculis; sporis globosis."

"Forming little patches on the wood, consisting of radiating, filiform, rather obtuse, whitish receptacles, which become yellowish when dry, simple, except at the base, composed of jointed threads, which towards the base are less closely compacted and without septa; spores globose, .0002 in diameter."

Isariopsis Linderæ (E. & E.) Sacc.

On Benzoin Benzoin, Peters' Coll. 142, under *Helminthosporium Petersii* B. & C. (See note under *Cercospora Petersii* [B. & C.] Atks.)

FAMILY TUBERCULARIACEÆ.

Fusarium Alabamense Sacc.*

On dead bark (Beaumont).

This was described in Grevillea, 3:98, under *F. erubescens B. & C.*, but as this name was preoccupied Saccardo (Syll. Fung. 4:722) renamed it as above.

The original description is as follows: "Punctiforme pallide roseum demum albidum tomentosum; sporis minutissimis."

"Scattered or arranged in lines, pale rose-colored, becoming nearly white, tomentose; spores extremely minute."

Fusarium cinnabarinum (B. & C.) Sacc.

On Acer Negundo, (Peters), Grevillea, 3:146.

On Carpinus Caroliniana, (Peters), Rav. Fung. Car. 3:80.

Originally described under *Fusisporium* as follows: "Effusum, demum crustaceum, cinnabarinum: sporis brevioribus quadrinucleatis."

"Forming a continuous stratum, which in drying cracks up into detached portions: spores short with four nuclei."

Fusarium helotioides B. & C.*

On Ilex decidua (I. prinoides), (Peters).

Described in Grevillea, 3:98, as follows: "Disco convexo carneo quandoque brevissime stipitato; sporis minutissimis."

"Disc convex, flesh colored, occasionally with a very short stem; sometimes two or three burst through the bark together; spores even smaller than in the last." [*F. microspermum.*]

Fusarium marginatum B. & C.*

On stems of Smilax (Beaumont).

Described in Grevillea, 3 : 97, as follows: "Disco carneo, albo-marginato; sporis minutis oblongis."

"Disc flesh-colored, with a narrow white margin; spores oblong, minute."

Fusarium miniatum (B. & C.) Sacc.

On pine wood, (Peters), Grevillea, 3 : 147.

On Vitis rotundifolia, Lee, 3, 1896.

Described under *Fusisporium* in part from Alabama specimens as follows: "Effusum miniatum; sporis brevioribus quadrinucleatis."

"Differs from the last [*F. cinnabarinum*] in its much brighter color; the spores are the same." In our specimens on *Vitis* the spores are uniseptate, constricted at the middle, somewhat curved, about 25x4μ.

Fusarium sarcochroum (Desm.) Sacc.

On Melia Azederach, Lee, 8, 1891, (Newman).

Fusarium Solani Mart.

On Solanum tuberosum, "Athens," 7, 1890, (Newman).

Fusarium vasinfectum Atks.

On Gossypium herbaceum, Lee, 7, 1891, (Atkinson).

Described in Ala. Agr. Exp. Sta. Bull. 41 : 19-29. The following is condensed from the above: "Causing the disease of cotton called 'Frenching,' infesting the ducts and staining the fibro-vascular system light brown; threads of the parasite colorless when young, with age bright yellow, 2-4μ in diameter; minute spores found in the ducts 1-2x 2-4μ—spores obtained in cultures vary from 2-4½x4-4μ, continuous or 1 to 4 or 5 septate according to length, minute ones narrowly oval, with increasing length in equilateral and curved, colorless, faintly granular, frequently one to several vacuoles according to size, short ones usually with one end rounded, opposite end rather sharply pointed, longer spores tend to be pointed at both ends when mature."

Illosporium minimum E. & E.*

On rotten wood, (Atkinson).

Described from Alabama material in Proc. Acad. Nat. Sci. Phil. 1893 : 465, as follows: "Sporodoche minute, 76-85μ in diameter, very short stiped or subsessile, white becoming yellowish; hyphae septate, 2-3 times dichotomous; spores biconic, 5-6μ in diameter."

Microcera coccophila Desm.

On Quercus nigra (Q. aquatica), Lee, 11, 1891, (Atkinson)

Myrothecium verrucaria (Alb. & Schw.) Ditm.*

On grass, (Beaumont), Grevillea, 3 : 99.

Spegazzinia tessarthra (B. & C.) Sacc.

On Saccharum officinarum, Macon, 8, 1896, (Carver).

Tubercularia Ailanthi Cooke.

On Juglans regia, Lee, 1, 1896.

On Melia Azederach, Lee, 1, 1896.

On Ficus carica, Lee, 1, 1896 (?).

The form on Ficus varies somewhat from the others in external appearance, and it is placed here with some doubt, though the microscopic characters are much the same.

Tubercularia vulgaris Tode (?).

On Morus sp. (cult.), Lee, 1, 1896.

Determined as above with some doubt; the sporodoches are less convex and more brilliantly colored than in our specimen of this species in Thuem. Myc. Univ. 480, and the conidia average smaller. It is very different from the specimen called *T. vulgaris* in Ell. &. Ev. N. A. F. 3397, which is like the forms we have recognized as *T. Ailanthi*. The specimen in Rav. F. C. Ex. 3 : 78 on Morus, called *Fusarium lateritium* Nees, is the same as our fungus. *Fusarium lateritium* of Thuem. Myc. Univ. 375, also on Morris, in our set at least, is also a *Tubercularia*, possibly the same as ours, though it differs somewhat in appearance.

Volutella setosa (Grev.) Berk.

On dead stems, Lee, 1891, (Atkinson).

ORDER MELANCONIALES.

Colletotrichum cladosporoides (E. & E.) Atks.

On Hypericum mutilum, Lee, 9, 1891, (Duggar).

Colletotrichum Gossypii Southworth.

On Gossypium herbaceum, Brunley, 9, 1891, (Atkinson).

Colletotricum Jussiaeae Earle.

On Jussiaea decurrens, Lee, 8, 1891, (Atkinson).

Described from the above specimens in Bull. Torr. Bot. Club., 24:29, as follows: "On orbicular, yellowish white, arid, purple bordered spots, 2-10mm. in diameter; ascervuli scattered, not erumpent, small, about 100µ; setae few, brown, transparent, occasionally septate, obtuse, mostly straight, from a somewhat enlarged base, about 70-100µ; conidia cylindrical or somewhat clavate, ends obtuse, continuous, irregularly guttate, 18-20x6-8µ."

Colletotrichum Lindemuthianum(Sacc. & Magnus)Scribner.

On Phaseolus vulgaris, Lee, 8, 1891, (Newman).

Coryneum disciforme ellipticum B. & Br.

On Betula nigra, Lee, 4, 1896.

Coryneum microstictum B. & Br.

On Rosa sp. (Peters). Mentioned in Grevillea, 2:153.

Cylindrosporium Celtidis Earle.

On Celtis sp. Montgomery, 11, 1891, (Atkinson).

Described from these specimens in Bull. Torr. Bot. Club, 24:29, as follows: "Spots small, yellowish, indefinite and indistinct; ascervuli hypophyllous, scattered, often only one on a spot, yellowish brown; spores clyindrical or clavate, guttate, at length obscurely several septate, 20-25x3µ."

Cylindrosporium Padi Karst.

On Prunus serotina, Lee, 8, 1891, (Newman & Duggar); Macon, 8, 1896, (Carver).

On Prunus sp. (cultivated plum), Lee, 7, 1890, (Atkinson in Econ. Fungi, 431).

Cylindrosporium saccharinum E. & E.

On Acer rubrum, Lee, 10, 1891, (Duggar).

Cylindrosporium ulmicolum E. & E.

On Ulmus Americana, Lee, 10, 1891, (Duggar).

Gloeosporium fructigenum Berk.

On Pirus malus, Lee, 8, 1891, (Atkinson).

On Vitis sp. (cultivated grapes), Washington, 7, 1896.

Gloeosporium lagenarium foliicolum E. & E.

On Citrulla vulgaris, Washington, 7, 1896.

Melanconium oblongum Berk.

On Juglans cinerea, (Peters).

Described in part from Alabama specimens in Grevillea, 2:153, as follows: "Pustulis elevatis late conicis tectis; sporis oblongis."

"Spores .0008 long, with an oil globule, one side curved. A very different plant from *Stilbospora ovata*, which also occurs on walnut."

Myxormia atroviridis B. & Br.*

On Rubus, (Beaumont), Grevillea, 3:100.

Pestalozzia annulata B. & C.

On Ilex sp. (Beaumont).

Described from Alabama specimens in Grevillea, 2:155, as follows: "Pustulis punctiformibus mucula alba fusco-cincta oriundis; epidermide centro excepta tectis annulatis; sporis fusiformibus 2-3 septatis."

"Pustules punctiform, perforated in the centre, covered with the cuticle, and surrounded by a black ring, springing from a large marginal white spot with a brown border; spores fusiform, bitriseptate .002 long, with a pedicel of the same length, attenuated downwards. Quite distinct from the last species." [*P. stellata* B. & C. on Ilex opaca.]

Pestalozzia concentrica B. & Br.

On Castanea pumila, (Beaumont).

On Crataegus sp. (Beaumont).

On Cydonia vulgaris, Washington, 7, 1896.

Described in part from Alabama specimens in Grevillea, 2:156, as follows: "Pustulis concentricis e macula pallida oriundis; sporis triseptatis, utplurimum monochaetis."

"Pustules concentrically arranged in the more typical form on a pallid or white spot; spores rather variable in form, about .001 long, with, in general, a single oblique process at the apex, more rarely with a three headed crest. The process is sometimes quite horizontal. Nearly allied to *P. monochaeta* Desm."

Pestalozzia flagellata Earle.

On Quercus sp. Lee, 8, 9, 1891, (Duggar).

Described from the above specimens in Bull. Torr. Bot. Club, 24:30, as follows: "Epiphyllous on large, orbicular or irregular, brown spots, bordered by a narrow darker brown line: ascervuli confined to a definitely limited, central, pallid area, usually elongated, seeming to follow the smaller veins, rimosely dehiscent: spores blackening the epidermis, fusoid, 4-septate, not constricted, three central cells dark fuscous, end cells hyaline, about 16x6µ stipe: straight, slender, about equalling the spore, the single seta or flagellum bent at an abrupt angle, and prolonged nearly twice the length of the spore, reaching 28 µ."

Pestalozzia stictica B. & C.*

On Tilia sp. (Beaumont).

Described in part from Alabama specimens in Grevillea, 2:155, as follows: Pustulis minutissimus; sporis subdoliiformibus biseptatis."

"Pustules very minute; spores swollen in the middle, with two septa, exclusive of those which separate the highly developed crest and the short pedicel. The dark part is .0006 long and almost as wide."

Steganosporium irregulare (B. & C.) Sacc.*

On Betula sp. (Beaumont).

Described under *Coryneum* from Alabama specimens in Grevillea, 2:154, as follows: "Pustulis elevatis distinctis; sporis obovatis 4-6-septatis; endochromatibus verticaliter divisis; pedicellis tenuissimus."

"Pustules distinct, raised; spores large, .002 long, obovate, attenuated below, 4-6 septate, the lower divisions very narrow, and gradually passing into the short very slender stem, the endochrome divided vertically, each division containing a single globose nucleus."

ORDER SPHAEROPSIDALES.

EAMILY SPHAERIOIDEACEAE.

Actinonema Rosae (Lib.) Fr.
On Rosa sp. (cult), Lee, 12, 1891, (Atkinson).

Aposphaeria Petersii (B. & C.) Sacc.*
On wood, (Peters).

Described in Grevillea, 2:81, under *Phoma*, as follows: "Erumpens, demum superficiale, hysteriiforme in lignum dealbatum situm, sporis ellipticis, binucleatis."

"Scattered, hysteriform, erumpent, then free; spores elliptic, .0003 long, with two nuclei. Distinct from *Phoma epileucum* B., in which the spores are .00015 long, and not so elliptic."

Botriodiplodia Ailanthi (Cooke) Sacc.
On Ailanthus, Lee, 1, 1896.

Cicinnobolus Cesatii De. By.
On Erysiphe (on Ambrosia), Lee, 7, 1890, (Atkinson).
On Microsphaera Grossulariae, Lee, 10, 1891, (Atkinson).

Coniothyrium concentricum (Desm.) Sacc.
On Yucca sp. (Peters), Grevillea, 2:82.
On Yucca filamentosa, Lee, 7, 1891, (Newman & Duggar).

Cornularia Persicae (Schw.) Sacc.
On Amygdalus persica, Lee, 5, 1896.

A peculiar form of this species in which the exuded spores remained crowning the stipe like a slender perithecium was, in error, described as *Isariopsis pilosa* Earle in Bull. Torr. Bot. Club, 24:30. Examination of additional material clearly shows the error.

Cytospora grandis Peck.

On Rhus. sp. Lee, 3, 1896.

Cytospora Persicae Schw.

On Amygdalus persica, Lee, 9, 1896.

Darluca Filum (Biv.) Cast.

On Puccinia Pruni-spinosae (on peach), Lee, 8, 1891, (Duggar).

On Uredo (on Andropogon), Lee, 8, 1891, (Newman and Duggar).

On Tea, (Beaumont), Grevillea, 2 : 179.*

Diplodia herbarum (Corda) Lev.

On Lactuca sp., Lee, 5, 1891, (Atkinson).

Diplodia macrospora Earle.

On Zea Mays (old weathered stalks), Lee, 3, 1896.

Described in Bull. Torr. Bot. Club, 24 : 29, as follows: "Perithecia scattered, large, carbonaceous, buried, ostiole erumpent, elevating and rupturing the epidermis; spores very long, dark fuliginous, irregularly clavate, on short, slender hyaline basidia, unequally uniseptate, scarcely constricted, each cell often biguttate, oozing out and blackening the epidermis, 70-80x6-8μ."

Diplodia maura Cooke.

On Pirus communis, Mobile, 1890, (Atkinson).

Diplodia Maydis (Berk.) Sacc.

On Zea Mays (old weathered stalks), Lee, 1, 1896.

Dothiorella macrospora (B. & C.) Sacc.*

On Magnolia glauca (Peters).

Described in part from Alabama material in Grevillea, 2 : 181, under *Sphæropsis*, as follows: "Peritheciis in massam communem congestis; sporis elongatis subfusiformibus."

"Perithecia crowded into a common mass, which is flattened above; spores elongated, subfusiform, with one side less curved, or slightly clavate, enucleate, .001-0016."

Hendersonia Cydoniæ Cke. & Ell.

On Cratægus flava (?), Lee. 8, 1890, (Atkinson).

Hendersonia Donacis Sacc.

On Erianthus sp., Lee, 11, 1891, (Duggar).

Hendersonia effusa B. & C.

On Aristida purpurascens, Lee, 10, 1891, (Atkinson).

Macrophoma Diospyri Earle.

On Diospyros Virginiana (green fruits), Lee, 7, 1896.

Described in Bull. Torr. Bot. Club, 24:30, as follows: "Thickly scattered over large indeterminate areas; perithecia buried, elevating the epidermis in prominent pustules, at length partially erumpent, surrounded by the ruptured epidermis, large, opening by a distinct ostiolum, dark brown, of soft cellular structure, reaching 200µ; spores cylindrical, sometimes slightly curved, ends abruptly pointed, faintly tinged with olive when seen in mass, contents homogeneous, not guttate nor granular, about 20x3µ; basidia thread-like, shorter than the spores, forming an agglutinated nebulous mass."

Phlyctæna vagabunda Desm.*

On Phytolacca, (Beaumont), Grevillea, 2:100.

Phoma campylospora B. & C.

On Panicum sp., Peters Coll. 113.

This seems to be a manuscript name, as it does not appear in Grevillea nor in Sacc. Syll. Fung.

Phoma chartarum B. & C.*

On white paper, (Beaumont).

Described in Grevillea, 2:83, as follows: "Sparsum e subiculo tenero byssoideo oriundum, sporis minimis."

"Perithecia scattered, each springing from some delicate radiating threads, spores very minute, .00012 long, sometimes ejected in the form of a tendril."

Phoma elongata (B. & C.) Sacc.*

On Gladiolus, (Peters).

Described under *Sphæropsis* in Grevillea, 2:181, as follows: "Peritheciis minutis nitidis sparsis ostioli brevi emergentibus; sporis subfusiformibus enucleatis; sporophoris sursum attenuatis."

"Perithecia minute, piercing the cuticle by the distinct ostiolum; sporophores attenuated upwards, spores oblong, subfusiform, .001-.0008 long, without any nucleus, one-fifth or one-sixth as much wide."

Phoma glandicola (Desm.) Lev.

On old acorns, Lee, 4, 1896.

Previously reported from this country only once before, (Proc. Indiana Acad. Sci., 1894, p. 150).

Phoma maculifera Sacc.*

On Diplopappus, (Beaumont).

Described in Grevillea, 2:83, as *P. maculare* B. & C., but as there was a previous *P. macularis* Desm., Saccardo changed the name as above. The original description is as follows: "Maculis orbicularibus bruneis immarginatis peritheciis irregularibus; sporis oblongis subcymbiformibus."

"Forming brown orbicular spots, in the centre of which are seated the irregular perithecia; spores oblong subcymbiform, .0004 long."

Phoma melaleuca B. & C.*

On Aralia spinosa, (Peters).

Described in part from Alabama material in Grevillea, 2:82, as follows: "Subcuticulare nitidum e macula albida oriundum; sporis oblongis."

"Growing on a pallid spot, subcuticular, shining; spores oblong, .0003 long."

Phoma micromegala (B. & C.) Sacc.*

On naked roots of pine, (Beaumont).

Described in Grevillea, 2:180, under *Sphæropsis*, as follows: "Peritheciis hysteriiformibus minutis nitidis; sporis ellipticis hyalinis."

"Perithecia minute, hysteriform, shining; forming little linear patches, the fibers of which are bleached; spores elliptic, with one side less arched, .001 long, hyaline, rather more than half as much wide."

Phoma uvicola B. & C.

On Vitis rotundifolia, Lee, 9, 1891, (Atkinson).

Phyllosticta Amaranti E. & K.

On Amaranthus retroflexus, Lee, 8, 1891, (Duggar).

Phyllosticta Azederachis Thuem.

On Melia Azederach, Lee, 7, 1891, (Duggar).

Phyllosticta Batatæ Thuem.

On Ipomœæ Batatas, Lee, 9, 1891, (Duggar); Macon, 10, 1896, (Carver).

Phyllosticta Catalpæ E. & M.

On Catalpa Catalpa (C. bignonoides), Hale, 5, 1896.

Phyllosticta circumvelata Winter.

On Liriodendron Tulipifera, Lee, 7, 1892, (Richards).

Phyllosticta cruenta (Fr.) Kx. (?)

On Vagnera racemosa (Smilacina), Lee, 7, 1896; Winston, 6, 1896.

This is what has been referred by American writers to this species, but it differs materially from European specimens and from the description in Sacc. Syll. Fung., 3 : 58, in character of spot, size of perithecia and size, shape and contents of spores. In our specimens the perithecia are about 120μ in diameter, and the spores are 10x7μ.

Phyllosticta Desmodii E. & E.

On Meibomea sp., 7, 1892, ———.

Phyllosticta glauca Cooke.

On Magnolia Virginica (M. glauca), Lee, 11, 1895.

The spores are oblong, about 6-8x2½μ.

Phyllosticta Lactucæ Atks.

On Lactuca Canadensis, Lee, 6, 1891, (Newman).

Phyllosticta Bumeliæ Underw. & Earle.*

On leaves of Bumelia, (Peters).

Described in Grevillea, 3 : 2, under *Sphæropsis*, as follows: "Maculis candidis rufo-marginatis; peritheciis punctiformibus; sporis obovatis brevibus."

"Spots white or pallid, surrounded by a thin umber border; perithecia minute punctiform; spores shortly obovate, .0005 long, nearly as much wide." This is *Phoma maculans* (B. & C.) Sacc., but there is a *Phoma maculans* (Lev.) Sacc., and the fact that this species inhabits spots on leaves clearly places it in *Phyllosticta*.

Phyllosticta minima (B. & C.) Underw. & Earle.

On Acer rubrum, DeKalb, 5, 1896; Lee, 5, 1896; Winston 6, 1896.

This is *Sphæropsis minima* B. & C., Grevillea, 3:2, and *Phoma minima* (B. & C.) Sacc., Syll. Fung., 3:115. It seems, however, to be a good *Phyllosticta*, so we write it as above.

Phyllosticta Phytolaccæ Cooke.

On Phytolacca decandra, Lee, 7, 1892, (Richards).

Phyllosticta pirina Sacc.

On Pirus malus, Lee, 7, 1896.

Phyllosticta Podophylli (Curt.) Winter.

On Podophyllum peltatum, DeKalb, 5, 1896.

Phyllosticta Rhododendri West.

On Azalea nudiflora, Lee, 7, 1892, (Richards).

Phyllosticta serotina Cooke.

On Prunus serotina, Lee, 7, 1891, (Duggar).

Phyllosticta Siliquestri Sacc. & Speg.

On Cercis Canadensis, Lee, 1891, (Duggar & Newman).

Phyllosticta sphæropsoidea E. & E.

On Æsculus Pavia, Lee, 5, 1896; Tuscaloosa, 5, 1896.

This is clearly distinct from *P. Paviæ* Desm., with which it is often confused.

Phyllosticta Vaccinii Earle.

On Vaccinium arboreum, Lee, 4, 1896.

Described in Bull. Torr. Bot. Club, 24:31, as follows: "Epiphyllous on brown, irregular, indeterminate spots, 1cm. or more in diameter; perithecia scattered, erumpent, of soft texture, ostiole large, 8-10μ, size variable, 80-120μ; spores large, usually ovate, with a large (4μ), spherical gutta near the broader end, about 12x6μ."

Phyllosticta viticola Thuem.

On Vitis rotundifolia, Lee, 10, 1895.

Prosthemium palmatum Earle.

On rotten wood, Lee, 3, 1896.

Described in Bull. Torr. Bot. Club, 24:31, as follows: "Perithecia scattered over large whitened areas, elongate-hysterioid, black, carbonaceous, buried, at length partially erumpent, rupturing irregularly, or becoming discoid by the breaking away of the upper portion; spores cylindric, light fuliginous, 1-3 septate, about 12-15x4μ, united at base into bundles of 3 to 6, not stellate, but palmate or fascicled; basidia obsolete."

Rhabdospora verrucæformis (B. & C.) Sacc.*

On branches of Cephalanthus, (Peters).

Described under *Septoria* in Grevillea, 3 : 11, as follows: "Peritheciis majoribus rugosis; sporis tenuissimis subrectis,"

"Perithecia rather large, rugged; spores very slender, nearly straight."

Septoria Alabamensis Atks.

On Glechoma hederacea (Nepeta glechoma), Lee, 1, 2, 1891, (Atkinson).

Described in Jour. E. Mitch. Sci. Soc., 10 : 78, as follows: "Spots indefinite, occupying irregular portions of the leaf. Perithecia 80-90μ. Spores 20-30x1μ or less, sometimes faintly 1-3 septate, straight or slightly curved or flexuous.'

Septoria albonigra B. & C.*

On living leaves, (Peters).

Described in Grevillea, 3 : 8, as follows: "Maculis albis, fusco-annulatis; peritheciis minimis; sporis filiformibus."

"Spots orbicular, white, marked with one or two concentric brown rings, and generally bordered; perithecia very minute; spores filiform, nearly straight, .0022 long."

Septoria Brunellae E. & H.*

On Prunella vulgaris, Montgomery, 7, 1890, (Atkinson in Jour. Elisha Mitch. Sci. Soc. 10 : 76).

Septoria Cacaliæ E. & K.

On Cacalia tuberosa, Lawrence, 6, 1896.

Septoria cerasina Peck.

On Prunus sp., Lee, 7, 1891, (Newman).

Septoria Cerastii Rob. & Desm.

On Cerastium arvense, Lee, 3, 1891, (Atkinson in Jour. E. Mitch. Sci. Soc. 10 : 76).

On Cerastium viscosum, Lee, 3, 1896.

Further study will probably show that our American species on Cerastium is distinct from this European one to which it has usually been referred.

Septoria Dianthi West.*

On Dianthus barbatus, Lee, (Atkinson in Jour. E. Mitch. Sci. Soc. 10 : 77).

Septoria Erechtites E. & E.

On Erechtites hieracifolia, Lee, 9, 1891, (Duggar).

Septoria graminum Desm.

On Digitaria sanguinalis (Panicum), Lee, 7, 1891, (Duggar).

Septoria Jussiaeae E. & K.

On Jussiaea leptocarpa, Lee, 7, 1891, (Duggar & Newman).

Septoria neglecta Earle.

On Quercus Phellos, Lee, 2, 3, 4, 1896.

Described in Bull. Torr. Bot. Club, 24:31, as follows: "On irregular determinate angular brownish arid spots, from 1mm-2cm. or more, usually with a darker border; perithecia epiphyllous, or amphigenous, prominently erumpent, irregularly scattered, 100-120 μ or more; spores thread like, continuous, faintly guttate, 30-40x1-1½ μ."

Septoria Œnotherae West.

On Œnothera laciniata (Œ. sinuata), Lee, 3, 1896.

On Onagra biennis, Lee, (Atkinson in Jour. E. Mitch. Sci. Soc. 10:77).

Septoria pulchella B. & C.*

On Andromeda, (Peters).

Described in Grevillea, 3:8, as follows: "Maculis rufulis linea nigra circumdatis; peritheciis punctiformibus; sporis lineari-oblongis."

"Spots suborbicular, rather irregular, very pale rufous, surrounded by a narrow black line ; perithecia punctiform ; spores linear, very slightly curved, .0002 long."

Septoria Rubi West.

On Rubus sp., DeKalb, 5, 1896.

Septoria Rubi alba Peck.

On Rubus trivialis, Mobile, 4, 1891, (Zimmer Bros. in Jour. E. Mitch. Sci. Soc. 10:77).

Septoria sambucina Peck.

On Sambucus Canadensis, Lee, 8, 1891, (Duggar).

Septoria Secalis Prill. & Delacr.

On Secale cereale, Lee, 4, 1896.

Our specimens agree with the description of this European species, except in having slightly larger perithecia. Very common in rye fields on the Station grounds.

Septoria sonchina Thuem.

On Sonchus oleraceus, Lee, 1891, (Benton).

Septoria Speculariae B. & C.

On Legonzia perfoliata (Specularia), Lee, 3, 1890, (Atkinson in Jour. E. Mitch. Sci. Soc. 10:77).

Septoria stigma B. & C.*

On Symplocos, (Peters).

Described in Grevillea, 3:9, as follows: "Peritheciis punctiformibus in folium dealbatum insidentibus; sporis linearibus brevioribus."

"Perithecia punctiform, seated on the whitened leaf; spores linear, .0006 long."

Septoria verbascicola B. & C.

On Verbascum Blattaria, Madison, 5, 1896.

Septoria Violae West.

On Violae primulaefolia, Macon, 7, 1890, (Atkinson).

Septoria virgaurae Desm. (?).

On Solidago serotina, Lee, (Atkinson in Jour. E. Mitch. Sci. Soc. 10:77).

Septoria Xanthii Desm.

On Xanthium sp. Perry, 7, 1891, (Atkinson).

Sphaeronema epigloeum B. & C.

On Tremella sp., Peters Coll. 110.

Sphaeronema spina B. & Rav.*

On dead leaves of ash, (Beaumont).

Described in part from Alabama specimens in Grevillea, 2:177, as follows: "Peritheciis erumpentibus spiniformibus nigris corticalis; sporis minimus globosis."

"Bursting through the bark by its spiniform often inclined ostiolum, covered with a thick bark; spores globose, very minute."

Sphaeropsis Maclurae Cooke.

On Toxylon pomiferum (Maclura aurantiaca), Lee, 3, 1896.

Sporonema Camelliae Earle.

On Camellia Japonica, Lee, 3, 4, 1896, (J. Q. Burton).

Described in Bull. Torr. Bot. Club, 24:32, as follows: "Epiphyllous on large, white, brown-bordered spots or areas, 2-5cm. in diameter; perithecia thickly scattered, buried, elevating the epidermis, orbicular or somewhat elongated, usually rimosely dehiscent, occasionally stellate laciniate, becoming discoid, of firm cellular texture, about 200 μ; spores cylindrical, ends obtusely rounded, sometimes curved, usually biguttate, 12-18x4-5 μ; basidia short and thick, about equalling the spore, usually simple."

Sporonema Ilicis Earle.

On Ilex opaca, Lee, 12, 1895; 1, 2, 3, 1896.

Described in Bull. Torr. Bot. Club, 24:32, as follows: "Epiphyllous on large deadened and whitened areas, usually involving the apical portion of the leaf; perithecia often somewhat concentrically arranged, or thickly scattered, large, membranaceous, buried in the epidermis and coming off with it, usually somewhat elongated, elevating the epidermis and at length cracking it longitudinally or stellately; spores continuous, elliptical, hyaline, on short, simple, hyaline basidia, about 12-15x4-5 μ."

Stagonospora Ischaemi Sacc.

On Andropogon furcatus, Lee, 9, 1891, (Duggar).

Vermicularia affinis Sacc. & Briard.

On Panicum virgatum, Lee, 2, 1888, (Newman).

On Sieglingia seslerioides, Lee, 1, 1889, (Newman).

On Sorghum halapense, Montgomery, 9, 1891, (Atkinson).

On Sorghum, sp. Lee, 7, 1890, (Atkinson).

Vermicularia Dematium (Pers.) Fr.*

On Phytolacca, (Beaumont), Grevillea, 3:6.

Vermicularia Eryngi (Corda) Fckl.

On dead umbelliferous stem, Lee, 4, 1896.

Vermicularia Liliacearum Schw.

On Agave Virginica, Lee, 7, 1896.

Vermicularia sanguinea E. & Hal.

On Sorghum vulgare (chicken corn), Perry, 7, 1890, (Atkinson).

On Sorghum sp. (Jerusalem corn), Lee, 10, 1895.

Family Nectrioidaceae.

Stagonopsis pallida (B. & C.) Sacc.*

On Cornus, (Peters).

Described under *Hendersonia* in Grevillea, 3:6, as follows: "Peritheciis sparsis nudis pallide carneis; sporis arcuatis hyalinis 7-8 septatis."

"Perithecia globose, scattered, pale flesh color, hyaline; spores fusiform, hyaline, with from 7-8 septa, each division containing a single nucleus. Possibly a state of some *Nectria.*"

Family Leptostromaceae.

Discosia Artocreas (Tode) Fr.

On Aralia spinosa, (Peters), Grevillea, 3:6.

On Fagus, (Beaumont), Peters Coll.

On Ilex, (Beaumont), Peters Coll.

Discosia fagina Lib.*

(Beaumont), Grevillea, 3:7. This is referred to *D. Artocreas* by Saccardo. (Syll. Fung., 3:653).

Discosia minima B. & C.

On Ilex sp. (Beaumont), Grevillea, 3:7.

On Ilex opaca, Lee, 7, 1896.

Described from Beaumont's specimens as follows: "Peritheciis minutissimis innumeris punctiformibus, sporis utrinque appendiculatis."

"Extremely minute, gregarious; spores .0015 long, without septa, but probably young, furnished as in *D. grammita* with a terminal appendix at either end."

Discosia rugulosa B. & C.

On Hicoria, Peters Coll. 1, 1855.

On Hicoria ovata, Lee. 7, 1891, (Newman).

Described in Grevillea, 3:7, as follows: "Peritheciis orbicularibus opacis rugosis."

"This seems to be quite different from *D. Artocreas*, the perithecia being rugulose and opaque and not at all shining, as in that species."

Entomosporium maculatum Lev.

On Amelanchier sp. (cult.), Lee, 7, 1896.

On Cydonia vulgaris, Lee, 8, 1890, (Atkinson); Washington, 7, 1896.

Leptostroma hypophyllum B. & Rav.

On Gleditschia triacanthos, Lee, 11, 1895.

Leptostromella filicina (B. & C.) Sacc.*

On dead ferns, (Peters).

Described in part from Alabama specimens under *Cryptosporium*, in Grevillea, 2:84, as follows: "Nitidum hysteriiforme; sporophoris duplo sporis curvatis filiformibus."

"Shining hysteriform; sporophores half as long as the thread-like curved spores, which are variable in length."

Leptothyrium dryinum Sacc.

On Castanea pumila, Lee, 1890, (Atkinson).

On Nyssa sylvatica (N. multiflora), Lee, 1892, (Richards).

Leptothyrium Lychnidis B. & C.*

On Lychnis Flos-cuculi, (Peters).

Described in Grevillea, 2:83, as follows: "Maculis pallidis; peritheciis punctiformibus; sporis oblongis utrinque irregularibus."

"Spots pallid, perithecia very minute; spores oblong, hollowed out on either side, .0004 long."

Melasmia acerina Lev.

On Acer rubrum, Lee, 9, 1891, (Atkinson).

Melasmia Gleditschiae E. & E.

On Gleditschia triacanthos, Lee, 1889, (Atkinson).

Piggotia Fraxini B. & C.

On Fraxinus sp. Lee, 11, 1895.

FAMILY EXCIPULACEÆ.

Amerosporium œconomicum Ell. & Tracy.
On Dolichos Sinensis, Lee, 11, 1890, (Atkinson).

CLASS ASCOMYCETES.

ORDER GYMNOASCALES.

Exoascus alnitorquus (Tul.) J. Kuhn.
On Alnus serrulata, Lee, 1890; 4, 1891, (Atkinson); 12, 1893, (B. M. Duggar); 4, 1896.

Exoascus australis Atks.
On Carpinus, Lee, 4, 1892, (Atkinson .
Described from Alabama material by Atkinson in Bull. Torr. Bot. Club, 21 : 379.*

Exoascus Farlowii Sadebeck.
On Prunus serotina, Lee, 1892, (Atkinson).

Exoascus mirabilis Atks.
On Prunus angustifolia, Lee, 4, 5, 1890-1892, (Atkinson).
Distributed as *Exoascus pruni* from Alabama material in Seymour & Earle, Econ. Fungi, No. 129.
Described from material collected in Alabama by Atkinson, in Bull. Torr. Bot. Club, 21 : 376.

Exoascus pruni Fuckel.
On Prunus serotina, Lee, 1891, (Atkinson).
On Prunus angustifolia, Lee, 1890, (Atkinson).

Exoascus rhizipes Atks.*
On Prunus triflora, Lee, (Atkinson).

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* This description and others given in this paper lack the compact form usually employed in specific descriptions, hence are not quoted here.

Described from material collected in Alabama by Atkinson in Bull. Torr. Bot. Club, 21 : 377.

Exoascus varius Atks.

On Prunus serotina, Lee, 5, 1891, (Atkinson) ; described from material collected in Alabama by Atkinson in Bull. Torr, Bot. Club, 21 : 378. Distributed from Alabama material in Seymour & Earle, Econ. Fungi, No. 128, as *Exoascus deformans.*

Taphria coerulescens (Mont.) Tul.

On Quercus nigra (Q. aquatica), Lee, 1892, (Atkinson); distributed from Alabama material in Seymour & Earle, Econ. Fungi, No. 180.

On Quercus rubra, (Atkinson).

On Quercus phellos, Lee, 1890, (Atkinson); distributed from Alabama material in Seymour & Earle, Econ. Fungi, No. 189.

On Quercus obtusiloba, Lee, 1890, (Atkinson).

On Quercus Marylandica (Q. nigra), Lee, 1890, (Atkinson).

On Quercus falcata, Lee, 1890, (Atkinson); distributed from Alabama material in Seymour & Earle, Econ. Fungi, No. 185.

On Quercus brevifolia (Q. cinerea), Lee, 1891, (Atkinson).

Taphria Virginica Sadebeck & Seymour.

On Ostrya Virginica, Lee, 5, 1896.

Order Perisporiales.

FAMILY ERYSIPHACEAE.

Erysiphe cichoracearum DC.

On Ambrosia artemisiaefolia, Lee, 5, 1890, (Atkinson in Jour. E. Mitch. Sci. Soc. 7:65).

On Ambrosia trifida, Perry, 1890, (Atkinson).

On Aster diffusus, Lee, 1891, (Atkinson).

On Aster Tradescanti, Lee, 1891, (Atkinson).

On Helianthus annuus, Lee, 1891, (Duggar).

On Willoughbya scandens (Mikania),Lee, 1891,(Atkinson).

On Phlox sp. Mobile, 1890, (Zimmer).

On Solanum Carolinense, Lee, 10, 1891, (Atkinson); Macon, 10, 1896, (Carver).

On Verbena urticifolia, Lee, 10, 1891, (Duggar).

On Xanthium Canadense, Lee, 10, 1889, (Atkinson); Macon, 8, 1896, (Carver).

The specimen on Verbena was referred by Atkinson in Jour. E. Mitch. Sci. Soc. 10:75, to *E. galeopsidis DC.;* but these forms are rightly retained under *E. cichoracearum* by Burrill (Ell. & Ev. N. A. Pyrenomycetes, 13).

Erysiphe communis (Wallr.) Lev.

On Onagra biennis, Lee, 5, 1890, (Atkinson in Jour. E. Mitch. Sci. Soc. 7:64).

On Pisum sativum, Lee, 5, 1890, (Atkinson).

Erysiphe Liriodendri Schw.

On Liriodendron tulipifera, Lee, 1891, (Duggar).

Microsphaera Alni (DC) Winter.

On Alnus serrulata, Lee, 1891, (Atkinson).

On Ilex mollis, Lee, 1891, (Atkinson).

On Hicoria sp., Lee, 1890, (Atkinson).

On Platanus occidentalis, Lee, 1891, (Atkinson).

On Syringa vulgaris, Lee, 10, 1896; Macon, 8, 1896, (Carver).

On Tecoma radicans, Lee, 1891, (Atkinson).

The form on Tecoma was determined by Atkinson (Jour. E. Mitch. Sci. Soc. 10:75) as *M. semitosta* B. & C. It is true that the base of the appendages is in some cases colored for a short distance, but this is not unusual among the varied forms that are referred to *M. Alni.* The coloring in this case is rather darker than usual; but it is not nearly so dark as in the true *M. semitosta* on Cephalanthus; and the branching of the appendages, and the recurved tips are different from that species.

Microsphaera diffusa C. & P.

On Meibomia sp. Lee, 1889, (Atkinson).

On Lespedeza striata, Lee, 1889, (Atkinson); Macon, 10, 1896, (Carver).

Microsphaera erineophila Peck.

On erineum of Fagus Americana, Lee, 3, 1896.

Microsphaera Euphorbiae B. & C.

On Euphorbia nutans, Lee, 1891, (Duggar).

Microsphaera Grossulariae (Wallr.) Lev.

On Sambucus Canadensis, Lee, 1891, (Atkinson).

Microsphaera quercina (Schw.) Burrill.

On Quercus nigra (Q. aquatica), Lee, 12, 1890, (Atkinson); Macon, 8, 1896, (Carver).

On Quercus Phellos, Lee, 1891, (Atkinson).

On Quercus sp. Lee, 12, 1895; Macon, 8, 1896, (Carver).

The form on Q. nigra is the *M. calocladophora* Atks. which was described in Jour. E. Mitch. Sci. Soc. 7:73, as follows: "Hypophyllous, mycelium thin, diffuse, or in orbicular patches, dense. Perithecia scattered, black, rather stout, 100-140 μ, reticulations rather distinct. Appendages one to two times diameter of perithecium, percurrent, primary branching opposite or nearly so, branches dichotomous, tips incurved, some of the tips unpaired as in *M. quercina*. Asci four to six, ovate or elliptical, pedicellate, 35-40x65-80 μ. Spores six to eight, 20-25 μ, granular."

There is nothing in the foregoing except the peculiar branching of the appendages by which to distinguish it from other of the varied forms on different species of oak that are at present regarded as belonging to *M. quercina*. This character is very easily recognized when present; and, if constant, would sufficiently separate the species. As the result of much study of the forms of *Microsphaera* on oak we cannot concede that this is the case. In none of the specimens examined is this character uniformly present. Hardly a perithecium can be found that does not show one or more appendages with the normal dichotomous branching of *M. quercina*. Again this character is by no means confined to the form on Q. nigra. Many specimens from Illinois, and other parts of the country, especially on Q.

alba, show occasional appendages having this peculiar form of branching. It is this that was referred to by Burrill and Earle, Parasitic Fungi of Illinois, 2:485, while discussing the form on Q. alba, in the sentence "While the branching is broader and more irregular, frequently being exceedingly ornate" *Microsphaera Hedwigii* is mentioned in Grevillea, 4:161, as being found in Alabama on oak by Beaumont, but this was doubtless some of the many forms of *M. quercina.*

Microsphaera Ravenelii Berk.

On Apios Apios (A. tuberosa), Lee, 10, 1896; Macon, 8, 1896, (Carver).

On Gleditschia triacanthos, Lee, 1889, (Atkinson).

Microsphaera semitosta B. & C.

On Cephalanthus occidentalis, Lee, 1891, (Atkinson).

Microsphaera Vaccinii C. & P.

On Vaccinium sp. Lee, 1891, (Duggar).

On Xolisma ligustrina, Lee, 10, 1896.

Phyllactinia suffulta (Rebent,) Sacc.

On Alnus serrulata, Lee, 1891, (Atkinson); Macon, 10, 1896, (Carver).

On Carpinus Caroliniana, Lee, 1891, (Atkinson).

On Cornus florida, Lee, 1891, (Atkinson).

On Cornus sp. Lee, 1891, (Atkinson).

On Crataegus sp. Lee, 1891, (Atkinson).

On Fagus sp. (Beaumont in Grevillea, 4:158).

On Liriodendron tulipifera, Macon, 10, 1896, (Carver).

On Quercus nigra (Q. aquatica), Lee, 1890, (Atkinson); Macon, 8, 1896, (Carver).

On Quercus Marylandica (Q. nigra), Lee, 1890, (Atkinson).

On Quercus Phellos, Lee, 1890, (Atkinson).

On Quercus minor (Q. stellata), Lee, 11, 1895.

On Ulmus alata, Lee, 1889, (Atkinson); Macon, 10, 1896, (Carver).

On Ulmus Americana, Macon, 10, 1896, (Carver).

Podosphaera biuncinata C. & P.

On Hamamelis Virginiana, Lee, 1891, (Duggar).

Podosphaera oxyacanthae (DC) DeBy.

On Crataegus sp., 1891, (Benton).

On Pirus malus, Lee, 4, 1896.

On Prunus Americana, 1891, (Duggar).

On Prunus Cerasus, (Peters in Grevillea, 4:158).

Sphaerotheca Castagnei Lev.

On Bidens frondosa, Lee, 1891, (Duggar).

On Erechthites hieracifolia, Lee, 1891, (Benton & Duggar).

On Lactuca sp., Lee, 10, 1896.

Sphaerotheca lanestris Hark.

On Quercus alba, Lee, 1891, (Atkinson).

Sphaerotheca pannosa (Wallr.) Fr.

On Rosa sp. (cult.), Lee, 1890, (Atkinson).

Uncinula circinata C. & P.

On Acer rubrum, Lee, 1891, (Atkinson).

Uncinula flexuosa Peck.

On Æsculus Pavia, Lee, 1890, (Atkinson).

Uncinula geniculata Ger.

On Morus rubra, Lee, 1891, (Atkinson).

Uncinula macrospora Peck.

On Ulmus Americana, Lee, 1890, (Atkinson).

It is probable that the specimens on elm referred by Berkeley to *U. adunca* (Grevillea, 4 : 159), and to *U. intermedia* (Grevillea, 4 : 160), are nothing but *U. macrospora.*

Uncinula necator (Schw.) Burrill.

On cultivated grape, Lee, 1889, (Atkinson in Jour. E. Mitch. Sci. Soc. 7 : 66).

Uncinula parvula C. & P.

On Celtis occidentalis, Lee, 1889 ; Montgomery, 1891, (Atkinson) ; Macon, 8, 1896, (Carver).

Uncinula polychaeta (B. & C.) Mass.

On Celtis occidentalis, (Peters), Rav. Fung. Car. Exsic. 4 : 68 ; 1891, (Atkinson).

First described from Alabama specimens under *Erysiphe* in Grevillea, 4 : 159, as follows : "Maculis orbicularibus ; appendicibus brevibus plurimus rectis ; ascis elongatis clavatis."

"Spots orbicular, yellow-brown in the centre from the young perithecia; appendages about equal to their diameter, straight; asci elongated, clavate."

FAMILY PERISPORIACEÆ.

Asterina comata B. & Rav.

On Magnolia Virginica (M. glauca), (Peters), Lee, 5, 1896; Mobile, 3, 1896.

Described in Grevillea, 4:10, in part from Alabama specimens as follows: "Sparsa major; mycelio obsoleto; floccis brunneis dense vestita."

"Scattered, without any visible mycelium, large for the genus, about one-third line broad, densely clothed with short brown hairs."

Asterina diplodioides B. & C.*

On Andromeda acuminata, (Peters).

Described in Grevillea, 4:9, as follows: "Maculis orbicularibus, mycelio interrupto; sporidiis oblongis obtusissimis uniseptatis fuscis."

"Forming orbicular interrupted spots; perithecia minute; sporidia .0003 long, shortly oblong, obtuse at either end, brown, resembling the spores of a *Diplodia*."

Asterina pelliculosa Berk.

On Ilex opaca, Lee, 2, 4, 1896.

Asterina spurca B. & C.*

On Hyptis radiata, (Beaumont).

Described in part from Alabama specimens in Grevillea, 4:10, as follows: "Peritheciis sparsis punctiformibus, floccis brevibus duobus vel pluribus junctis articulatis radiantibus ornatis."

"Scattered, dot-like, surrounded by short articulated submoniliform, radiating threads, which are joined together laterally by twos, sometimes forked at the apex."

Capnodium elongatum B. & Desm.*

On Bignonia, (Peters).

Capnodium sp.

On Chrysanthemum sp., Lee, 1889, (Atkinson).

On Nerium Oleander, Lee, 1890, (Atkinson).

(Antennaria) semiovata B. & Br.

On Magnolia Virginica (M. glauca), (Beaumont).

This probably belongs with Capnodium. A number of other specimens of black fungi have been collected that seem to follow insect injuries on various hosts. They probably belong here, but as they are in not condition for determination they are not enumerated.

Meliola amphitricha Fr.

On Osmanthus Americana (Olea), Lee, 10, 1896.

Specimens of *Meliola* on many diverse hosts have been referred to this species by American writers. It is perhaps doubtful if any of our species are entitled to this name, but it is retained provisionally in the present case.

Meliola bidentata Cooke.

On Bignonia capreolata, Lee, 1891, (Duggar); Mobile, 3, 1896.

Meliola manca E. & M.

On Myrica cerifera, Mobile, 3, 1896.

On Rubus villosus, Lee, 1891, (Atkinson).

Meliola Martiniana Gaill.

On Persea palustris, Lee, 4, 1896.

Meliola Mitchellae Cooke.

On Mitchella repens, Lee, 3, 1896.

Meliola nidulans (Schw.) Cooke.

On living twigs, 1891, (Atkinson).

On living twigs of Cornus, Lee, 4, 1896.

Meliola palmicola Winter.*

On Sabal sp. (Beaumont), in Grevillea, 4 : 158, under *M. amphitricha* Fr.

Meliola tenuis B. & C.

On Arundinaria tecta, Lee, 1891, (Atkinson).

Parodiella perisporioides (B. & C.) Speg.

On Desmodium sp., Lee, 1891, (Newman & Duggar).

Perisporium Zeae Desm. (?)

On Zea Mays, (Beaumont), Rav. Fung. Car. exsic. 3 : 65.

This is probably an error (see note by Farlow in Ell. & Ev. N. A. Pyr., 56). In the specimen examined by us the minute black perithecia (?) were sterile.

Scorias spongiosa (Schw.) Fr.

On Alnus serrulata, Lee, 2, 1896.

On Fagus Americana, Lee, 7, 1896.

ORDER HYPOCREALES.

Calonectria Curtisii (Berk.) Sacc. (?)

On Arundinaria sp., Lee, 1, 1896.

We have seen no authentic specimens of this species and the description is insufficient for positive identification.

Calonectria polythalama (Berk.) Sacc.*

On Liquidambar, (Peters, Grevillea, 4 : 46).

Claviceps sp. (sclerotium stage only.)

On Chrysopogon avenaceus, Macon, 8, 1896, (Carver).

On Erianthus sp., Macon, 8, 1896, (Carver).

Cordyceps capitata Fr.*

(Peters, Grevillea, 4:13).

Cordyceps ophioglossoides (Ehrh.) Link.

Peters Coll. 1:54; Winston, 6, 1896.

Dothicloe Aristidia Atks.*

On Aristida purpurascens, Lee, (Duggar).

Described in Bull. Torr. Bot. Club, 21 : 224, as follows : "Stroma dimorphic, sterile portion confluent, forming a thin black layer, in the specimens seen entirely surrounding the culm. Fertile portion much thicker, confluent or interrupted, forming small perpendicular elevations on the sterile portion, projecting apices of the crowded perithecia more or less confluent in an irregular manner, giving a rugulose or convolute appearance to the stroma. Otherwise as in *D. Hypoxylon.*"

Dothichloe Hypoxylon (Peck) Atks.* (*Epichloe Hypoxylon* Peck.)

On Andropogon Virginicus, (Atkinson, Bull. Torr. Bot. Club, 21 : 223).

Echinodothis tuberiformis (B. & Rav.) Atks. (*Hypocrea tuberiformis* B. & Rav.)

On Arundinaria, Lee, 1891, (Atkinson).

Gibberella pulicaris (Fr.) Sacc. (?)

On living roots of cotton, Lee, 11, 1889, (Atkinson). With a *Fusarium*. The specific determination we consider quite doubtful.

Hypocrea apiculata C. & P.

Lee, (Atkinson).

Hypocrea citrina (Pers.) Fr.

On Exidia glandulosa, Lee, 7, 1896.

Hypocrea contorta (Schw.) B. & C.

Peters Coll. 3 : 68.

Hypocrea Petersii B. & C.*

Alabama (Peters.)

Described in Grevillea, 4 : 13, as follows: "Agariciformis; stipite rugoso; peritheciis periphericis; ascis linearibus; sporidiis globosis."

"At first sight this looks like an Agaric infested with some Hypomyces, but the fructification is exactly that of an Hypocrea. Stem irregular, dilated upwards, about an inch high; head orbicular, irregular rufous; perithecia both on the under and upper sides; sporidia globose in linear asci."

Hypocrea polyporoidea B. & C.

On Fagus, Peters Coll. 1 : 152.

Described in Grevillea, 4:15, as follows: "Peritheciis tomentosis liberis in crustam pallidam insidentibus."

"Fawn-colored; perithecia free, tomentose, with a naked ostiolum seated on a pale crust, here and there elevated, which is thin towards the margin. A very curious species."

In the Peters specimen the asci are very numerous, cylindrical, about 40-50x3µ; spores end to end in a single row, crowded, soon separating, ends of the cells truncate from mutual pressure, becoming rounded when freed from the ascus, orbicular, about 3µ.

Hypocrella atramentosa (B. & C.) Sacc.

On Andropogon, (Beaumont, Grevillea, 4 : 15).

Described in Jour. Linn. Soc. 10 : 377, in part from Alabama material, under *Hypocrea*, as follows: "Effusa, tenuis, elongata, atra, demum rugosa; peritheciis globosis ostiolisque immersis (419)."

"On leaves of grass. Hab. Alabama. On Andropogon, No. 4018. Forming a thin stratum on the under side of the leaves. Allied to *H. semiamplexa* B., a very similar species from Surinam on *Cyperaceae*, with filiform sporidia (*Sphaeria cyperacearum* Schwein.! herb.)."

This is considered by Atkinson to be a synonym for *Dothichloe Hypoxylon* (Bull. Torr. Bot. Club, 21 : 223).

Hypomyces aurantius (Pers.) Fckl.

On Cantherellus aurantiacum, (Peters), in Rav. Fung. Car. exsic. 5 : 64.

Hypomyces lactifluorum (Schw.) Tul.

On various species of Lactarius, Lee, 12, 1895; Winston, 6, 1896.

Hypomyces xylophilus Peck.

On rotten wood, Lee, 11, 1896.

Myriogenospora Paspali Atks.

On Paspalum laeve, Lee, (Duggar).

Described in Bull. Torr. Bot. Club, 21 : 225, as follows: "Stroma one to two centimeters long, seated upon one side of the young culm in the cases observed, and partly enclosed on the sides by the equitant leaf blade. Perithecia large, 200-500μ in diameter oval or obovate, projecting above the stroma but little by a small conical apex, producing a slight unevenness on the surface. Asci large, 200-250x15-20μ, tapering each way to slender ends, more strongly so at the base, so that they appear oblanceolate in side view. Spores very numerous, several hundred, narrowly apiculate, 15-25x .5-.8μ, fusoid, straight or slightly curved."

Nectria episphaeria (Tode) Fr.

Lee, 1891, (Atkinson).

On Diatrype sp., Lee, 3, 1896.

On Eutypella sp., Lee, 2, 3, 1896.

Nectria rubicarpa Cooke.

On Gelsemium sempervirens (?), Lee, 2, 1896.

Nectria saccharina B. & C.

Peters Coll. 1:165.

Nectria viticola B. & C.*

On Vitis, (Peters).

Described in Grevillea, 4:45, as follows: "Parva, nitide coccinea, mollis lateraliter collabens e strato albo tenui oriunda; sporidiis uniserialibus ellipticis uniseptatis."

"Scattered, bright crimson, soft, collapsing laterally, seated on a thin white mycellum; sporidia uniseriate, elliptic, uniseptate."

Sphaerostilbe gracilipes Tul.*

On Platanus, (Peters, Grevillea, 4:46).

ORDER SPHAERIALES.

Anthostoma atropunctata (Schw.) Sacc.

On Quercus sp., Lee, 11, 1895.

nthostomella eliminata (B. & C.) Sacc.*

On Smilax, (Peters).

Described in Grevillea, 4:148, under *Sphaeria*, as follows: "Peritheciis epidermide nigrefacta tectis; ostiolo albo; ascis linearibus; sporidiis auguste oblongis uninucleatis."

"Perithecia covered by the jet black cuticle; which is the more conspicuous from the unoccupied parts being white, marked in the centre with white from the ostiolum; asci linear; sporidia uniseriate, oblong, .00057 long, from four to five times longer than broad."

Apiospora Apiospora (Dur. & Mont.)*

On Arundinaria, (Peters in Grevillea, 4:144, under *Sphaeria*.

Botriosphaeria fuliginosa (M. & N.) E. & E.

On Melia Azedarach, Lee, 3, 1895.

On dead bark, Lee, 1, 1893.

Caryospora putaminum (Schw.) DeNot.

On peach pits, Lee, 2, 1896; Mobile, 12, 1895.

Ceratostoma piliferum (Fr.) Fckl.*
On Quercus, (Peters in Grevillea, 4 : 146, under *Sphaeria.*)
Chaetosphaeria pannicola (B. & C.)Sacc.
On Vitis rotundifolia, Lee, 2, 1896.
On Vitis sp. (cult.), Lee, 1, 1896.
Clypeosphaeria sabaligera (B. & C.) Sacc.*
On Sabal sp., (Beaumont).
Described in Grevillea, 4 : 147, under *Sphaeria*, as follows: "Sparsa minuta epidermide nigrefacta tecta, ascis clavatis; sporidiis biseriatis."
"Scattered, minute, covered by the blackened cuticle; sporidia biseriate; sporidia fusiform, curved, triseptate, .001 long."
Daldinia concentrica (Bolt.) Ces. & DeNot.
On Magnolia Virginica (M. glauca), Lee, 11, 1895; Winston, 6, 1896.
Daldinia vernicosa (Schw.) Ces. & DeNot.
On Magnolia Virginica (M. glauca), Lee, 11, 1895.
Diaporthe dichaenoides (B. & C.) Sacc.*
On Quercus, (Beaumont).
Described in Grevillea, 4 : 98, under *Melogramma*, as follows: "Maculis ostiolis conicis rugosis exasperatis; sporidiis oblongis obtusis uniseptatis."
"Looks at first like a *Dichaena;* spots bursting out transversely, but generally orbicular, very rough with conical rugose pulverulent ostiola; asci clavate; sporidia hyaline in one or sometimes two rows, oblong, sometimes narrower below, obtuse, .001 long."
Diatrype disciformis (Hoffm.) Fr.*
(Peters in Grevillea, 4 : 95.)
Diatrype platystoma (Schw.) Berk.
On Ostrya, (Peters in Rav. Fung. Car. exsic. 5 : 55, under *Hypoxylon.*
Diatrype stigma (Hoffm.) DeNot.
On dead limb, Winston, 6, 1896.
Diatrype tremellophora Ell.
On Magnolia Virginica (M. glauca), Lee, 1, 3, 1896.

Diatrype virescens (Schw.) Ell.
(Peters in Grevillea, 4 : 95, under *D. disciformis virescens.*)
On Fagus Americana, Lee, 2, 1896.
Diatrypella Cephalanthi (Schw.) Sacc.*
(Beaumont in Grevillea, 4:96, under *Diatrype*).
Diatrypella discoidea Alni Cooke.
On Alnus serrulata, Lee, 1, 5, 1896.
Diatrypella nigro-annulata (Grev.) E. & E.
On dead twigs, Lee, 6, 1896.
Diatrypella quercina (Pers.) Nits.
(Peters, in Grevillea, 4:95).
On dead twig, Lee, 2, 1896.
Didymosphaeria polysticta (B. & C.) Sacc.*
On Smilax, (Beaumont).
Described in Grevillea, 4:149, under *Sphaeria*, as follows: "Ostiolo excepto cuticula tecta; ascis linearibus; sporidiis oblongis uniseptatis fuscis."

"Perithecia scarcely raising the cuticle, visible chiefly from the black dot-like ostiola; asci linear; sporidia oblong, uniseptate, .0003 long, rather more than twice as long as wide."

Endothia gyrosa (Schw.) Fckl.
On Liquidambar, Lee, 3, 1896.
On Quercus, Lee, 2, 1896.
Eutypa spinosa (Pers.) Tul.
On Quercus, Lee, 2, 4, 1896.
Eutypella cerviculata (Fr.) Sacc.
On Alnus serrulata, Lee, 3, 1896.
Eutypella glandulosa (Cooke) E. & E.
On Melia Azedarach, Lee, 3, 1896.
In our specimens the ostiola are not distinctly sulcate, but are long exserted, with the mouths smoothly umbilicate; perithecia few, often only one or two; asci 20x4 μ; spores 4x1 μ. The general appearance, and the minute asci and spores so much resemble specimens of the species on Ailanthus (Rav. N. A. Fungi exsic. 6[illegible]; Ellis N. A. F. 2343), that we can hardly consider it distinct.

Eutypella Platani (Schw.) Sacc.

On Platanus, (Peters in Rav. Fung. Car. exsic. 5:62).

Eutypella stellulata (Fr.) Sacc.

On Melia Azedarach, Lee, 3, 1896.

On Smilax sp., Lee, 2, 1896.

Fracchiaea calista (B. & C.) Sacc.

On Carpinus, (Peters in Rav. Fung. Car. exsic. 5:67).

Heptameria mesoedema (B. & C.) Sacc.

On Eupatorium sp., Lee, 1891, (Duggar).

Herpotricha rhodomphala (Berk.) Sacc.

On dead wood, (Beaumont in Peters Coll. 3:44).

Hypoxylon annulatum (Schw.) Mont.

On Acer rubrum, Lee, 2, 1896.

On Magnolia Virginica (M. glauca), Lee, 3, 1896.

On Quercus sp., Lee, 2, 3, 1896.

Hypoxylon atramentosum (Fr.)

On dead wood, Lee, 12, 1895; 1, 2, 1896.

Hypoxylon Beaumontii B. & C.*

Alabama (Beaumont).

Described in Grevillea, 4:93, as follows: "Peritheciis globosis connatis; ostiolo distincto papillaeformi; sporidiis oblongo-ellipticis uniseptatis."

"Perithecia rather small at first, slightly brown, then black, smooth, with a distinct papillaeform ostiolum; asci linear; sporidia uniseriate, oblongo-elliptic, .0004 long, uniseptate."

From this description Saccardo (Syll. Fung. 1:753) puts this in *Valsaria;* but Cooke (Grevillea, 11:134) says "The sporidia are certainly not septate in the original specimens. It is an effused *Hypoxylon.*"

Hypoxylon calostroma (Schw.) B. & C.*

On Ilex verticellata, (Beaumont in Grevillea, 4:51).

Hypoxylon caries (Schw.) Sacc.

On Acer, Lee, 2, 1896.

On dead wood, Lee, 3, 1896.

Hypoxylon coccineum Bull.

On Alnus serrulata, Lee, 3, 1896.

Hypoxylon crocopeplum B. & C.

On bark, Lee, 12, 1895.

Hypoxylon decorticatum (Schw.) Berk.
On bark, Lee, 2, 1896.
Hypoxylon fuscum (Pers.) Fr.
On Alnus serrulata, Lee, 12, 1895.
On Ostrya Virginiana, Lee, 2, 1896.
Hypoxylon Howeianum Peck., Lee, 2, 1896.
Lee, 2, 1896.
Hypoxylon insidens (Schw.) Fr.
On Liriodendron tulipifera, Lee, 2, 1896.
Hypoxylon investiens (Schw.) Berk.
On Liriodendron, (Beaumont in Rav. Fung. Car. exsic. 4:33).
On dead wood, Lee, 3, 4, 1896.
Hypoxylon luridum Nits.
On carpinus, Lee, 1896.
Hypoxylon marginatum (Schw.) Berk.
On Acer rubrum, Lee, 3, 1896.
On Quercus nigra (Q. aquatica), Lee, 3, 1896.
On Quercus, (Beaumont in Grevillea, 4:49).
Hypoxylon perforatum (Schw.) Fr.
On Arundinaria tecta, Lee, 1891, (Atkinson). (?)
On Liquidambar, Lee, 1, 1896.
On Quercus, Lee, 1, 1896.
On Smilax, Lee, 1, 1896.
On Vitis, Lee, 1, 1896.
Hypoxylon Petersii B. & C.
On Quercus alba, Winston, 1882, (Peters in Peters Coll., 1:158).

Described in part from Alabama material in Jour. Linn. Soc. 10:384, as follows: "Stromate pulvinato hemisphaerico duro ex umbrino nigro, intus umbrino; peritheciis stratosis elongatis; superficie papillosa, ostiolis minutis nigris. (329)."

"On dead wood. Hab. Alabama. Stroma 1 inch across, 1-3 thick. Surface, at length, sometimes cracked, so as to show the internal umber tint. Sporidia .0003 inch long."

Hypoxylon rubignosum (Pers.) Fr.
On dead wood, Lee, 2, 3, 1896.

Hypoxylon rutilum Tul.
On oak bark, Winston, 6, 1896.
Hypoxylon serpens Pers.*
(Beaumont in Grevillea, 4:93.)
Hypoxylon subchlorinum E. & Calk.
On Alnus serrulata, Lee, 2, 1896.
On Carpinus Caroliniana, Lee, 2, 1896.
On Viburnum sp., Lee, 1, 1896.
Hypoxylon xanthocreas B. & C.
On Alnus serrulata, Lee, 2, 1896.
Laestadia Bidwellii (Ell.) Sacc. "Black rot."
On Parthenocissus quinquefolia (Ampelopsis), Lee, 1890, (Atkinson).
On Vitis sp. (cult.), Lee, 1891, (Atkinson).
On Vitis rotundifolia, Lee, 1890, (Atkinson).
On Vitis vinifera, Lee, 1891, (Atkinson).
Lasiosphaeria pezizula (B. & C.) Sacc.
On dead wood, Lee, 1, 2, 1896.
Lasiosphaeria Rhacodium (Pers.) DeNot.
On rotten wood, Lee, 2, 1896.
Leptosphaeria Beaumontii (B. & C.) Sacc.*
On grass, (Beaumont).
Described in Grevillea, 4:145, under *Sphaeria*, as follows: "Linearis brevis erumpens, axis elongatis, sporidiis biserialibus linearibus multiseptatis."

"Forming little short black lines bursting through the cuticle; asci elongated, clavate; sporidia linear, sometimes oblique, with about nine septa, and a nucleus in each joint, .002 long."

Leptosphaeria orthogramma (B. & C.) Sacc.
On Erianthus sp., Macon, 4, 1896.
Massaria epileuca B. & C.
On Morus rubra, Lee, 1, 1896.
Melogramma Meliae Curt.
On Melia Azedarach, Lee, 3, 1896.
Metasphaeria infuscans E. & E.

On Andropogon Virginicus, Lee, 10, 1891, (Atkinson in N. A. F. 2754).

Nummularia clypeus, (Schw.) Cke.
On Alnus serrulata, Lee, 11, 12, 1895.
On Magnolia Virginica, (M. glauca) Lee, 12, 1895.
On Quercus sp., Lee, 12, 1895; Macon, 8, 1896, (Carver).
On Vitis sp., Lee, 1, 1896.

Nummularia discreta (Schw.) Tul.*
On Cercis, (Peters, Grevillea, 4:94).

Nummularia punctulata (B. & Rav.) Sacc.
On Alnus serrulata, Lee, 3, 1896.
On Quercus sp., Lee, 3, 1896.

Nummularia repanda (Fr.) Nits.
On Cercis, Peters Coll. 3;66, (under *Sphaeria*).

Ohleria regulosa Fckl.
Lee, 2, 1896.

Ophiobolus acuminatus (Sowb.) Duby.*
(Peters in Grevillea, 4:150, under *Sphaeria*).

Ophiobolus anguillides (Cooke) Sacc.
On Ambrosia artemisiaefolia, Lee, 1892, (Atkinson).

Ophiobolus glomus (B. & C.) Sacc.*
On Ambrosia, (Beaumont).
Described in Grevillea, 4:152, under *Sphaeria*, as follows: "Convexa media perforata; sporidiis linearibus sigmoideis; stylosporis obovatis primum per paria connatis."

"Perithecia convex, perforated; sporidia linear, sigmoid, .001–002 long. Stylospores are produced within flat dark specks, seated on forked threads, and at first joined in pairs so as to make an obovate mass, then separating and still obovate but narrow, .001 long."

Phomatospora argyrostigma (Berk.) Sacc.
On Yucca filamentosa, Lee, 2, 1896.

Physalospora disrupta (B. & C.) Sacc.
On Smilax sp., Lee, 3, 1896.

Physalospora phlyctanoides (B. & C.) Sacc.*
On Dolichos, (Beaumont).

Described in Grevillea, 4:151, under *Sphaeria*, as follows: "Irregularis fusca deplanata; ascis late lanceolatis brevibus; sporidiis biseriatis cymbaeformibus endochromate utrinque retracto."

"Forming little brown irregular specks on a white ground; asci short, broadly lanceolate; sporidia cymbaeform, with the endochrome retracted at either end, .0005–.00057 long."

Pleospora herbarum (Pers.) Rabh.*

(Beaumont, Grevillea, 4:150, under *Sphaeria*).

Plowrightia morbosa (Schw.) Sacc. "Black knot."

On Prunus augustifolia, Lee, 11, 1895.

On Prunus domestica, (Pike roads), 1891, (Atkinson).

On Prunus serotina, Lee, 2, 1896.

On Prunus triflora, Mobile, 1, 1896.

On Prunus umbellata, Lee, 1881, (Newman).

Poronia Œdipus Mont.

On horse dung, (Peters in Rav. Fung. Car. exsic. 3:46).

Rosellinia aquila (Fr.) DeNot.

On Liriodendron, Lee, 1, 4, 1896.

Rosellinia pulveracea (Ehrh.) Fckl.

On Vitis rotundifolia, Lee, 2, 1896.

Rosellinia subiculata (Schw.) Sacc.

On rotten wood, Lee, 2, 1896.

Sphaerella colorata Peck.

On Kalmia latifolia, (Peters in Rav. Fung. Car. exsic. 3:71, under *Depazea kalmicola S*).

Lee, 1891, (Atkinson).

Sphaerella Fragariae Tul.

On Fragaria sp. (cult.), Mobile, 12, 1895.

Sphaerella gossypina Atks.

On Gossypium herbaceum, (Albert Station), 1890, (Cathcart).

Described in Bull. Torr. Bot. Club, 18:300, in part as follows: "Perithecia immersed, ostiolum projecting—66–70x 65–90u. Asci subcylindrical, varying to slightly clavate or lanceolate, 8–10x40–45u.—spores elliptical, or nearly fusoid, and when mature constricted at the septum, one cell being usually somewhat smaller than the other. They are obliquely uniseriate or partly biseriate, 3-4x15-18 μ,"

Sphaeria (Depazea) concentrica B. & C.*

On Asarum Virginicum.

Described in Grevillea, 4:155 as follows: "Maculis annulis concentricis albis bruneisque variegata, peritheciis in annullis pallidis sitis."

"Spots more than an inch in diameter, orbicular, consisting of about seven alternate white and brown rings; perithecia numerous, situated on the fallen rings. Unfortunately I could find no perfect fruit."

Sphaeria palmarum Mont.*

On Sabal, (Beaumont, Grevillea, 4:147).

Trabutia quercina Fr.

On Quercus nigra (Q. aquatica), Lee, 4, 1896.

Ustulina vulgaris Tul.

On old stumps, Lee, 2, 3, 1896.

Valsa Americana B. & C.

Peters Coll. 3 : 67.

Valsa munda B. & C.*

On branches of Cornus, (Peters).

Described in Grevillea, 4 : 100, as follows: "Subcuticularis disco parvo albocincto; ascis lanceolatis; sporidiis allantoideis."

"Pustules completely covered by the bark, which is blackened over them, or appears black by transparence, the disc alone, which is bordered with white, being free; asci lanceolate; sporidia sausage-shaped."

Valsaria exasperans (Ger.) E. & E.

On bark, Lee, 2, 1896.

Xylaria corniformis Fr.

On Salix, Lee 2, 1896.

The conidial state, *Isaria flabelliformis*, (*Thelephora roselal Pk.)* Lee, 5, 1896.

Xylaria fulvella B. & C.

On Salix, Lee, 2, 1896.

Described from Alabama material in Jour. Linn. Soc. 10 : 380, as follows: "Clavata, rubiginosa, papillata; peritheciis semiprominulis, ostiolis nigris; stipite cylindrico pallide fulvo lineato-rugoso (590)."

"On dead wood. Hab. Alabama (No. 4902). Sporidia oblong, .0003 inch long. Closely allied to an Australian species, *X. phosphorea* B. MS., but differs in the absence of the white ring around the ostiolum. The Cuban specimens are immature, so that the characters are drawn up from the Alabama plant."

Xylaria Hypoxylon (L.) Grev.

On Acer rubrum, Lee, 2, 1895.

Xylaria polymorpha (Pers.) Grev.

Conidial stage, Lee, 4, 1896.

Ascomycetous stage, Hale, 5, 1896.

ORDER DOTHIDEALES.

Phyllachora Ambrosiae (B. & C.) Sacc.

On Ambrosia artemisiæfolia, (Beaumont), Lee, 1891, (Duggar).

On Ambrosia trifida, 1891, (Duggar).

Described, under *Dothidea*, in Grevillea, 4:105, as follows: "Convexa nitida; ascis linearibus; sporidiis uniseriatis ellipticis hyalinis."

"Convex, shining; asci linear; shorter than the slender paraphyses; sporidia uniseriate, elliptic, hyaline."

Phyllachora Beaumontii (B. & C.) Cooke.

On Prunus Caroliniana, Macon, (Beaumont, Peters Coll. 1:194).

Described in Grevillea, 13:63, as follows: "Epiphylla. Stromate hemisphærico-convexo, atro (5mm. diam.) opaco ad basim contracto; ascis clavatis; sporidiis inordinatis, ellipticis, continuis, hyalinis, (.008-.01x.004mm.)."

Phyllachora graminis (Pers.) Fckl.

On Andropogon Virginicus, Lee, 1891, (Duggar).

On Eragrostis tenuis, Lee, 1891, (Duggar).

On Muhlenbergia diffusa, Lee, 1891, (Duggar).

On Panicum ciliatifolium, Lee, 1891, (Duggar).

On Panicum dichotomum, Lee, 1891, (Duggar).

On Panicum Porteranum, Lee, 1891, (Atkinson).

On Panicum sp., Lee, 1891, (Duggar); Macon, 8, 1896, (Carver).

On Paspalum læve, Lee, 1891, (Duggar).

On Paspalum setaceum, Lee, 1891, (Newman).

Phyllachora Lespedezae (Schw.) Cooke.

On Lespedeza sp., Lee, 11, 1896.

Phyllachora Ulmi (Duv.) Fckl.

On Ulmus sp., Macon, 8, 1896, (Carver).

Scirrhia Groveana Sacc.

On Typha latifolia, Lee, 3, 1896.

Agrees with the description, except in the somewhat smaller asci and spores. In our specimens the asci are about 40µ long; and all the asci in a cell escape together in a globular fassicle.

Order Hysteriales.

Angelina rufescens (Schw.) Duby.

On Quercus (Peters), Rav. Fung. Car. exsic. 5:44, under *Ascobolus conglomeratus* Schw.

Aulographum pinorum Desm.

On pine needles, Lee, 1, 1891.

Dichaena faginea (Pers.) Fr.

On Fagus Americana, Lee, 3, 1896.

Dichaena sp.*

On Quercus, (Peters).

Mentioned in Grevillea, 4:158, as being probably a form of *D. quercina.*

Gloniella Curtisii (Duby) Sacc.

On Vitis, dead stems, Lee, 7, 1896.

Gloniopsis praelongum, (Schw).

On Morus, Lee, 4, 1896.

This is *Gloniopsis lineolatum* (Cooke) Sacc., and *Hysterographium praelongum* (Schw.) E. & E.

Gloniopsis smilacis, (Schw).

On Smilax, Lee, 1896.

This is evidently a *Gloniopsis* and not a *Hypoderma,* where it is placed by Rehm and Saccardo.

Glonium chlorinum (B. & C.) Sacc.*

On Quercus nigra (Q. aquatica), Beaumont.

Described in Grevillea, 4 : 12, as follows : "Cito liberatum ellipticum primum chlorino-pruinosum, demum denudatum ; labris sulcatis ; sporidiis biseriatis magnis oblongis hyalinis uniseptatis medio contractis."

"Soon liberated from the cuticle, elevated from the bark, often narrowed at the base, elliptic, at first greenish from a fine powdery coat, which soon wears off ; lips sulcate ; disc greenish ; sporidia in two rows, oblong, uniseptate, constricted in the middle, .003 long ; the endochrome has frequently a little emargination."

Glonium lineare angustissimum DeNot.

On Liquidambar, Lee, 3, 1896.

Glonium macrosporum Tracy & Earle.

On Prunus serotina, Lee, 2, 1896.

On Rubus villosus, Lee, 4, 1896.

On Vitis rotundifolia, Lee, 2, 1896.

Glonium parvulum (Ger.) Sacc.

On Hicoria, Lee, 2, 1896.

On Liriodendron, Lee, 2, 1896.

Glonium stellatum Muhl.

(Beaumont in Rav. Fung. Car. exsic. 3 : 43.)

On rotten log, Lee, 1, 1896.

Glonium velatum E. & E.

On dead wood, Lee, 2, 1896.

Hypoderma ilicinum DeNot.

On Quercus nigra (Q. aquatica), Lee, 7, 1896.

On Quercus sp., dead leaves, Lee, 1, 1896.

Hysterium insidens Schw.

On dead wood, Lee, 2, 1896.

Hysterium macrosporum Peck.

On weathered pine wood, Lee, 3, 4, 1896.

Hysterium Prostii Duby.

On Quercus, Lee, 2, 1896.

Hysterium pulicare Pers.

On Betula, Macon, 4, 1896.

Hysteriographium Mori (Schw.) Rehm.
On Gleditschia, Lee, 2, 1896.
Hysterographium vulvatum (Schw.) Rehm.
On Quercus sp., Lee, 2, 1896.
On Vitis rotundifolia, Lee, 2, 1896.
Lembosia illiciicola Tracy & Earle.
On Illicium Floridanum, Mobile, 3, 1896.
Lophodermium arundinaceum (Schrad) Chev. (?)
On Arundinaria, Lee, 1, 1896.
Lophodermium culmigenum (Fr.) Karst.
On Arundinaria, (dead sheaths,) Lee, 1, 1896.
Lophodermium cyrillicolum Tracy & Earle.
On Cyrilla racemiflora, Lee, 4, 1896.
Lephodermium Petersii (B. & C.) Sacc.*
On Juniperus, (Peters).
Described in Grevillea, 4:13, under *Hysterium*, as follows: "Cuticula conditum ellipticum elongatumve flexuosum sporidiis filiformibus."

"Covered by the cuticle, elliptic, or elongated and flexuous; sporidia filiform. This does not grow on a pallid spot."

Lophodermium Pinastri (Schad.) Chev.
On Pinus echinata (P. mitis), dead needles, Lee, 3, 1896.
Tryblidiella rufula (Spreng.) Sacc.
On Rhus, (Beaumont), Peters Coll. 3:66.
On dead twigs, Lee, 1, 1896.
Tryblidiella rufula microspora (E. & E.)
On Melia Azedarach, Lee, 3, 1896.

ORDER PHACIDIALES.

Coccomyces Juniperi Karst, (?).
On bark of Juniperus, Peters Coll. 1:150, under the herbarium name of *Rhytisma Petersii* B. & C. The specimen is referred as above with some doubt since the spores are considerably longer than in the published description.

Coccomyces triangularis (Schw.) Sacc.
On Quercus, Lee, 4, 1896.
In our specimens the asci are about 100u long, spores filiform, about equalling the ascus, paraphyses thread like, branched, loosely coiled at the tip like a tendril.

Dothiora asterinospora (E. & E.) Sacc.

On Ilex, (Peters), Rav. Fung. Car. exsic. 3:63 under *Tympanis picastra* B. & C.

On living bark of various trees, Lee, 1, 2, 3, 1896.

Phacidium elegantissimum B. & C.*

On leaves of Ilex, (Peters).

Described in Grevillea, 4:8, as follows: "In maculis orbiculares albas nigrocinctas situm punctiforme angulatum."

"Seated on white orbicular black-margined spots, minute, angular. An extremely pretty species, but unfortunately I have found no fruit."

Rhytisma acerinum (Pers.) Fr.

On Acer rubrum, Lee, 11, 1895; 3, 10, 1896.

Rhytisma Curtisii B. & Rav.

On Ilex opaca, Lee, 4, 1896.

The oval spores (16x4u) and gross appearance on the leaf make it very doubtful if this should be retained under *Rhytisma*.

Rhytisma decolorans Fr.

On Xolisma ligustrina (Andromeda), Lee, 1, 1896; Macon, 8, 1896 (Carver).

Rhytisma Solidaginis Schw.

On Solidago Canadensis, Lee, 1891 (Newman).

Rhytisma tostum B. & C. *

On Quercus lancifolia, (Beaumont).

Described in Grevillia, 4:9, as follows: "Tenue in maculam luteam situm, gyrosum hic illic tantum fertile."

"Seated on yellow spots, thin, gyrose, only here and there producing fruit bearing perithecia, which soon shell off. Undoubtedly distinct, but the specimens are imperfect."

Rhytisma Vaccinii (Schw.) Fr.

On Vaccinium arboreum, Lee, 1891, (Atkinson).

Scleroderris concinna (B. & C.) Sacc.*

On Sassafras, (Peters).

Described in Grevillia, 4:5, in part from Alabama material, under *Cenangium*, as follows:—"Cupulis sessilibus subtiliter pulverulentis marginatis; disco plano nigro; sporidiis biserialibus oblongis triseptatis."

"Cups flat, with a strong brownish margin; disc black; sporidia biseriate; sporidia oblong, triseptate, .0006 long."

ORDER PEZIZALES.

Acetabula Acetabulum, (L).

On ground in pine woods, Lee, 4, 1896.

Agyrium brunneolum B. & C.*

On roots of pine, (Beaumont).

Described in Grevillea, 4:6, as follows:—"Convexum brunueolum, ascis oblongis; sporidiis minoribus breviter fusiformibus."

"Much larger than the last (*A. Tuckermanii* B. & R.), with narrower oblong asci, and smaller sporidia. The wood is not bleached."

Agyrium rufum (Pers.) Fr.*

On dry fir wood, (Peters), Grevillea, 4:6.

Ascobolus brunneus Cooke.

On cow dung, Lee, 1, 1896.

Barlaea exasperata (B. & C.) Sacc.*

On burnt earth, (Peters).

Described in Grevillea, 3:152, under *Peziza*, as follows:—"Coccinea; cupula subglobosa extus verruculosa; margine inflexo; sporidiis globosis echinulatis."

"Cup ½ inch across, scarlet, subglobose, clothed externally with minute warts; margin inflexed; sporidia globose echinulate, .0005 in diameter."

Belonidium Aurelia (Pers.) DeNot.

On Liriodendron, (Peters), Rav. Fung. Car. exsic. 5:41, under *Peziza*.

Belonium eustegiaeforme (B. & C.) Sacc.

On Arundinaria sp. Lee, 1, 1896.

Bulgaria inquinans (Pers.) Fr.

On Quercus coccinea, (Peters), Rav. Fung. Car. exsic. 5:43.

Cenangella Ravenelii (Berk,) Sacc.*

On Ilex prinoides, (Peters).

Described in part from Alabama material in Grevillea, 4:3, under *Tympanis*, as follows :—"Sparsa vel fasciculata;

cupulis breviter pedicellatis marginatis, disco cinereo; sporidiis biconicis commissura medioque constrictis."

"Scattered or fascicled, cups strongly marginate, shortly pedicellate, disc cinereous; sporidia biconical, the divisions and commissure constricted, with occasionally a globular body at the commissure, 0013-0015; paraphyses crowned with narrow abovate conidia."

Cenangium Cephalanthi (Schw.) Fr. *

On Cephalanthus occidentalis, (Peters), Grevillea, 4:4.

Cenangium contortum B. & C.

On dead wood, Peters Coll. 1:149.

Described in Grevillea, 21:75, as follows: "Gregarious, black, cups at first orbicular, sessile, then variously contorted when dry, margin slightly elevated, then somewhat connivent (1-2mm. broad), smooth. Asci cylindrical, cotosporous. Sporidia hyaline, allantoid, obtuse, 8x1-½ ú."

Cenangium leptospermum B. & C.*

On Abies, (Peters).

Described in Grevillea, 3:5, as follows: "Fasciculatum minutum nitidum subglobosum disco punctiformi; sporidiis elongato-fusiformibus arcuatis pluri-nucleatis."

"Fasciculate, minute, shining, subglobose, disc small almost punctiform; sporidia slender, fusiform, arched, with many globose nuclei."

Cenangium Magnoliae B & C.*

On Laurus, (Beaumont).

Described in part from Alabama material, in Grevillea, 4:5, as follows: "Caespitosum apertum marginatum nigrum; ascis amplis, sporidiis magnis allantoideis."

"Caespitose; disc open, marginate, black; asci ample, sporidia sausage shape, .0013 long, about half as much wide."

Cenangium turgidum Fr.

On Quercus, (Peters), Rav. Fung. Car. exsic. 4:24.

Cenangium ustale (B. & C.) Sacc.*

On decayed twigs, (Peters).

Described in Grevillea, 3;152, under *Peziza*, as follows:

"Congesta irregularis extus rufa subtiliter tomentosa; hymenio spadiceo; stipite cylindrico brevi."

"Crowded, irregular, externally rufous, minutely tomentose; hymenium bright brown; stem short, cylindrical."

Chlorosplenium versiforme (Pers.) Karst.*

On Quercus, (Peters), Grevillea, 3:160.

Dasyscypha Arundinariae (Berk.) Sacc.

On Arundinaria, Lee, 5, 1896.

Ascoma 0.5mm. spores oblong, 6x1 ú, paraphyses fusiform, rigid, acute.

Dasyscypha calycina (Schum.) Fckl.

On Pinus, Peters Coll. 3:16.

Dasyscypha lacnoderma (Berk.) Rehm.

On Pinus, Lee, 3, 7, 1896.

Erinella sp.

On Magnolia, Peters' Coll. 1:28, under *Peziza albo-violacea* A. & S. Closely sessile; ascoma covered with short, white or flesh colored hairs, upturned margine narrow, disc flat, expanded, ochraceous, about 1mm.; asci narrowly clavate, obtuse, about 80x6 ú; paraphyses thread like equaling the asci; spores thread like, nearly straight in the ascus, multiseptate, faintly yellowish, about 75x1½ ú.

Humaria spissa (Berk) Sacc.*

On the ground, (Peters).

Described in Grevillea, 3:152, as follows: "Cupulo irregulari; margine lobato; hymenio crasso spadiceo; stipite brevissimo candido; sporidiis ellipticis binucleatis."

"Cups ¾ inch across, irregular; margin lobed; hymenium thick, bright brown, rather convex; stem very short, white; sporidia elliptic, binucleate, .00057 long."

Lachnea scutellata (L.) Sacc.

On rotten wood, Peters' Coll. 1:32.

Winston, 6, 1896.

Lachnella extricata (B. & C.) Sacc.*

On some unbellifer, (Peters).

Described in Grevillea, 3:152, as follows: "Erumpens, congesta margine undulato; extus pallide umbrina sericeo-tomentosa, intus albida."

"Bursting through the cuticle; crowded; margin undulated, externally pale umber, hymenium dirty white."

Lanzia rugipes (Peck) Sacc.

Lee, (Atkinson).

Lecanidion atratum (Hedw.) Rabenh.

On Liriodendron, Lee, 2, 1896.

Macropodia macropus (Pers.) Fuckel.

Peters Coll. 3,17, July 1855.

Macropodia pubida (B. & C.) Sacc.*

On the ground, (Peters).

Described in Grevillea, 3:153, under *Peziza*, as follows: "Cupulis congestis hemisphericis, margine inflexo extus stipiteque brevi velutinis; paraphysibus brunneis; sporidiis fusiformibus granulatis."

"Cups $\frac{3}{4}$ inch across, crowded, hemispherical, with an inflexed margin, velvety externally as well as the short stem; paraphyses brown; sporidis spindle-shaped, granulated, .001-0015 long. Mycelium densely betulose. Closely allied to the last (*Peziza senitosta* B. & C)."

Macropodia Schweinitzii Sacc.

Lee, (Atkinson).

Niptera atro-fusca (B. & C.)

Peters' Coll. 1:13, under *Peziza atro-fusca* B. & C.

This is the *Tapesia atro-fusca* (B. & C.) Sacc. (Syll. Fung. 8:373); but as the spores in our specimen are clearly septate it must be transferred to *Niptera*. We find the following characters. Ascoma covered with crisp fuscous hairs, which are about 40x6 μ; asci slender, cylindrical, spore bearing part 50x5μ; Spores end to end in a single rank, oval, colored, uniseptate, about 8x4μ; paraphyses and asci staining red in potash; paraphyses about 60x2 μ, simple, straight, thread-like.

Ombrophila decolorans (B. & C.) Sacc.*

On Quercus, (Peters).

Described in Grevillea, 4:6, under *Bulgaria*, as follows: "Alba demum cornei-color concava extus cum stipite venosa; ascis elongatis; sporidiis uniseriatis oblongo-cymbaeformibus."

"At first white, then horn-colored, externally venose, together with the short stem; asci long; sporidia in a single row, oblongo-cymbaeform, .0013 long, about 1-5 as much wide."

Orbilia vinosa (A. & S.) Karst.

Peters' Coll. 3:26.

Otidea euplecta Cooke.*

On moist sandy soil, (Peters), Grevillea, 3:151, under *Peziza phlebophora* B. & Br. Var.; with the remark: "The sporidia are .00074 long, whereas in the British plant they are .0004 long. There is apparently no other difference." It is described and figured in Cooke Mycogr. 125, f. 216, as follows: "Sessilis, obliqua, subochracea, intus fuscescens, extus farinosa, basi plicato-costata. Ascis cylindraceis, elongatis. Sporidiis ellipticis, laevibus. Paraphysibus sursum incrassatis."

"Cups ½-1 1-3 in. broad. Sporidia .02x012mm. Quite dfffferent from *P. phlebophora*, with which it was at first associated."

Patinella inquinans (Cooke) Sacc.

On dead wood, Lee, 3, 1896.

Pezicula rhabarbarina (Berk.) Tul.*

On Cornus Amonum (C. sericea) (Peters), Grevillea, 4;2, under *Patellaria*.

Peziza aurantia Pers.

On the ground, Peters Coll. 11, 1864; Lee, 12, 1896.

Peziza badia Pers.

On the ground, Lee, 3, 1896.

Peziza chlora Schw.

(Peters) Rav. Fung. Car. exsc. 5:39. Our specimen seems to be an *Erinella*, but it is rather immature. We cannot trace this species in Sacc. Syll. Fung.

Peziza cochleata L.

Peters Coll. 1:26.

Peziza decolorans B. & C. *

On the grounds, (Peters).

Described in Grevillea, 3 : 150, as follows:— "Cupula parva obconica ; ex albo fuliginea ; sporidia ellipticis binucleatis."

"Cups small, obconical, then dingy; sporidia elliptic, binucleate, .00057.

Peziza Petersii Berk.*

On burnt soil (Peters).

Described in Grevillea, 3:150, as follows:— "Gregaria crispata extus pallida ; hymenio spadiceo ; sporidiis ellipticis angustis binucleatis."

"An inch or more across, rather shallow, gregarious, crisped, externally pallid; hymenium bright brown; sporidia narrow, elliptic, binucleate, .00038 long."

Pezizella soleniformis (B. & C.) Sacc.

On dead wood. Peters Coll. 3:17.

Described in Grevillea. 3:160, under *Peziza*, as follows:— "Minuta candida primum hemispherica, margine tumido, dein cylindrica, demum ore expanso flexuoso."

"Minute, white, at first hemispherical, with a swollen margine, then cylindrical; mouth at length expanded; flexuous. A curious little species."

Phialea cyathoidea (Bull.) Gill.*

(Peters), Grevillea, 3:160, under *Peziza*.

Phialea fructigena (Bull.) Gill.

On Hicoria (shells), Lee, (Atkinson).

Pseudohelotium sacchariferum (Berk.) Sacc. *

On Liquidambar, (Peters).

Described in Grevillea, 3:157, under *Peziza* as follows:— "Mollis gregaria pallide aurantiaca irregularis extus saccharina ; margine tumidula ; disco concavo."

"Soft gregarious, pale orange, irregular, externally saccharine ; margin swollen; disc concave."

Pyrenopeziza atrata (Pers.) Fckl.*

On Solidago, (Peters, Beaumont), Grevillea, 3:159.

Sarcoscypha occidentalis (Schw.) Sacc.*

On the ground, (Peters) Grevillea, 3:152, under *Peziza*.

Sphaerospora confusa Cooke.

On burnt ground in damp woods, Lee, 7, 1886.

Tapesia candido-fuiva (Schw.) Saac.

On dead wood, Lee, 1896. Spores cylindric, somewhat curved, 12x3ú

Urnula craterium (Schw.) Fr.

On the ground, Lee, 3, 1896.

Order Helvellales.

FAMILY RHIZINACEAE.

Psilopezia flavada. B. & C. *

On Quercus alba, (Peters).

Described in Grevillea, 4:1, as follows:—"Congesta flavida irregularis flexuosa; margine demum elevato; sporidiis oblongis."

"About one fourth inch across, dirty yellow, somewhat confluent, flexuous; asci linear; sporidia oblong, 0006 long, about half as wide."

Rhizina Inflata. (Schaeff.) Karst.

On the ground, Lee, 7, 1896.

FAMILY GEOGLOSSACEAE.

Geoglossum Peckianum Cke.

Winston, 1862 (Peters); Peters coll. as *G. Glutinosum.*

Leptoglossum Alabamense. Underw.

Alabama (Herb. A. P. I.) Described from Alabama material in Bull. Torr. Bot. Club, 24 : 82, as follows:—

"Black throughout, gregarious, 2-3 cm high. Ascoma about 1 cm. long, flattened, in the dry condition about 2 mm. wide and 0. 5. mm. thick, blunt or rounded, horny, yellowish within; stem roughened, somewhat enlarged at base; spores hyaline, straight or slightly more or less curved, biseriate in the asci, becoming 4 septate, 18-20 x 4 µ; paraphyses abundant, thickened and darker colored at the tip.

On the ground, Auburn, Alabama. July."

Mitrula Phalloides. (Bull.) Chev.

"Alabama" (Beaumont).

In swampy places, Lee, 5, 1896.

FAMILY HELLVELLACEAE.

Morchella Esculenta. (L.) Pers.

On the ground in low places, Lee, 3, 1896. A slender form with light brownish spores. This species and its congeners are known as "morels" are the most delicious of the edible species.

CLASS BASIDIOMYCETES.

ORDER USTILAGINALES.

Cerebella Andropogonis Ces.

On Chrysopogon avenaceus, Macon, 8, 1896, (Carver).

On Erianthus contortus, Macon, 8, 1896, (Carver).

Corebella Paspali Cke. & Mass.

On Paspalum platycaule, Lee, 1891, (Atkinson) ; Macon, 10, 1896, (Carver).

Cintractia axicola (Berk) Cornu.

On Cyperus, (Beaumont), Grevillea, 3:59.

On Fimbristylis autumnalis, Lee, 9, 1896.

Entyloma compositarum Farl.

On Gnaphalium sp. (?) Lee, 4, 1896.

Entyloma Saniculae Peck.

On Sanicula sp. Lee, 1892, (Atkinson).

Graphiola congesta Berk & Rav.

On Sabal Adansoni, Lee, 7, 1896.

Sorosporium Syntherismae (Schw.) Farl

On Andropogon macrourus, Lee, 1891, (Atkinson).

On Andropogon scoparius, Lee, 1891, (Atkinson).

On Andropogon Virginicus, Lee, 1889, (Atkinson, in Economic Fungi :74).

On Andropogon sp. Macon, 8, 1896, (Carver).

Ustilago Avenae (Pers.) Jensen.

On Avena sativa, Lee, 5, 1896.

Ustilago Euchlaenae Arcang.

On Euchlaena luxurians, Lee, 10, 1895.

Ustilago Rabenhorstiana Kuhn.

On Panicum sanguinalis, Lee, 1085.

Ustilago Sorghi (Link) Pass.

On Sorghum sp. Lee, 11, 1895.

Ustilago sparsa Underw.

In scattered ovaries of Dactyloctenium Aegyptium, Lee, 11, 1895; 10, 1896. Described from this material in Bull. Torr. Bot. Club, 24:86, as follows:

"Parasite infesting occasional ovaries and transforming them into somewhat spherical olivaceous pustules covered by the changed and roughened seed coat, 1–3 mm. in diameter, the remainder of the inflorescence unchanged; spores regularly oval, distinctly echinulate, about 7–9 µ in length."

"Related to *U. neglecta* Niessl. and *U. spermophora* B. & C., but distinguished from them by its larger pustules and smaller spores. It has nothing in common with *U. Dactyloctaenii* P. Henn. Die Pflanzenwelt Ost-Afrika, 5:48 which occurs on the same host, has dark violet horn-shaped sori and smooth spores, 10–14 µ."

"In scattered ovaries of *Dactyloctenium Aegyptium*, Auburn, Alabama, November, 1885, and October, 1896. Underwood & Earle."

Ustilago Tritici (Pers). Jensen.

On Triticum vulgare, Lee, 1891, (Atkinson).

Ustilago utriculosa (Nees.) Tul.

On Polygonum hydropiper, Prague, 6, 1890, (Atkinson).

On Polygonum Pennsylvanicum, Lee, 1891, (Atkinson).

Ustilago Zeae (Berkm.) Magn.

On Zea Mays, Lee, 1891, (Duggar).

ORDER UREDINALES.

Aecidium Asterum Schw.

Oh Aster sp. DeKalb, 5, 1896.

On Solidago Canadensis, Lee, 1892 (Duggar).

On Solidago sp. Lee, 1891 (Newman & Duggar); Dallas, 5, 1896; DeKalb, 5, 1896.

Aecidium compositarum Mart.

On Eupatorium purpureum, DeKalb, 5, 1896.

On Eupatorium verbenaefolium, DeKalb, 5, 1896.

On Helianthus sp., Madison, 5, 1896.
On Silphium sp. Lee, 5, 1896.

Aecidium Epilobii D. C.
On Oenothera laciniata (Œ. sinuata), Lee, 1891 (Atkinson).

Aecidium Euphorbiae Gmel.
On Euphorbia nutans, Lee, 7, 1896.

Aecidium Gerardiae Pk.
On Dasystoma flava, Madison, 5, 1896.

Aecidium Gnaphaliatum Schw.
On Gnaphalium purpureum, Lee, 7, 1896.

Aecidium hibisciatum Schw. *
On Hibiscus Moscheutos, (Peters).

Aecidium hydnoideum B. & C.
On Dirca palustris, (Peters); Distributed in Ravenel, Fung. Car. exsic. 4:94; Winston, 6, 1896.

Aecidium Hypericorum B. & C. *
On Hypericum sp. (Peters). Probably not distinct from Æ. hyperici frondosi Schw.

Aecidium Impatientis Schw.
On Impatiens aurea (pallida), Lee, 4, 1896; DeKalb, 5, 1896.

Aecidium leucostictum B. & C.
On Lespedeza, various species. DeKalb, 5,1896; Madison, 5, 1896.

Aecidium Lycopi Gerard.
On Lycopus Virginicus, Lee, 5, 1892, (B. M. Duggar).

Aecidium Mariae-Wilsoni Pk.
On Viola obliqua, Lee, 4, 1896; Peters' Coll. No. 196 reported as *Ae. Petersii* B. & C.

Aecidium Oldenlandianum Ell. & Tracy.
On Houstonia patens, Lee, 2, 1891 (Atkinson). Very distinct from *Ae. houstoniatum* Schw. and appears to agree with the above, though fresh material gathered in March, 1896, seems to show more conspicuous spotting of the leaves than is called for in the type.

Aecidium Orobi B. C. *
On Meibomia (Desmodium). (Peters). The only collec-

tion of an *Aecidium* on this host in this country which renders the determination of either the fungus or the host the more doubtful.

Aecidium Penstemonis Schw.

Penstemon pubescens, Lee, 5, 1896.

Aecidium Petersii B. & C.

On Viola, sp. (Peters).

On Viola pedata, Lee, 4, 1896.

This very distinct species was described from Alabama in Grevillea, 3:61. 1874, as follows:

"Pseudoperidiis gregariis cylindricis emacula flava oriundis."

"Pseudogregarious, cylindrical, seated on a yellow spot. Distinct from the last (*Ac. violac* D. C.)" The long cylindric bright yellow peridia opening by a narrow mouth with erect or incurved teeth clearly separates this species from our other *Aecidia* on Viola.

Aecidium Plantaginis Ces.

On Plantago Virginica, Lee, 3, 1896. Only once found'

Aecidium Proserpinacae B. & C. *

On Proserpinaca sp. (Beaumont).

Described in Grevillea, 3:60. 1874 from Alabama specimens as follows:

"Hypophyllum; pseudoperidiis sparsis margine radiatis; maculis nullis."

"Scattered over the surface of the leaves; margin of pseudoperidia radiated, spots none."

Aecidium Pteleae B. & C. *

On Ptelea sp. (Peters).

Described from Alabama specimens in Grevillea, 3:60. 1874, as follows:

"Maculis pallidis hypophyllis extrorsum bullatis; pseudoperidiis congestis brevibus radiatis."

"Spots pallid, in a hollow on the under side of the leaves; pseudoperidia crowded, short radiatek."

Aecidium Punctatum P.

On Anemone decapetale, Lee, 4, 1896.

Aecidium Sambuci Schw.

On Sambucus Canadensis, (Peters) ; Lee, 3, 1894 (Quaintance).

Aecidium Saniculae Carm.

On Sanicula sp. Lee, 3, 4, 1896.

Aecidium Verbesinae Schw.

On Verbesina occidentalis, DeKalb, 6, 1896. Although Schweinitz himself in his later writings combined this species with A. asteris. These specimens, if the same, seem very distinct in the character of the spores and peridium. The Aecidia on the Compositae need a careful revision.

Caeoma Agrimoniae Schw.

On Agrimonia parviflora, Lee, 1891 (Duggar).

On Agrimonia Mollis (?), Lee, 5, 1896.

Caeoma nitens Schw.

On Rubus trivialis, Mobile, 1891 (Zimmer).

On Rubus villosus, Lee, 1891 (Atkinson).

On Rubus sp., Lee, 4, 1896.

Chrysomyxa albida Kuhn.

On Rubus villosus, Lee, 1891, (Atkinson).

On Rubus sp., Macon, 1891, (Atkinson).

Coleosporium Amsoniae (Cke.)

(Trichobasis amsoniae Cke. in Ravenel, Fungi Americani, exsiccati, no. 489.)

On Amsonia tabernaemontana, Alabama, 1864, (Peters) Peters' Coll.; Lee, 7, 1896.

A very distinct species of *Coleosporium!*

Coleosporium Ipomoeae (Schw.) Burr.

On Convolvulus sepium, Lee, 1891, (Atkinson).

On Ipomoea pandurata, Lee, 7, 1896.

On Ipomoea purpurea, Lee, 1891, (Duggar & Newman).

On Ipomoea sp., Lee, 1890, (Atkinson).

A very abundant species.

Coleosporium Sonchi-arvensis (P.) Lev.

On Aster dumosus, Lee, 1891, (Atkinson).

On Aster puniceus, Lee, 1891, (Atkinson);.

On Aster Tradescanti, Lee, 1891, (Atkinson).

On Aster undulatus, Lee, 1891, (Duggar).

On Elephantopus Carolinianus, Lee, 1890, (Atkinson, Duggar).

On Elephantopus tomentosus, Lee, 1891, (Bennett, Newman).

On Elephantopus sp., Macon, 1890, (Atkinson).

On Helianthus sp., Lee, 1891, (Duggar, Atkinson).

On Liatris graminifolia, Lee, 1891, (Duggar).

On Solidago altissima, Lee, 1891, (Atkinson).

On Solidago caesia, Lee, 1891, (Atkinson).

On Solidago Canadensis, Lee, 1891, (Newman).

On Solidago sp., DeKalb, 5, 1896.

Coleosporium Vernoniae B. & C.

On Vernonia sp., (Beaumont).

On Vernonia sp., Lee, 10, 1895.

Originally described from Alabama specimens in Grevillea, 3:57. 1874, as follows:

"Maculis pallidis; soris parvis sparsis melleis; sporis exobovatis subfusiformibus triseptatis."

"Spots pallid; sori small, scattered, honey-colored, at first obovate, then subfusiform, triseptate, resembling those of *Bactridium*."

This species is referred to the preceding by most authors.

Gymnosporangium clavipes Cke. & Pk.

On Juniperus Virginiana, Lee, 1891, (Atkinson); 1892. (Duggar). Very common.

Gymnosporangium globosum Farl.

On Juniperus Virginiana, Lee, 3, 1896. Rare in Eastern Alabama.

Gymnosporangium macropus Link.

On Juniperus Virginiana, Lee, 1890, (Atkinson). Everywhere abundant, and in its alternating stage forming the "rust" on apples.

Gymnosporangium nidus-avis Thax.

On Juniperus Virginiana, Lee, 3, 1896. Rare.

Gymnosporangium sp.

On Juniperus Virginiana, Lee, 3, 1896. Frequent.

Melampsora farinosa (P.) Schroet.

On Salix fragilis, Lee, 1891, (Atkinson).

On Salix nigra, Lee, 1891, (Duggar).

On Salix sp., Lee, 1891, (Duggar).

Melampsora populina (Jacq.) Lev.

On Populus monilifera, Macon, 8 : 1896 (G. W. Carver).

On Populus grandidentata, Lee, 1889 (Atkinson).

On Salix sp, Macon, 8, 1896 (G. W. Carver).

Melampsora Scolopendri (Fckl.) Farl. (*Gloeosporium Phegopteridis.*)

On Woodwardia areolata, Macon, 8, 1896 (G. W. Carver).

Peridermium cerebrum Pk.

On Pinus echinata (P. mitis), Lee, 1896.

On Pinus Taeda Lee, 4, 1896.

On Pinus Virginiana, Winston, 6, 1896.

Peridermium orientale Cke.

On Pinus palustris Lee, 4, 1896.

On Pinus Taeda Lee, 4, 1896.

On Pinus sp. Macon, 4, 1896.

On Pinus sp. Dekalb, 5, 1896.

Phragmidium Fragariastri (DC.) Schroet.

On Duchesnea Indica (Fragaria) Lee, 2, 4, 1896; Tuscaloosa, 5, 1896. Uredospores only.

Phragmidium Rubi-Idaei (Pers.) Wint. (?)

On Rubus cuneifolius, Lee, 7, 1996. Aecidium (Caeoma) only; the specimens are referred with some doubt to this species; the spore masses occur in large pustules underneath the bark of the young stems forming when they burst bright golden patches; spores about 20-25μ oval or nearly spherical and almost smooth, in which they differ from European aecidial forms.

Puccinia Andropogi Schw.

On Andropogon argyrius, Lee, 1891 (Atkinson).

On Andropogon furcatus, Lee, 1891 (Duggar).

On Andropogon scoparius, Lee, 1891 (Duggar).

On Andropogon Virginicus, Lee, 12, 1895 ; 3, 1896.

On Andropogon sp. Lee, 1891, (Duggar).

Puccinia angustata Pk.

On Scirpus cyperinus eriophorum, Lee, 1890 (Atkinson), 1891 (Duggar).

Puccinia argentata (Schultz) Wint.

On Impatiens biflora (I. fulva), Lee, 1891 (Atkinson.)

Puccinia Asteris Duby.

On Aster sp. Lee, 1891 (Duggar); De Kalb, 5, 1896.

Puccinia Caricis (Schum.) Rebent.

On Carex lurida, Lee, 1891 (Atkinson.)

On Carex sp., Lee, 1891, (Duggar.)

Puccinia clavispora Ell. & Barth.

On Chrysopogon nutans, Lee, 12, 1895; 3, 1896; Macon, 8, 1896 (G. W. Carver.)

Puccinia Convolvuli Cast.

On Convolvulus sp., De Kalb, 5, 1896. (Aecidial stage only).

Puccinia emaculata Schw.

On Panicum maximum, Lee, 1891 (Duggar, Newman.)

On Panicum virgatum, Lee, 3, 1896.

On Sieglingia seslerioides, Lee, 1891 (Duggar.)

Puccinia Fuirenae Ckc.

On Fuirena squarrosa, Lee, 7, 1896.

On Fuirena sp. Lee, 1891 (Duggar.)

Puccinia graminis P.

On Hordeum vulgare, Lee, 7, 1896.

On Secale cereale, Lee, 1890 (Atkinson).

On Sieglingia seslerioides, Lee, 10, 1895.

On Triticum vulgare, Lee, 5, 1896.

On Vilfa aspera, Lee, 1889 (Newman.) Ellis, N. A. Fungi, no. 2417.

Puccinia heterospora B. & C.

On Sida spinosa, Montgomery, 1891 (Atkinson); Lee, 10, 1895.

Puccinia Hieracii (Schum.) Mart.

On Cnicus, sp., Lee, 1891 (Atkinson.)

On Sitilias Caroliniana, Lee, 1890 (Atkinson), 1891 (Newman).

Puccinia Hydrocotyles (Link) Plowr.

On Hydrocotyle umbellata, Lee, 1891 (Duggar.)

Puccinia investita Schw.

On Gnaphalium purpureum, Lee, 1890 (Atkinson.)

Puccinia lateritia B. & C.

On Spermacoces glabra, Rav. Fung. Car. exsic. 3:93. (1855). Peters. This name is not given in Saccardo nor in Notices of North Amer. Fungi in Grevillea. It seems to be the same as *Puc. Spermacoces* B. & C. which was not published until 1874.

Puccinia Maydis Carradori.

On Zea mays, Lee, 1891 (Newman.)

Puccinia Menthae P.

On Kœllia (Pycnanthemum) Lee, 1891 (Atkinson); Montgomery, 1881 (Atkinson).

Puccinia Phragmitis (Schum) Korn.

On Arundinaria sp. Lee, 2, 1896.

Puccinia Podophylli Schw.

On Podophyllum peltatum, Lee, 4, 1896; Hale, 5, 1896: Madison, 5, 1896; DeKalb, 5, 1896.

Puccinia Polygoni-amphibii P.

On Polygonum Pennsylvanicum, Lee, 1890 (Atkinson); 1891 (Duggar).

On Polygonum sp., Lee, 1889 (Atkinson).

Puccinia polysora Underw.

On Tripsacum dactyloides, Lee, 8, 10, 1891 (B. M. Duggar). Mobile 10, 1896 (S. M. Tracy.) Described from this material in Bull. Torr. Bot. Club, 24: 86, as follows:—

II., III. Amphigenous; sori very small, short, very numerous but irregularly scattered, remaining long enclosed in the tough epidermis of the host, at length rupturing by a narrow slit; uredospores large, broadly oval, 35x30 ú scarcely echinulate, the epispore of medium thickness, pale rusty brown; teleutospores variable, usually short, irregularly oblong, often somewhat constricted at the septum, averaging 25 x 40ú, the cells often irregularly angled, the upper usually broader than long, blunt or rounded above; apex not thickened; pedicel usually short."

"On *Tripsacum dactyloides*, Auburn, Alabama, August and October, 1891, B. M. Duggar."

Puccinia Pruni-spinosae P.

On Prunus Americana, Lee, 1891 (Duggar).

On Prunus serotina, Lee, 1891 (Duggar).

On Amygdalus persica Macon, 10, 1896 (G. W. Carver).

On Prunus sp. Lee, 1890 (Atkinson).

Puccinia purpurea Cke.

On Sorghum halapense Macon, 10:1896, G. W. Carver.

Puccinia rubigo-vera (D. C.) Wint.

On Avena sativa, Lee, 1890 (Atkinson).

On Secale cereale, Lee, 5, 1896.

Puccinia Saniculae Grev.

On Sanicula sp. Lee, 1891 (Benton).; Hale, 5, 1896; Tuscaloosa, 1896.

Puccinia Silphii Schw.

On Silphium Asteriscus, Lee, 4, 7, 1896.

On Silphium laevigatum, Lee, 1891 (Atkinson).

Puccinia Smilacis Schw.

On Smilax sp. 10, 12, 1895; Macon,10,1896 ;(G. W. Carver)

Puccinia Sorghi Schw.

On Sorghum cernuum, Lee, 1888 (Newman).

Puccinia Spegazzinii De Toni.

On Micania scandens, Lee, 1891 (Atkinson).

Puccinia Spermacoces B; & C. *

On Spermacoces glabra, (Peters).

Originally described from Alabama specimens in Grevillea, 3:53. 1874, as follows:—

"Hypophylla, maculis flavis parvis; soris rubiginosis; sporis brevibus laevibus utrinque obtusis pedicello brevioribus."

"Spots yellow, small, orbicular; sori rust-colored; spores short obtuse at either end, even, very slightly constricted, shorter than the hyaline stem." (See note under P. lateritia.)

Puccinia stromatica B. & C. *

On stems of Clematis sp. (Peters).

Described from specimens collected in Alabama, in Grevillea, 3:53, 1874, as follows:—

"Soris affusis rubiginosis; sporis laevibus brevibus utrinque obtusis "pedicello longo flexuoso."

"Sori effused, rust-colored; spores short, even, obtuse at either end, seated on a long flexuous pedicel, which is attenuated downwards."

Puccinia Tanaceti D. C.

On Helianthus angustifolius, Lee, 1891 (Atkinson).

On Helianthus annuus, Lee, 1891 (Atkinson).

On Helianthus tuberosus, Lee, 1891 (Atkinson.) ; Macon, 8, 1896 (G. W. Carver).

On Helianthus sp:, Lee, 1890 (Atkinson).

Puccinia Violae (Schm.) D. C.

On Viola blanda, Winston, 6, 1896, (Uredo stage only).

On Viola sp. Lee, 1891 (Benton).

Puccinia Xanthi Schw.

On Xanthium Canadense, Perry, 1891 (Newman) ; Macon, 8, 1896 (G. W. Carver).

On Xanthium strumarium, Lee, 10, 11, 1895.

On Xanthium sp. Lee, 1890 (Atkinson).

On Ambrosia trifida, Lee, 1891 (Atkinson).

Ravenelia cassiaecola Atk.

On Cassia nictitans, Lee, 1890 (Atkinson): 1891 (Atkinson) : 1893 (Duggar).

Described from material collected at Auburn, Alabama, in Bot. Gaz. 17 : 314. 1891, as follows :—

"Caulicolous or hypophyllous. Sori on leaves 1 mm. or less, rotund or oblong: on stems oblong, irregular, confluent, sometimes covering a space 1-10 cm. in length, frequently ambient, rupturing irregularly or longitudinally. Pseudoperidium composed of loosely cohering, irregularly angular, small cells, yellowish brown. Uredospores in mass appearing dirty yellowish white: singly, hyaline or dull yellow to fulvous, oval or rotund, minutely asperulate, 9-13 by 12-16ú Teleutospores in mass appearing black: singly, fulvous to dark brown: 30-100ú, convex at free ends, depressed where joined to pedicel, small ones rotund, composed of from 5-30 cuneate cells, their free ends frequently bearing a single hyaline, short spine : cells 18-23 by 20-30ú : cystoid cells 5-15 rotund, hyaline or colored, rigid, 14-18ú ; pedicel fulvous, stout, 50-80ú long.

Ravenelia glandulaeformis B. & C.

On Cracca hispidula, Lee, 1891 (Duggar.)

On Cracca spicata, Lee, 1891 (Duggar).

On Cracca Virginiana, Lee, 1891 (Atkinson): 1893 (Duggar): Macon, 8, 1896 (G. W. Carver).

Roestelia aurantiaca Pk.

On Crataegus sp. Lee 1891 (Atkinson,) Benton, (Duggar); 1892 (ibid).

On Cydonia vulgaris, Lee, 1891 (Atkinson, Newman).

Roestelia flaviformis Atk.

On Crataegus spathulata, Lee, 10, 1895.

Roestelia pirata (Schw.) Thax.

On Pirus augustifolia, Lee, 5, 1896.

On Pirus coronaria, Lee, 7, 1896.

On Crataegus spathulata, Lee, 10, 1895.

On Pirus coronaria x malus, Lee, 8, 1890 (Atkinson). Seymour and Earle. Econ. Fungi, no. 228.

On Pirus malus (fruit). Lee, 1891 (Atkinson); (leaves) 5, 7, 1896, Regarded as the alternate stage of *Gynmosporangium macropus.*

Thecopsora Vacclnorum (Lk.) Karst.

On Xolisma ligustrina (Andromeda) Lee, 10, 1896.

Uredo Azaleae Schw.

On Azalea nudiflora, Lee, 1891 (Benton).

Uredo Fici Cast.

On Ficus carica, Lee, 1890 (Atkinson).

Uredo miniata P.

On Rosa sp. (lucida?), Lee, 5, 1896.

There appears to be so much uncertainty concerning the relations of this common fungus that it is perhaps best to leave it under the original name until something definite can be determined.

Uredo Quercus Brond.
On Quercus alba, Lee, 1891 (Atkinson).
On Quercus nigra (Q. aquatica), Lee, 1891 (Duggar).
On Quercus minor (Q. stellata) 1891 (Atkinson).
On Qnercus sp., Lee, 1891 (Atkinson).

Uromyces Andropogonis Tracy.
On Andropogon Virginicus, Lee, 1891 (Duggar); Macon, 8, 1896 (G. W. Carver).
On Andropogon sp. Lee, 10, 1895.

Uromyces appendiculatus (P.) Link.
On Phaseolus vulgaris, Mobile, 1890 (Atkinson); Lee, 1891 (Atkinson)
On Phaseolus sp. Peters coll,—under *Uredo leguminosorum*, collected by Beaumont.

Uromyces Eragrostidis Tracy.
On Agrostis tenuis, Lee, 1891 (Duggar).

Uromyces Euphorbiae B. & C.
On Euphorbia nutans (E. Preslii), Lee, 1891 (Duggar).

Uromyces Hedysari-paniculati (Schw.) Farl.
On Meibomia rotundifolia, Macon, 8, 1896 (G. W. Carver)
On Meibomia paniculata, Lee, 1891 (Atkinson).
On Meibomia (Desmodium) sp., Peters' Coll., 1858 (under *Uredo appendiculata*), Lee, 1890 (Atkinson); Perry; 1891 (Atkinson); Macon, 8, 1896 (G. W. Carver)

Uromyces Hyperici (Schw.) Curt.
On Hypericum mutilum, (Prague Junction). 1890 (Atkinson). Lee, 1891 (Duggar); 10, 1896.
On Hypericum Virginicum, Lee, 11, 1895.

Uromyces Junci Desm.
On Juncus sp., Lee, 1891 (Atkinson).

Uromyces Lespedezae (Schw.) Pk.
On Lespedeza hirta, Lee, 1891 (Atkinson).
On Lespedeza procumbens, Lee, 1891 (Newman, Duggar).
On Lespedeza repens, Lee, [Atkinson].
On Lespedeza Stuvei, Lee, 1890 [Atkinson].
On Lespedeza Virginica, Lee, 1880 (Atkinson).
On Lespedeza sp., Macon 8, 1896 [G. W. Carver.)

Uromyces Medicaginis-falcatae (D C.) Wint.
(*U. striatus* Schroet).
On Trifolium Caroliniamm, Lee, 1890 [Atkinson]; also the aecidial form, Lee, 3, 1896.
(*Uromyces pluriannulatus* B. &. C. described originally from Alabama proved to be a *Synchitrium* q. v).

Uromyces Polygoni (P.) Fckl.
On Polygonum setaceum, Lee, 1891 (Atkinson.)

Uromyces Rhynchosporae Ellis.
On Rhynchospora glomerata, Lee, (Atkinson); 1891 (Duggar).
On Rhynchospora sp., Macon, 8, 1896 (G. W. Carver).

Uromyces Spermacoces (Schw.) Curt.
On Diodia teres, Macon, 1891 Atkinson; 10, 1886, (G. W. Carver); Lee, 1893 (Duggar).

Uromyces Terebinthi (D. C.) Wint.
On Rhus toxicodendron, (Beaumont); Perry, 1891 (Atkinson); Lee, 1891 (Atkinson).
Pileolaria brevipes B. & R. Grevillea, 3: 58, 1874, was foxnded on specimens of this plant collected in Alabama by Beaumont.

Uromyces Trifolii (A. & S.) Wint.
On Trifolium pratense, Lee, 1891 (Newman, Duggar) Madison, 5, 1896.
On Trifolium sp., Lee, 1890 (Atkinson).

Uropyxis Amorphae (Curt.) Schroet.
On Amorpha fruticosa, Macon, 1890 (Atkinson); Lee, 10, 1895.

Order Tremellales.

FAMILY AURICULARIACEAE.

Hirneola Auricula-Judæ (L.) Berk.
On Hicoria, Lee, 3; 1896.
Peters' Coll. 8; 1864.

Hirneola scutelliformis B. & C.*
Described in Grevillea, 2:19, as follows:

"Minuta orbicularis, subtus candida; hymenio fusco. On branches of Asimina. Alabama, Peters. No. 6343."

"About 1-12 inch across, looking like a flat *Peziza*; thin, orbicular, white beneath, hymenium brown. Sometimes laterally confluent, and forming a continuous mass."

FAMILY TREMELLACEAE.

Exidia glandulosa (Bull.) Fr.

On Alnus sp., Lee, 2; 1896.

On Liquidambar, Lee, 3; 1896.

On Quercus sp., Lee, 3; 1896.

Exidia truncata Fr. (?).

On Vitis rotundifolia, Lee, 1; 1892, (Atkinson).

Naematelia encephala Fr. *

On Oak, Peters, Grevillea 2:20.

Naematelia nucleata (Schw.) Fr.

On Tilia Americana, Peters, in Rav. Fungi Car. Exsc. 4:82.

Tremella dependens B. & C. *

On Liriodendron, described in Gredillea, 2:19, as follows:

"Sacciformis subclavata, viridi-flava dependens. On Liriodendron. Alabama, Peters. No. 6455."

"Sack like, elongated, subclavate, subtranslucent, thin, watery, mucilaginous, dissolving when the thin outer skin is broken; watery, greenish-yellow, 1-8 inch long. Hanging down from the under side of rotting tulip logs after rains. July, Sep. Allied to *T. vesicaria*."

Tremella gigantea B. & C. *

Described in Grevillea 2:19 as follows:

"Maxima, pallide ferruginea, foliacea, firma. Alabama, Peters. No. 3806."

"Very near *T. ferruginea*, but paler and firmer."

Tremella mesenterica Retz.

On Alnus sp. Lee, 12; 1895, 2: 1896.

Tremella ———.

On rotten wood of Hicoria, Peters' Coll. No. 96.

This is erroneously labled *T. foliacea* Pers. It is large, cæspitose thin, foliaceus, somewhat venose; basidia orbicular deeply four parted, dark fuscous about 12µ; spores oval 12x8µ.

Tremellodon gelatinosum (Scop.) Pers.

On Pinus sp., Lee, 3; 1896. Alabama (Peters). Peters' Coll. No. 62 under the name *Hydnum gelatinosum.*

Ulocolla foliacea (Pers.) Bref. ?

On Quercus sp., Lee, 3; 1896.

On Vitis rotundifolia, Lee, 2; 1896.

On Alnus sp. Lee, 2; 1896.

FAMILY PILACRACEAE.

Pilacre taginea (Fr.) B. & Br.

Peters' Coll. 1:195, under *Onegyna faginea F.*

Pilacre Petersii B. & C.

On Ilex opaca (Peters.) Distributed in Ravenel, Fung. Car. exsic. 3:39.

On Carpinus Alabama, 1865 (Peters.) Peters' Coll.

FAMILY DACRYOMYCETACEAE. †

Arrhytidia flava B. & C.

On Pinus sp, (rotten wood), Lee, 2; 1896.

Arrhytidia fulva B. & C.

On Pinus sp. (rotten wood), Peters' Coll., Lee, 1; 1896.

Dacryomyces chrysocomus (Bull.) Tul.

On Pinus sp. (rotten wood), Lee, 1 and 2; 1896.

Dacryomyces deliquescens (Bull.) Dub.

On Pinus sp. (rotten wood), Lee, 3; 1896.

Dacryomyces stillatus Nees.

On Pinus sp. (rotten wood), Lee, 2, 1896.

Guepinia elegans B. & C.

Alabama, Peters, distributed in Rav. Fungi Car. exsic. 5:23.

Guepinia petaliformis B. & C. *

Described in Grevillea 2:5, as follows:

"Pileo flabelliformi margine crispato tuberculoso, hyme-

† It is possible that this group should rank as an order.

nio supra nudo, infra venoso. No. 6052, Alabama, Peters."

"On dead wood about an inch high; stem compressed; pileus flabelliform, with the margin crisped and tuberculate; hymenium naked above, pubescent and venose below,"

Guepinia Spathularia (Schw.) Fr.

On Pinus, Lee, 12, 1896.

On various woods, Lee, 11, 12, 1895; 7, 1896.

ORDER HYMENIALES.

FAMILY TOMENTELLACEAE.

Coniophora umbrina (A. & S.) Fr. (*Telephora umbrina* A. & S.)

"Alabama (Peters)." Peters coll. no. 70.

Corticium Armeniacum Sacc. * (*C. molle* B. & C. not of Fr.)

On Vitis. (Peters, Beaumont).

Corticium caeruleum (Schrad.) Fr. (*Telephora Indigo* Schw.] Lee, 11, 1895; 1, 1896.

Corticium calceum (Pers.) Fr.

On Pinus, Lee, 1, 1896.

Corticium cervicolor B. & C.

(Peters). Described from Alabama specimens in Grevillea, 1; 179 as follows:—"Subiculo delicato byssaceo; hymenioque cervinis."

"On smooth wood. Fawn colored. Subiculum very delicate byssoid, spreading over the wood, but scarcely formtng a distinct margin; hymenium of the same color, scarcely pulverulent."

Corticium chlorinum B. & C.

On Abies. (Peters). Peters coll., no., 82: also under the name, *prasinum* collected 9, 1864. The plant is quite as likely to be a species of *Zygodesmus*.

Described from Alabama material in Grevillea, 1:179, as follows:— "Forming a thin, brittle, olive-green membrane, which is at first pulverulent, but afterwards rough, with minute papillae; resembling such Thelephorae as *T. laxa*, &c."

Corticium chrysocreas B. & C.*

On Pinus. (Peters).

Described in Grevillea, 1:178 partly from Alabama specimens as follows:— "Subiculo parco flavo; hymenio ex albido fulvo papillato."

"Subiculum bright yellow thin; hymenium immarginate pallid, or yellow tinged with tawny."

Corticum cremoricolor B. & C. *

On Ilex (Peters).

Described in Grevillea 1:180 from Alabama specimens as follows:— "Mycelio albo innato; hymenio immarginato rimoso areolato, hic illic papillato."

"Mycelium white innate; hymenium cream-colored when fresh, soon cracked into largish areolae, here and there papillose."

Corticum crocicreas B. & C.*

On Vitis. (Peters.)

Described in Grevillea, 8:178 from Alabama specimens as follows:— "Subiculo amplo, tomentoso, laeteritio; hymenio tenui flavo."

"Subiculum spreading widely, bright saffron yellow; hymenium thin, more or less yellow. A curious species."

Corticium deglubens B. & C. *

On Juniperus. (Peters.)

Described in Grevillea, 1:166 from Alabama specimens as follows:—"Tenue papyraceum secernibile subtus candidum; hymenio laevissimo ochraceo."

"At first resupinate with a very narrow white byssoid margin, soon detached, white beneath like kid leather; hymenium honey-colored, very even and continuous."

Cortcium diminuens B. & C.

On Ostrya Virginica. (Peters.) Ravenel, Fung. Car. exsic. 3:31. Described from Alabama material in Grevillea, 2:3 as follows:— "Album stratosum, hymenio cretaceo diminuente."

"Consisting of several layers, each separated by a dark line; hymenium white, diminishing in width each time of growth, so as to leave a narrow zoned border."

Corticium dryinum B. & C.*

On Quercus. (Peters.)

Described in Grevillea, 1:179 from Alabama material as follows:— "Subiculo vix distincto; hymenio crassiusculo rhabarbarino-rufo."

"Running over very rough wood, on which it forms an irregular stratum of a deep rufous tint, with a rhubarb-colored velvety aspect."

Corticium ephebium (Peters). Peters coll., no., 80

Described in Grevillea, 1:178 from Alabama material as follows:— "Subiculo tomentoso pallido; margine secernibili, velutino; hymenio ex ochroleuco rufulo setuloso."

"Spreading widely. Subiculum tomentose; margin becoming free, velvety pale, umber; hymenium setulose as in *C. velutinum.*"

Corticum evolvens Fr. *

On Liquidambar. (Peters.)

Corticium filamentosum B. & C.*

(Peters.)

Described from Alabama specimens in Grevillea, 1:178 as follows:— "Subiculo molli tomentoso fibrilloso pallido; hymenio pulverulento ochraceo, vel subolivaceo."

"Subiculum consisting of soft tomentose threads, over which the ochraceous or olivaceous pulverulent hymenium forms athin stratum."

Corticium lactescens Berk.

On Alnus serrulata, Lee. 1891, (Duggar.)

Corticium leve (Pers.) Pers. *

On Liquidambar. (Peters).

Corticium Martianum B. & C.

On Betula (Peters). Distributed in Ravenel, Fung. Car. exsic. 5:30 from material collected by Peters.

Corticium miniatum Berk.

On Liquidambar. (Peters.) Peters coll. no. 85. This is not the C. *miniatum* Cooke; Grevillea, 9:2, and perhaps is not described. Berkeley reports it under this name in Grevillea, 1:178. It appears to be a well marked species.

(*Corticium molle*) B. & C. See above under (*C. Armeniacum* Sacc).

Corticium akesii B. & C.

On Ostrya Virginica (Peters;) Lee, 1, 2, 1896. Distributed in Ravenel, Fung. Car. Exsic. 3 : 32 from Alabama material collected by Peters.

Corticium ochroleucum erimosum B. & C.*

On Sassafras. (Peters) Characterized in Grevillea, 1 : 166 by the words, "Hymenio continuo."

Corticium Petersii B. & C.

On the ground (Peters) ; Winston, 6, 1896. Distributed in Ravenel, Fung. Car. exsic. 5 : 28 from Alabama material collected by Peters. Described in Grevillea, 1 : 177 from material collected in Alabama as follows:—

"Subiculo tenui tomentoso, pallido hic illic in fibrillas compacto ; hymenio alutaceo hic illic lateritio."

"Subiculum, thin, pallid, tomentose, here and there forming creeping fibres ; hymenium pale, tan-colored, in parts tinged with brick-red."

Corticium polyporoideum B. & C.

Alabama 9, 1863, (Peters.) Peters coll. no. 84.

Described in Grevillea, 1 : 177 from material sent from Alabama as follows:—

"Subiculo tomentoso candido marginem angustum formante ; hymenio pulverulento, pallide alutaceo."

"Effused irregular ; subiculum white, well developed, tomentose, projecting beyond the pale tan-colored pulverulent hymenium and forming a narrow border. Allied to *C. Dregeanum* Mont. & B."

Corticum prasinum B. & C.

On the ground under Liquidambar. (Peters) Peters coll. 9, 1864 ; Distributed in Ravenel, Fung. Car. exsic. 5 :29 from Alabama material collected by Peters.

Described in Grevillea, 1 ; 179 from Alabama specimens as follows :—"Subiculo parco arachnoideo ; hymenio continuo tenui fragili prasino ; margine albo."

"Subiculum delicate spidery ; hymenium thin, brittle, continuous, with a white margin when young."

Corticium radiosum (Fr.) Fr.

Lee, 1891 (Duggar.)

Corticium scutellare B. & C.

Alabama (Peters) ; Lee, 1, 2, 1896.

Described in Grevillea, 2: 4 in part from Alabama material, as follows :—

"Resupinatum effusum, immarginatum, ex albido subalutaceum ; hymenio in areolas minutas fisso."

"Widely effused, thin, inseparable, immarginate; hymenium from dirty white to tan-colored or tawny."

Corticium siparium B. &. C.*

On Liquidambar. (Peters).

Described in Grevillea, 1: 177 from Alabama specimens, follows :—

"Subiculo spongioso tomentoso pallido; hymenio ochraceo demum fuscescente."

"Subiculum consisting of spongy pallid down; edge turned slightly up; hymenium at first ochraceous, gradually acquiring a brownish tint."

Corticium viticolum Schw.

On Vitis aestivalis. Distributed in Ravenel, Fung. Car. exsic. 3 : 34 from Alabama material collected by Peters.

Exobasidium Andromedae Pk.

On Xolisma ligustrina (Andromeda) Lee, 5, 1896.

Exobasidium Azaleae Pk.

On calyces of Azalea nudiflora, Lee, 1892 (Benton); 4, 1896.

Exobasidium discoideum Ellis.

On leaves of Azalea nudiflora, Lee, 4, 5, 1896; Winston, 6, 1896.

Exobasidium Vaccinii (Fuck.) Wor.

On leaves of Vaccinium, Lee, 4, 1896.

On flowers of Gaylussacia frondosa, Lee, 5, 1896. Perhaps a distinct species as the character of the deformity produced and the gross characters are very different from the form on Vaccinium. Culture methods are revealing something of the relations of these curious forms.

Hypochnus anthochrous (Pers.) Fr.*
"Alabama (Peters.")

FAMILY CLAVARIACEAE

Clavaria aurea Schaeff.
Lee, 10, 1896.
Clavaria botrytes Pers.
Lee, 10, 1896.
Clavaria falcata Pers.*
"Alabama (Peters)."
Clavaria gracilis Pers.
Distributed in Ravenel, Fung. Car. exsic. 5: 34 from material collected in Alabama by Peters.
Clavaria Petersii B. & C.
Distributed in Ravenel, Fung. Car. exsic. 5:33 from material collected in Alabama by Peters.

Described in Grevillea, 2; 7 from specimens collected in Alabama by Peters, as follows:—

"E communi basi ramosa; ramis strictis subfastigiatis apice apiculato divisis rufis."

"About two inches high, branched from the very base; branches very straight, somewhat fastigiate, rufous, tips apiculate."
Clavaria pistillaris L.
On the ground, Lee, 11, 1896.
Sparassis crispa (Wulf.) Fr.
Lawrence, (Peters). Peters coll. no. 91; Lee, 12, 1896.
Sparassis Herbstii Pk.
On the ground, Lee, 7, 1896.

FAMILY THELEPHORACEAE

Craterellus Cantharellus (Schw.) Fr. (*C. lateritius* Berk.)

On the ground, Winston, 6, 1896; Lee, 7, 1896. Some specimens show the characteristic brick-red color ascribed to *C. lateritius* but the greater number are yellow. A specimen in the Peters collection marked "*C. unicolor* Rav."* collected 1864 is apparently the same species.

C. lateritius was described from Alabama material collected by Peters, in Grevillea, 1:147, as follows:

"Pileo profunde umbilicato lobato stipite deorsum angustato hymenioque radiato venoso lateritiis."

"On the ground; 2 inches wide; brick-red; pileus deeply umbilicate, cyathiform, margin lobed; stem 1½ inches high, dilated above; veins narrow, radiating. This is *Thelephora craterellus* Schwein."

Craterellus cornucopioides (L.) Pers.

On the ground, Lee, 7, 1896.

Cyphella fulva B. & Rav.

On Alnus. Lee, 1, 2, 1896.

Cyphella furcata B. & C. *

On Alnus. (Beaumont.)

Described in Grevillea, 2: 5 from Alabama material as follows:—

"Stipite cylindrico hic illic furcato, cupulisque cyathiformibus ferrugineis tomentosis."

"Like the last (*C. fulva*) growing in little groups, but consisting of fewer individuals; stem cylindrical, often forked, terminated by cyathiform cups, tomentose and ferruginous externally. A very curious species."

Hymenochaete agglutinans Ellis.

Encircling twigs, often living ones, Lee, 2, 1896.

Hymenochaete corrugata (Fr.) Lev. (*Corticium corrugatum* Fr.)

Lee, 1, 2, 1896; distributed in Ravenel, Fung, Car, exsic. 5:26 from Alabama material collected by Peters.

Hymenochaete epichlora (B. & C.) Cke. (*Corticium epichlorum* B. & C.)

On Vaccinium (Peters.)

On Symplocos; Distributed in Ravenel, Fung. Car. exsic. 5:24 from Alabama material collected by Peters.

Described as *Corticium epichlorum* in Grevillea, 1:178 from specimens collected in Alabama by Peters, as follows:—

"Subiculo tenui viridi-luteo marginem angustum formante, hymenio olivaceo umbrino demum rimoso."

"Subiculum thin, yellow-green, forming a slight margin; hymenium olive-umber, at length cracked."

Hymenochaete purpurea Cke. & Morg.

Lee, 11, 1895. According to Morgan this species will go in the genus *Peniophora.*

Hymenochaete setosa B. & C.*

On Quercus. (Peters.)

Described from material collected in Alabama, in Grevillea, 1:165, as follows:—

"Laete ferruginea, continua, resupinata setis eximiis exasperata."

"Widely spread, or [sic] a bright ferruginous; hymenium rough with fascicles of setae."

Stereum albobadium (Schw.) Fr.

On various twigs and branches, Lee, 1891 (Atkinson); 12, 1895 1, 2, 1896. Common.

Stereum Bicolor (Pers.) Fr.

On stumps, Lee, 10, 1895; 2, 3, 18‿6; Winston, 6, 1896.

Stereum candidum (Schw.) Fr.

On Quercus, Lee, 12, 1895. Forming small patches on the bark of large trees.

Stereum Curtisii Berk.*

"Alabama (Peters)." This species is sometimes referred to *Hymenochaete.*

Stereum fasciatum (Schw.) Fr.

On old logs, Lee, 11, 1895; 3, 12, 1896. In habit like *S. versicolor*, of which it was formerly regarded a variety.

Stereum frustulosum (Schw.) Fr.

On Quercus, Lee, 11, 12, 1895, 1895, 3, 7, 1896. Very common.

Stereum gausapatum (Fr.) Fr. *

"Alabama (Peters)."

Stereum Levilleanum B. & C.

Lee, 11, 1895.

Stereum nivosum (Rav.)

On Juniperus, Lee, 11, 1895; 3, 1896. Very common.

Stereum pergameneum B. & C.

Distributed in Ravenel, Fung. Car. exsic. 3:25 from Alabama material collected by Peters.

Described from Alabama in Grevillea, 1 : 161 as follows:—

"Pileo cyathiformi rufo vix zonato subtiliter lineato; margine tenui dentato laceratove; stipite cylindrico hymenioque albidis."

"On decayed wood. Pileus 1½ inches across, cup-shaped, bright rufous, not shining, minutely lineate, very obscurely zoned; margin thin, often toothed or laciniate stem ½-1½ inch high, 1 line thick, whitish, very minutely tomentose; hymenium nearly of the same subochraceous tint."

Stereum radians Fr.

On twigs, Lee, 11, 12, 1895; 1, 1896.

Stereum Ravenelii B. & C. *

On the earth in swamps. "Alabama (Peters, Beaumont.)"

Described in part from material collected in Alabama by Peters and Beaumont, Grevillea, 1:162, as follows:—

"Gregarium ecommuni mycelio oriundum; pileo cyathiformi, fusco; margine pallidiore plicato stipite gracili tomentoso hymenioque pallidis."

"Pileus very variable in size, from a line to an inch across, cup-shaped, sometimes split on one side, brownish, with a slight admixture of red, paler toward the plicate margin; stem ½–1½ inch high, ½ a line thick, gregarious, springing from a common mycelium, finely tomentose, pallid, as well as the hymenium, closely allied to *S. nitidulum* B."

Stereum sericeum (Schw.) Morg.

On twigs, Mobile, 12, 1895; Lee, 12, 1895, 1, 1896. Not common.

Stereum subpileatum B. & C.

Lee, 11, 1895; 4, 1896; Winston, 6, 1896.

Stereum versicolor (Swz.) Fr.

Lee, 11, 1895; Mobile, 12, 1895; Winston 6, 1896. Everywhere common.

Thelephora filamentosa B. & C. *

"Alabama [Peters]."

Described from Alabama material in Grevillea, 1:148 as follows:— "Pileis filiformibus pallidis e mycelio lato communi oriundis."

"Growing on decayed matted herbaceous fragments, on which it forms a mycelium, which is in part smooth, in part filamentous ; pilei thread-shaped. A very curious species, but the specimens scarcely show whether the pilei are really filiform or deeply split."

Thelephora botryoides (Schw.)* (*T. olivacea*, var. *Botryoides*, Schw.; *T. Granosa*, B. & C.)

"Alabama [Peters]."

Thelephora griseo-zonata Cke.

On the ground, Lee, 12, 1895; 10, 1896.

Thelephora lobata Bertol.

Described from Alabama material in Mem. Accad. Sci., Bologna 7:360, as follows :

"Semiorbicularis; stipite beevissimo lateraliter affixa, margine lobata, ora nigrescente, supra sinereo-tomentosa, quadrizonata, zonis senescentipes nigro-limbatis; hymenio laevi, extus lutescente. *Tab. 19, fig. e. f. g.*"

"Habui ex Alabama a Doct. Gates."

"Nata super ramum arboris, quem determinare non potui, cum careat foliis, et floribus. Sterps parva, coreacea licet tenuis, horizontalis, ramo lateraliter affixa stipite brevissimo, margine lobata, ora marginali demum nigra, junior supra convexa, cinereo-tomentosa, concolor, quadrizonata, postea complanata, tomento fere subcano, zonis senio linea nigra limbatis, subtus hymenio laevi, glabro, ad interiora cinereo, ad exteriora lutescente."

"Pertinet ad sectionem tertiam *Auriculariarum Fries, El. Fung., vol. 1, p. 174.* Appropinquat *Telephoram stiracifluam Schwein. in Fries l. c. p.* 177, sed descriptio ejus manca non sinit, ut de identitate judicem, neque at exemplaribus siccis dignoscere possum, si nostra junior sit ut illa lutescens; insuper in *Telephora stiraciflua* non adnotantur zonæ nigrolimbatæ."

A species not noted by Saccardo nor, so far as we know, by any other writer on American mycology.

Thelephora pedicellata Schw.

On living stems of shurbs, [Crataegus, etc.], Lee, 11 1895; 2, 1896.

On Cornus (Peters.)

Thelephora Schweinitzii Pk. (*T. pallida* Schw, not of Pers)

On the ground (Peters.) Peters coll.; Lee, 10, 1895; Winston, 6, 1896.

Thelephora sebacea Pers.

Incrusting living leaves of Viola. 1893 (Peters.) In Peters coll. as *Thelephora Micheneri* B. & C.

Incrusting various leaves and stems, Lee, 7, 1896.

Thelephora terrestris Ehrh.

Lee, 7, 1896.

FAMILY HYDNACEAE.

Caldesiella ferruginosa (Fr.) Sacc. (*Hydnum ferruginosum* Fr.)

"Alabama (Beaumont); Lee, 5, 1896.

Hydnum adustum Schw.

Lee, 1891 (Atkinson); Winston, 6, 1896.

Hydnum atroviride Morg.

Lee (Atkinson.) Described [with an illustration] in Jour. Cincinnati Soc. Nat. Hist, 18:38. Pl. 1. f. 5. as follows: — "Dark green in color throughout. Pileus fleshy-coriaceous, thin, convex then expanded, orbicular or somewhat irregular. Stipe more or less difform, short or elongated, central or excentric. Aculei slender, acute. Spores dark green, rough and irregular, 6-9 mic. in diameter."

"Growing on old wood, Auburn, Alabama, Prof. George F. Atkinson. Pileus 1-2 cm. in diameter, the stipe 1-2cm. in length. Easily recognized by the dark green color in every part even of the spores."

Hydnum chrysocomum Underw.

Under decayed wood, Lee, 11, 1895.

Hydnum cirratum Pers. *

On Quercus, (Beaumont.)

Hydnum compactum Pers.

On the ground, Mobile, 12, 1895.

Hydnum erinaceus Bull.

On Quercus, 1863 (Peters) coll. no. 60.

On old log, Lee, 11, 1896, (Miss J. Skehan.)

Hydnum fascicularia B. & C.*

Described in Grevillea, 1 :99. from material in part collected in Alabama, as follows:

"Totum resupinatum ceraceum pallidum; aculeis fasciculatis brevibus obtusis quandoque apice ciliatis."

"Widely, effused, very thin, waxy, inseparable from the matrix, pallid, but varying in tint; prickles fasciculate, short, obtuse, sometimes ciliated at the top as in *Kneiffia.*"

Hydnum ferrugineum Fr.

Lee, 1891 (Atkinson); 11, 1896.

Hydnum flabelliforme Berk.

On standing trunks, Lee, 1, 1896.

Hydnum fragilissimum B. & C.

Distributed in Ravenel, Fung. Car. exsic. 5: 21, from Alabama material collected by Peters.

Hydnum himantia Schw.

"Alabama (Peters). Peters coll. no. 56.

Hydnum imbricatum L.

Alabama (Peters.) Peters coll. no. 55 as *H. subsquamosum.*

In pine woods, Lee, 12, 1895; 3, 1896 (E. F. Lee); 7, 1896 (J. Q. Burton); 12, 1896; rather common.

Hydnum læticolor B. & C.*

Ou Quercus, (Beaumont.) Described in part from Alabama specimens in Grevillea, 1: 99, as follows:— "Læte effusum, margine demum separabili subbyssoideo; aculeis laete ochraceis compressis subvelutinus apice dentato laceratis."

"Effused for several inches, at length more or less separable at the margin, where it is slightly byssoid or tomentose; hymenium reddish-ochre; prickles compressed, somewhat velvety, toothed and lacerated at the apex. A fine species."

Hydnum membranaceum Bull.

Distributed in Ravenel, Fung. Car. exsic. 5:20, from Alabama material collected by Peters.

Hydnum mucidum Pers. *

On logs, Lee, 10, 12, 1895; 1, 2, 1886.

Hydnum ochraceum Pers.

On logs, Lee, 10, 12, 1895; 1, 2, 1896.

Hydnum parasitans B. & C.*

On Ulmus Americana, (Peters)

Described from specimens collected in Alabama, in Grevillea, 1:100 as follows:

"Parasiticum, aculeis brevibus compressis obtusis."

"Parasitic on the teeth of some *Hydnum*; subiculum obsolete; prickles short, compressed, obtuse."

Hydnum pulcherrimum Lee, 10, 12, 1895; Hale, 4, 1896; Winston, 6, 1896.

Hydnum repandum L.

On the ground (Peters.) Peters coll. no. 61; Lee, 1, 11, 12, 1896.

Hydnum septentrionale Fr. *

On Tilia, (Peters.)

Hydnum setulosum B. & C.

On Liquidambar (Peters.) Peters coll. No. 59.

Described from Alabama specimens in Grevillea, 1:100, as follows:— "Subiculo candido lacteo membranaceo; aculeis flexuosis subulatis acutis subtiliter setulosis."

"Subiculum membranaceous, white, forming a broad border to the hymenium, which is quite confined to the centre; prickles waved, subulate, minutely setulose under a lens. A very distinct species."

Hydnum spathulatum (Schw.) Fr.

On decaying wood, Lee, 11, 1895: 1, 1896.

Hydnum spongiosipes Pk.

Alabama (Peters.) Peters coll. no. 57 as "*H. ferrugineum*?"

Hydnum subsquamosum Batsch.

On the ground, 1864 (Peters) Peters coll. uo. 55.

Hydnum zonatum Batsch.

Lee, 7, 1896.

Irpex coriaceus B. & Rav.

On Quercus (Peters). Lee, 11, 1895. Distributed in Ravenel, Fung. Car. exsic. 3:21 from material collected in Alabama.

Irpex fuscescens Schw.

On Quercus, Lee, 11, 1895; 1, 2, 1896. Not uncommon.

Irpex Schweinitzii B. & C.*

Alabama (Beaumont).

Described from specimens sent from Alabama in Grevillea, 1:102, as follows:

"Resupinatus, subiculo membranaceo, separabili, margine sterili, brevi, byssoideo; dentibus carneo-griseis compressis."

"Scarcely exceeding ½ an inch in breadth; suborbicular; subiculum, thin, membranaceous, byssoid, separable from the matrix; teeth confined to the centre, compressed, pinkish-grey, subporiform."

Kneiffiella candidissima (B. & C.) Underw.

On Juniperus Virginiana, (Peters). Distributed in Ravenel, Fung. Car. exsic. 5:32, from material collected in Alabama by Peters.

Kneiffiella aspera (Pers.) Underw. (*Kneiffia setigera* Fr.)

On Juniperus Virginiana (Peters). Distributed in Ravenel, Fung. Car. exsic. 5:31, from material collected by Peters in Alabama.

Odontia fimbriata B. & C.

Alabama (Peters) Peters coll., no. 67.

Odontia lateritia B. & C.

On Quercus (Peters). Distributed in Ravenel, Fung. Car. exsic. 5:22, from material collected in Alabama.

Described in Grevillea, 1:147, from specimens collected in Alabama, as follows:

"Effusa immarginata lateritia, matricem tingens."

"Widely effused, without any distinct margin; brick-red, staining the wood with the tint; spines short, tomentose."

Phlebia radiata Fr.

On Liriodendron, 1863, (Peters). Peters' coll., no. 66.

Phlebia zonata B. & C.

On Tilia, 7, 1855, Alabama, (Peters). Peters' coll.; a badly preserved specimen.

Radulum orbiculare Fr.

On dead wood, Lee, 12, 1895.

Radulum spinulosum B. & C.*

"Alabama (Peters)."

Described from material sent from Alabama, in Grevillea, 1:146, as follows:

"Effusum, isabellinum, margine elevato tomentoso, dentibus minutis sparsis spinulosum."

"Effused, opaque, of a pallid pinkish-grey; margin slightly raised, tomentose; hymenia sprinkled with short spinules."

FAMILY POLYPORACEAE.

Daedalea ambigua Berk.

On Quercus, Lee, 4, 1896.

Daedalea confragosa (Bolt.) Pers.

On Salix, Lee, 12, 1895; 2, 3, 11, 1896; 10, 1896, (C. F. Baker).

Daedalea glaberrima B. & C.

Lee, 12, 1895. Sufficiently distinct from *D. ambigua.*

Daedalea unicolor (Bull.) Fr.

Alabama, (Beaumont). Peters' coll., 44, as *Daedalea cinerea.*

Favolus alveolarius (D. C.) Fairm.

On Fagus, Lawrence, 1863, (Peters) Peters' coll., no. 48; Lee, 3, 1896. This includes the forms that have been variously named *F. Europaeus, etc.*

Gloeoporus conchoides Mont.

Lee, 11, 12, 1895; 1, 7, 1896; Mobile, 12, 1895; Hale, 5, 1896, common. When rather young and moist the entire hymenium will readily separate in a waxy or gelatinous-waxy membrane entirely different from anything seen in species of *Polyporus*. Its generic character must hold. A specimen is in the Peters coll. (1854) under the name of *Polyporus nigropurpurascens*.

Lenzites Berkelei Lev.*

"Alabama, (Beaumont)."

Lenzites betulina (L.) Fr.

Lee, 10, 12, 1895; 11, 1896.

Lenzites corrugata Kl.

Lee, 1, 1896.

Lenzites Crataegi Berk.*

"Alabama (Peters).*

Lenzites Klotzschii Berk.

On Liquidambar, Lee, 10, 11, 12, 1895; 1, 1896; very common.

Lenzites repanda Fr.*

"Alabama (Peters)."

Lenzites rhabarbarina B. & C.

On Pinus, Lee, 10, 1895; 1, 1866.

Lenzites sepiaria Fr.

On Pinus, Lee, 1, 1896; Hale, 5, 1896.

Merulius bellus B. & C.

On Abies, 1858, (Peters). Peters coll., No. 52. A small specimen but agreeing well with the brief description.

Described in Grevillea, 1:69, from material sent from Alabama, as follows:

"Effusus subbyssoideus irregularis; hymenio alutaceo poris ab initio distinctis brevibus."

"Effused, more or less byssoid; hymenium tan-colored, distinctly porous as soon as the hymenium is formed. This is quite different from the last, [*M. ceracellus*] though difficult of definition; the walls of the pores are not rigid as in *M. ceracellus*."

Merulius corium Fr.

Alabama, 1855 (Peters); Peters coll.; Lee, 1, 2, 3, 7, 12, 1896; common.

Merulius haedinus B. & C.

On Tilia, (Peters) distributed in Ravenel, Fung. Car. exsic. 4:8, from material collected in Alabama.

Described from specimens sent from Alabama, in Grevillea, 1:69, as follows:

"Pileo dimidiato candido glaberrimo, hymenio reguloso."

"Pileus an inch or more across, long, white, except at the margin, where it has a pale umber tint, quite smooth, slightly wrinkled; margin lobed, probably from the lateral confluence of one or more individuals; hymenium deep flesh-colored, wrinkled."

Merulius porinoides Fr. *

On Quercus, (Peters.)

Merulius serpens Tode.

On Pinus Lee, 1, 1896.

Merulius tremellosus Schrad.

Lee, 12, 1895; 1, 11, 12, 1896.

Polyporus acanthoides (Bull.) Fr.

Lawrence (Peters.) Peters coll. No. 35.

Polyporus adustus (Willd.) Fr.

On Hicoria, Lee 12, 1896.

On various trunks, Lee, 11, 12, 1895; 3, 1896.

Polyporus abietinus (Dicks.) Fr.

On Pinus, Lee, 11, 12, 1895; 1, 1896. Common.

Polyporus aneirinus Sommerf.

On Juglans, 2, 1855 (Peters.) Peters coll.; a badly eaten specimen.

Polyporus applanatus (Pers.) Wallr.

Alabama (Atkinson). Apparently this usually common species is not common in this state ; only a single specimen seen.

Polyporus arcularius (Batsch.) Fr.

On various fallen branches, Lee, 3, 5, 7, 1896 ; Tuscaloosa, 5, 1896; Madison. 5, 1996. A second form of this species (or possibly a distinct species) was collected in Auburn in February, and March 1896, with darker brown pileus and smaller pores with light cinereous mouths. It should be studied carefully in the field.

Polyporus barbatulus Fr.

Lee, 11, 1895.

Polyporus barbæformis B. & C.

On Vitis (Peters); Lee, 12, 1895; 1, 1896.

Described from material sent from Alabama, in Grevillea, 1:53 as follows:—

"Totus resupinatus margine tenui, albo; hymenio fulvo; poris parvis, elongatis, dissepimentis tenuibus."

"Wholly resupinate with a thin white margin; hymenium tawny; pores 1-48 inch wide, but variable in size."

Polyporus Beaumontii B. & C. *

"Alabama (Beaumont)."

Described in Grevillea, 15:26 from material sent from Alabama under the name of *Poria Beaumontii* as follows:—

"Effusa, adnata, crassiuscula, ochraceo-pallida, margine angusto, subtomentoso, poris majusculis, subaequalibus, rotundo-angulatis; dissepimentis acie acutis integris. *Polyporus Beaumontii* B. & C. in Herb. Berk. No. 2919."

Polyporus biformis Klotz.*

"Alabama (Beaumont)."

Polyporus carneus Nees.

On Juniperus (Peters.) Distributed in Ravenel, Fung. Car. exsic. 5:14. Also collected by Atkinson.

Polyporus cervinus Schw. *

"Entirely resupinate without any distinct margin; of a golden yellow, inclining to olive; pores elongated, oblique, 1-36 inch wide; spores ferruginous."

Polyporus chrysoloma Fr.

On pine chips, Lee, 1, 1896. We cannot separate this material from the species figured under the above name in Fries, Icones, *pl. 189; f. 3;* it agrees well with the description, except that the stratum of pores frequently becomes thicker than the description calls for. The yellow mycelial strands (fading to whitish in the dried specimens) and the strikingly dædalioid pores will readily distinguish it.

Polyporus cinnabarinus (Jacq.) Fr.

On Prunus, Lee, 1885; 11, 1896; Winston, 6, 1896.

Polyporus connatus Fr. ?

On Gleditschia triacanthos, Lee, 2, 1896. Referred with some hesitation to this species are several specimens growing on the upper limbs of a dying tree, quite unlike the habit of ordinary *P. connatus.* The characters of the pileus and pores are not like typical forms of this species. It is desirable to have additional and younger material.

Polyporus corticola Fr.

On bark, Lee, 12, 1895.

Polyporus Curtisii Berk.

On Quercus, etc. Lee, (Atkinson); 10, 11, 12 (1895); 6, 7, 1896. Very common and usually perennial. Very distinct from the annual *P. lucidus* with which it has sometimes been united.

Polyporus dealbatus B. & C.

Alabama 7, 9, 1864 (Peters, Beaumont). Peters coll. No. 40. Distributed from Alabama material in Ravenel, Fung. Car. exsic. 3:10.

Polyporus delicatus B. & C. *

Alabama (Peters).

Described from Alabama specimens in Grevillea, 1:37 as follows:

"Pileo orbiculari, ochraceo, tomentoso; margine tenui, acuto; stipite brevi, radicante; poris angulatis, dissepimentis tenuibus, usque ad basin decurrentibus."

"Pileus 3-4 inch across, orbicular, ochraceous, tomentose; margin thin, acute ; stem 1-4 inch high, 2 lines thick; rooting; pores angular, dissepiments thin, decurrent to the very base, 1-50 inch across."

Polyporus dibaphus B. & C. *

On Ilex opaca, (Peters).

Described from Alabama specimens in Grevillea, 1:36, as follows:

"Pileo orbiculo, atropurpureo, subtiliter tomentoso, glabrescente, lineis pallidis hic illic radiato; stipite gracili, subconcolore, deorsum pruinato ; poris decurrentibus, ochroleucis, angulatis, parvis."

"Pileus 1 in. across; orbicular, dark purple, finely tomentose, becoming smooth, with here and there pallid radiating lines; stem slender, nearly of the same color, pruinate downwards; pores decurrent, pale ochre, angular, small."

Polyporus Earlei Underw.

On the ground, Lee, 11, 1896. Described from material collected in Alabama in Bull. Torr. Bot. Club, 24:84, as follows:

"Mesopous; terrestrial; stem 4-5 cm. long, 1-1.5 cm. or more thick, colored like the pileus; pileus 7-12 cm. each way, cinereous, slightly darker towards the centre; margin very thin, much incurved in drying; context soft-fleshy, grayish, drying to a thin layer; pores 1-2 mm. deep, somewhat whitish-stuffed when young, cinereous gray, paler when young and, towards the margin, small (less than 0.5 mm.), the dissepiments rather firm, entire."

"Pine woods, Auburn, Alabama, Nov. 1896. Prof. F. S. Earle."

"The plant is cinereous throughout and retains this color when dry."

Polyporus elegans (Bull.) Fr.

On fallen branches, Lee, 2, 1896; Hale 5, 1896.

Polyporus endocrocinus Berk.

Hale, 5, 1896; Lee, 10, 1896 (C. F. Baker).

Polyporus ferruginosus (Schrad.) Fr.

On fallen limbs, Lee, 12, 1895; 1, 1896.

Polyporus flavo-squamosus Underw.

On the ground, Lee, 11, 1896.

Described from Alabama material in Bull. Torr. Bot. Club, as follows:

"Pleuropous; terrestrial; stem 7-8 cm. thick, slightly flattened, irregular roughened, colored like the pileus; pileus 1.5 cm. each way, yellowish, with a slight tinge of greenish; covered with rather small floccose imbricate scales, which form a very thin fragile crust, channeled behind where the edges nearly meet; margin rather acute, more or less incurved in drying; context white or slightly yellowish, fleshy, firm, becoming almost woody when dry; pores 5 mm. deep, rather large (about 1 mm.), irregular, angular, with thin dissepiments, slightly decurrent, white, changing to greenish when wounded, yellowish when dry; spores oval or ovoid, 9x6µ, with a single large highly refractive gutta."

"Growing in clayey soil, Auburn, Alabama, 23 Nov., 1896. Mrs. F. S. Earle."

Polyporus flavovirens B. & Rav.

On clay banks in woods, Lee, 7, 1896.

Polyporus gilvus Schw.

On trunks and fallen logs, Lee, 11, 12, 1895; 3, 12, 1896; Mobile, 3, 1896; Hale, 5, 1896; Winston, 6, 1896. Common.

Polyporus hemileucus B. & C.

On Liriodendron, Lee, 12, 1895; 3, 1896; Mobile, 12, 1895.

Polyporus hirsutus (Wulf.) Fr.

On trunks and branches, Lee, 12, 1895; 3, 4, 1896; Mobile, 12, 1895; 3, 1896; Hale, 5, 1896; Winston, 6, 1896. Very common.

Polyporus ilicincola B. & C.

On Ilex opaca, (Peters). Distributed by Ravenel, Fung. Car. exsic. 5:17, from Alabama.

Described from Alabama material in Grevillea, 1:52, as follows:

"Pileo flabelliformi, pallido, glabrato nitido radiato reguloso; poris pallidis sinuatis."

"Pileus 3-4 inch wide and long, flabelliform, but frequently laterally confluent, pallid, at length quite smooth, marked with little radiating lines; pores 1-72 wide, sinuated. Hymenium much like that of *P. abietinus*."

Polyporus isidioides Berk. ?

On trunks and branches, Lee, 12, 1895; 1, 3, 1896; Hale, 5, 1896; Winston, 6, 1896. With some hesitation and following common usage we refer this common form to this New Zealand species of which we have seen no authentic specimens. The species, whatever its name, is distinct from *P. gilvus* to which some have united it.

Polyporus irregularis Underw.

Under a pine log, Lee, 2, 1896. Described from Alabama material in Bull. Torr. Bot. Club, 24:85, as follows:

"Pileus irregular, more or less branching, brownish, paler towards the margin, uneven, subtomentose, with a thin imperfect crust, the under layer of which is darker colored, forming a delicate brown line in section; 4-6 cm. long, 3-4 cm. wide, the margin usually thin; context white, floccose-felty, pores white, 5 mm. or more deep, irregular, more or less angular, small (0.25 mm.), the dissepiments rather thin, firm, even."

"Growing irregularly underneath a pine log, Auburn, Alabama, Feb., 1896."

"The older portions are ferruginous brown above, and the free margins, when developed, are thin and distinctly paler brown for a space of about 1 cm. The extreme margin is sterile, and the pores which are normally even, become irregular and oblique as the margin tends to become erect."

Polyporus lucidus (Leys.) Fr.

On Tsuga, Winston, 6, 1896.

Polyporus Meliae Underw.

On branches of Melia Azedarach, Lee, 10, 1895. Described from material collected in Alabama, in Bull. Torr. Bot. Club, 24: 85, as follows:

"Pileus convex, dirty white, subtomentose, anoderm, 5-8 cm. in diameter, occasionally coalescing; margin obtuse, sometimes extending nearly or quite around the pores; cortex floccose-corky, whitish; pores cream white, becoming darker with age, more or less rimose, 5-6 mm. deep, minute (about 0.2 mm.), the dissepiments firm, slightly uneven, usually with obtuse edges; spores narrowly oblong, 6x3 hyaline."

"On branch of *Melia Azedarach*, Auburn, Alabama, Oct., 1895."

"In very old specimens the layer of pores becomes cracked in all directions and very much discolored."

Polyporus obliquus (Pers.) Fr.

Lee, 12, 1895; 1, 2, 1896.

Polyporus obtusus Berk.

On Quercus rubra, Lee, 11, 1895. Once found.

Polyporus occidentalis (Fr.) Klotzsch.*

"Alabama (Beaumont)."

Polyporus parvulus Klotzsch.

Lee, 7, 1896.

Polyporus pergamenus Fr.

On various deciduous trunks, Lee, 10, 12, 1895; 1, 2, 12, 1896; Mobile, 12, 1895; Winston, 6, 1896. Very common.

Polyporus perennis (L.) Fr.

Lee, 7, 1896. Young specimens scarcely separably from this species.

Polyporus picipes Fr.

Alabama (Atkinson).

Polyporus plebeius Berk.

On Prunus serotina, Lee, 4, 5, 1896.

On Magnolia?, Mobile, 12, 1895. Following reference of similar specimens by others we refer some of this species which is not uncommon in the southern part of the State to this New Zealand species. It appears very doubtful that two regions so widely separated should have any species in common that are not cosmopolitan in their character.

Polyporus poripes Fr.

Lee, 11, 1895.

Polyporus pulchellus Schw.

Alabama, 1855. (Peters). Peters coll. Apparently this species.

Polyporus purpureus Fr.

On rotten wood, Lee, 2, 1896.

Polyporus reniformis Morg.

Lee, 3, 1896; Winston, 6, 1896.

Polyporus retipes Underw.

In pine woods, Lee, 12, 1896. Described from material collected in Alabama, in Bull. Torr. Bot. Club, 24:85, as follows:

"Terrestrial; stem excentric, 4-6 cm. long, 2 cm. or more thick, yellowish-white towards the base; pileus 6-15 cm. each way, brown, appressed tomentose, finely areolate-rimose so as to appear finely mottled; context fleshy, rather thick

(2 cm. or more), becoming quite thin in drying, whitish; margin acute; pores decurrent half the length of the stem, shallow, whitish, large (1.5 mm. or more), mostly hexagonal, the dissepiments thin and finely lacerated."

"The young pores are very shallow and the stem appears reticulate-veined nearly to the base. As the pores become older they deepen and those nearest the base of the stem become more or less obscured."

"In pine woods, Auburn, Alabama, December, 1896. Mrs. F. S. Earle."

Polyporus resinosus (Schrad.) Fr.

On a fallen trunk, Lee, 3, 1896. Once found, the specimens the growth of the preceding autumn, which is its proper season.

Polyporus rhipidium Berk.

On a very much decayed log, Etowah, 5, 1896. Has the exact habit of *Panus stypticus* from which its pileus could scarcely be distinguished. Found only once.

Polyporus rimosus Berk.

On Robinia pseudacacia, Madison, 5, 1896; DeKalb, 5, 1896. Also collected somewhere in the State by Professor Atkinson, but exact locality unknown.

Polyporus sanguineus (L.) Mey.

On fallen trunks, Lee, 11, 12, 1895; 1, 1896; Tuscaloosa, 5, 1896; Winston, 6, 1896. Very common and conspicuous. Abnormal forms which were described by Fries as *Hydnum cinnabarinum* were found in Lee, 5, 1896; and Winston, 6, 1896.

Polyporus Schweinitzii Fr.

On the ground, Lee, 10, 1896 (J. Q. Burton); 11, 12, 1896.

Polyporus scutellatus Schw.

On branches of Alnus, Lee, 1, 1896. Very distinct from *Trametes Ohiensis* Berk. with which some have united it.

Polyporus spissus Schw.

On branches, Lee, 1, 1896.

Polyporus splendens Pk.

Alabama, 8, 1864. (Peters). Peters coll. no. 37, as *P. perennis*. Lee, 7, 1896. A single specimen.

Polyporus sulphureus (Bull.) Fr.

Winston, 6, 1896. Also collected in the State by Professor Atkinson.

Polyporus supinus (Sw.) Fr.

On Prunus angustifolia, Lee, 11, 1895; 3, 1896. Not uncommon.

Poylporus vaporarius Fr.

On various dead branches, Lee, 11, 12, 1895; 1, 1896. Very common.

Polyporus velutinus Fr.

Lee, 10, 12, 1895; 1, 6, 7, 1896; Winston, 6, 1896.

Polyporus versicolor (L.) Fr.

On various deciduous trees, Lee, 10, 11, 12, 1895; 3, 1896; Winston, 6, 12, 1896.

Polyporus vesiculosus B. & C.

On Pinus, (Peters). Peters coll. no. 39.

Described from material collected in Alabama, in Grevillea 1:65 as follows:

"Late effusus alutaceus; poris pezizaeformibus veluti e vesiculis ruptis enatis."

"Widely spreading, pale tan-colored; pores 1-100 inch wide, looking like minute burst bladders."

Polyporus virgineus Schw.

Alabama (Peters). Distrfbuted from Alabama material in Ravenel, Fung. Car. exsic. 3:11.

Polyporus viticola Schw.

On Vitis, (Peters). Peters coll. no. 38.

Polyporus vulgaris Fr.

On Abies, (Peters). Peters coll. no. 36 as *P. communis.*

Polyporus xanthus Fr. *

"Alabama (Peters)."

Porothelium fimbriatum (Pers.) Fr.

On Betula, Winston, 1861. (Peters). Peters coll. no. 52 bis.

Solenia anomala (Pers.) Fr.

On Alnus, Lee, 1, 5, 1896.

Solenia villosa Fr.

On Quercus (Peters). Distributed from Alabama material in Ravenel, Fung. Carol. exsic. 5:42.

Trametes lactea Fr.

Alabama (Peters). Peters' coll., no. 41.

Trametes Petersii B. & C.*

"Alabama (Peters)."

Described from specimens sent from Alabama in Grevillea, 1:66, as follows:

"Pileo applanato subtiliter tomentoso pallide fulvo marginem versus subsulcato-zonato, poris minimis punctiformibus, dissepimentis ab initio rigidis."

"Pileus flattened, but slightly convex, minutely tomentose; of a very pale tawny, somewhat sulcate or zoned at the margin, which is barren; pores quite punctiform, with rigid obtuse dissepiments about 1-150 inch wide."

Trametes rigida B. & Mont.

"Alabama (Beaumont); Lee, 11, 1895.

Trametes sepium Berk.

"Alabama (Peters, Beaumont);" Lee 11, 1895; 1, 7, 1896.

FAMILY BOLETACEAE.

Boletinus decipiens (B. & C.) Pk.

Lee, 10, 12, 1896 (C. F. Baker).

Boletus auriporus Pk.

Lee, 7, 1896.

Boletus brevipes Pk.

Lee, 11, 1895; 10, 11, 1896 (C. F. Baker). Common.

Boletus chromapes Frost.

Lee, 5, 1896.

Boletus edulis Bull.

Lee, 7, 1896.

Boletus felleus Bull.

Lee, 7, 10, 1896.

Boletus ferrugineus Frost, var.?

Lee, 7, 1896. Differs from the brief description of this species in the pileus becoming at length concave, the longer stem, and the reticulations lined with darker brown.

Boletus fistulosus Pk.

Lee, 7, 1896. Described in Bull. Torr. Bot. Club, 24:144; from Alabama specimens as follows:

"Pileus convex, viscid, glabrous, yellow, the margin at first incurved or involute, flesh yellow; tubes plane or subventricose, medium size, round with thin walls, adnate or sometimes depressed around the stem, yellow; stem rather slender, subequal, viscid, glabrous, hollow, yellow, with a white mycelioid tomentum at the base; spores elliptical, .0005 in. long, .00025 broad. Pileus about 1 in. broad; stem 2-4 in. long, about 3 lines thick."

"Grassy woods. Auburn, Alabama. July. Underwood."

"A small but pretty species of a yellow color throughout. It is remarkable for its hollow stem, which is suggestive of the specific name. It is referable to the tribe Viscipelles."

Boletus fraternus Pk.

On the streets of Auburn, Lee, 7, 1896. Described from Alabama material in Bull. Torr. Bot. Club, 24:145, as follows:

"Pileus convex, becoming plane or depressed, slightly tomentose, deep red when young, becoming dull red with age, flesh yellow, slowly changing to greenish-blue where wounded; tubes rather long, becoming ventricose, slightly depressed about the stem, their walls sometimes slightly decurrent, the mouths large, angular or irregular, sometimes combined, bright yellow, quickly changing to blue where wounded; stem short, cespitose, often irregular, solid, subtomentose, slightly velvety at the base, pale reddish yellow, paler above and below, yellow within, quickly changing to dark green where wounded; spores .0005 in. long, .00025 broad. Pileus 1-1.5 in. broad; stem 1-1.5 in. long, 3-6 lines thick."

"The species is apparently allied to *R. rubens*, but is very distinct by its small size, cespitose habit, color of the flesh of the stem and by the peculiar hues assumed where wounded. When the pileus cracks the chinks become yellow as in *B. subtomentosus*. This species belongs to the tribe Subtomentosi."

Boletus frustulosus Pk.

Along the highway on clay banks, Hale, 5, 1896. Described in part from Alabama material in Bull. Torr. Bot. Club, 24:146, as follows:

"Pileus thick, convex or nearly plane, subglabrous, rimosely areolate, white or whitish, flesh whitish; tubes equal to or a little longer than the thickness of the flesh of the pileus, depressed about the stem, whitish, becoming pale brown; stem equal, solid, whitish, reticulated above; spores .0006-.0007 in. long, .0002-.00025 broad. Pileus 3-5 in. broad, stem 1-2 in. long, 6-10 lines thick."

"The deeply cracked surface of the pileus is the most notable feature of this species. This sometimes is seen even in quite young plants. The areolae are quite unequal in size. The deep chinks with sloping sides cause them to appear like frustra of polygonal pyramids. In some specimens the reticulations of the stem extend nearly or quite to its base, and make the place of the species ambiguous between the Calopodes and Edules."

Boletus granulatus L.

In pine woods, Lee, 10, 1896.

Boletus griseus Frost.

Lee, 7, 1896.

Boletus hirtellus Pk.

In pine woods, Lee, 10, 1896.

Boletus Morgani Pk.

Lee, 10, 1896 (C. F. Baker).

Boletus ornatipes Pk.

Lee, 7, 1896.

Bolletus pallidus Frost.

Lee, 10, 1896.

Boletus parvus Pk.

Lee, 7, 1896. Described from material collected in Alabama, in Bull. Torr. Bot. Club, 24:145, as follows:

"Pileus convex, becoming plane, often slightly unbonate subtomentose, reddish, flesh yellowish white, slowly changing to pinkish where wounded; tubes nearly plane, adnate, their mouths rather large, angular, at first bright red, becoming reddish-brown ; stem equal or slightly thickened below, red ; spores oblong, .0005 in. long, .00016 broad. Pileus 1-2 in. broad ; stem 1-2 in. long, 2-3 lines thick."

"This is one of the smallest species of the tribe. It is referable to the tribe Luridi."

Boletus Ravenelii B. & C.

Lee, 7, 1896.

Boletus retipes B. & C.

Lee, 7, 1896.

Boletus subluteus Pk.

Lee, 10, 11, 1896.

Boletus tabacinus Pk.

Along roadsides, Lee, 5, 1896.

Described from Alabama specimens in Bull. Torr. Bot. Club, 23:418 as follows:

"Pileus fleshy, convex, nearly plane, subglabrous, often rimose-areolate, tawny-brown, flesh at maturity soft and similarly colored ; tubes concave or nearly plane, depressed around the stem, their mouths small, angular, colored like the pileus; stem subequal, solid, reticulated, concolorous ; spores oblong or subfusiform, .0005 to .00055 in. long, about .0002 broad; pileus 2.5 to 5 in. broad ; stem 1.5 to 3 in. long, 6 to 10 lines thick."

"The species is referable to the section Calopodes, but the tubes are more or less depressed about the stem. It is well marked by its color which is some shade of brown or tawny-brown throughout, inclining at one time toward wood-brown, isabelline-brown or broccoli-brown, at another toward sepia-brown. The flesh in the dried specimens appears a little darker than the surface of the pileus. It is almost tomentose in texture."

Boletus Underwoodii Pk.

Lee, 7, 1896. Described from material collected in Alabama, in Bull. Torr. Bot. Club, 24:145, as follows:

"Pileus rather thin, convex, becoming nearly plane, slightly velvety, bright brownish-red, becoming paler with age, flesh yellow, changing to greenish-blue where wounded: tubes adnate or slightly decurrent, greenish-yellow, becoming bluish where wounded, their mouths very small, round, cinnabar-red, becoming brownish-orange; stem equal or slightly tapering upward, somewhat irregular, solid, yellow without and within; spores .0004-.0005 in. long, .0002 broad. Pileus 2-3 in. broad; stem 3-4 in long, 4-6 lines thick."

"The species is remarkable for its adnate or subdecurrent tubes in which it departs from the character of the tribe to which it belongs according to the colors of the tubes."

Fistulina pallida B. & Rav.*

"At base of a stump of Quercus alba." (Peters.)

Described in part from material collected in Alabama, in Grevillea, 1:71 as follows:

"Pileo reniformi pallido-rubente, stipite laterali, tubis decurrentibus."

"Pileus 1-2 inches across, about one inch long, uniform, pallid red, pulverulent; margin inflexed; stem lateral, 1½ inch high, ⅓ thick, striate when dry; tubes more or less decurrent."

Fistulina radicata Schw.

At the roots of a decaying chestnut stump, Alabama, 9, 1864 (Peters). Peters coll. no. 24.

Fistulina spathulata B. & C.*

"Base of an oak" (Quercus) (Peters).

Described in Grevillea 1:71, from material collected in Alabama as follows:

"Pileo tenui, spathulato in stipitem gracilem basi attenuatum tubulis decurrente."

"Pileus ¾ inch across, thin, pulverulent, spathulate, attenuated behind into the lateral stem; stem 2 inches or more high, 1½ lines thick above, much attenuated downwards. Apparently a very distinct species."

Strobilomyces strobilaceus B. & C.

Lawrence, (Peters). Peters coll. no. 33; Lee, 7, 1896.

FAMILY AGARICACEAE.

Agaricus campestris L.

Lee, 11, 1895; 2, 3, 7, 1896. The common edible field mushroom.

Agaricus placomyces Pk.

Lee, 7, 1896.

Amanita abrupta Pk.

Lee, 7, 1896.

Described from Alabama specimens in Bull. Torr. Bot. Club, 24:138, as follows:

"Pileus thin, broadly conxex or nearly plane, verrucose with small angular or pyramidal erect somewhat evanescent warts, white, slightly striate on the margin, flesh white; lamellae moderately close, reaching the stem and sometimes terminating in slightly decurrent lines upon it, white; stem slender, glabrous, solid, bulbous, white, the bulb abrupt, subglobose, often coated below by the white persistent mycelium, the annulus membranous, persistent; spores broadly elliptical or subglobose, .0003-.0004 in, long, .00025-.0003 broad. Pileus 2-4 in. broad; stem 2.5-4 in. long, 3-4 lines thick."

"The chief distinguishing mark of this species is its abrupt nearly globose bulbous base of the stem. This is somewhat flattened above and is sometimes longitudinally split on the sides. The small warts of the pileus are easily separable, and in mature specimens they have often wholly or partly disappeared. The remains of the volva are not present on the bulb in mature dried specimens, which indicates that the species should be placed in the same group with *A. rubescens*, *A. spissa*, etc. The latter species has the bulb of the stem similar to that of our plant, but the color of the pileus and other characters easily separate it."

Amanita caesarea Scop.

Tuscaloosa, 5, 1896; Lee, 7, 10, 1896. Abundant. Edible. *Cf.* Bulletin no. 73.

Amanita candida Pk.

Lee, 10, 1896.

Described from Alabama specimens in Bull. Torr. Bot. Club, 24:137, as follows:

"Pileus thin, broadly convex or nearly plane, verrucose with numerous small erect angular or pyramidal easily separable warts, often becoming smooth with age, white, even on the margin, flesh white; lamellae rather narrow, close, reaching to the stem, white; stem solid, bulbous, floccose-squamose, white, the annulus attached to the top of the stem, becoming pendent and often disappearing with age, floccose-squamose on the lower surface, striate on the upper, the bulb rather large, ovate, squamose, not margined, tapering above into the stem and rounded or merely abruptly pointed below; spores elliptical, .0004 to .0005 in. long, .0003 in. broad. Pileus 3 to 6 in. broad; stem 2.5 to 5 in. long, 5 to 8 lines thick, the bulb 1 to 1.5 in. thick in the dried specimens."

"This is a fine large species related to *A. solitaria*, but differing from it in the character of its bulb and of its annulus. The bulb is not marginate nor imbricately squamose. Its scales are small and numerous. Nor is it clearly radicating, though sometimes it has a slight abrupt point or mycelioid-agglomerated mass of soil at its base. The veil or annulus is large and well developed, but it is apt to fall away and disappear with age. Its attachment at the very top of the stem brings it closely in contact with the lamellae of the young plant and the striations of its upper surface appear to be due to the pressure of the edges of these upon it. It separates readily from the margin of the pileus and is not lacerated. In the mature plant the warts have generally disappeared from the pileus and sometimes its margin is curved upward."

Amanita chlorinosa (Pk.).

Lee, 11, 1896.

Amanita Frostiana Pk.

Lee, 7, 1896. Resembles the fly-agaric closely, but smaller.

Amanita muscaria L.

Lee, 10, 1896 (Burton); 11, 12, 1896 (C. F. Baker). The "fly-agaric;" poisonous. *Cf.* Bulletin no. 73.

Amanita phalloides Fr.

Lee, 12, 1895; 7, 10, 1896; Mobile, 12, 1895. Reputed poisonous. A form collected in Lee, 7, 1896, closely resembles this species, but differs in its evanescent volva and veil, and is possibly a distinct species.

Amanita rubescens Fr.

Lee, 7, 1896.

Amanita solitaria Bull.

Lee, 7, 1896.

Amanita spreta Pk.

Lee, 7, 11, 1896.

Amanita strobiliformis Vitt.

Lee, 10, 1896.

Amanita virosa Fr.

Lee, 7, 1896.

Amanitopsis strangulata (Fr.) Roze.

Lee, 11, 1896.

Amanitopsis vaginatus (Bull.) Roze.

Alabama, 9, 10, 1864 (Peters). Peters coll. Lee, 7, 1896.

Amanitopsis volvata (Pk.) Sacc.

Lee, 7, 1896.

Armillaria apdendiculata Pk.

Lee, 10, 1896 (C. F. Baker).

Described from Alabama specimens in Bull. Torr. Bot. Club, 24:140, as follows:

"Pileus broadly convex, glabrous, whitish, often tinged with ferruginous or brownish-ferruginous on the disk, flesh white or whitish; lamellae close, rounded behind, whitish; stem equal or slightly tapering upward, solid, bulbous, whitish, the veil either membranous or webby, white, commonly adhering in fragments to the margin of the pileus; spores subelliptical, .0003 in. long, .0002 broad. Pileus 2-4 in. broad; stem 1.5–3.5 in. long; 5–10 lines thick."

"The general appearance of this species is suggestive of *Tricholoma album*, but the presence of a veil separates it from that fungus and places it in the genus *Armillaria.* The veil, however, is often slightly lacerated or webby and adherent to the margin of the pileus."

Armillaria mellea Vahl.

About stumps, etc., Alabama, 10, 11, 1864 (Peters). Peters coll. Lee, 11, 12, 1895; 7, 10, 11, 12, 189·.

Cantharellus Cantharellus (L.) (*C. cibarius* Fr.)

Winston, 6, 1896; Lee, 7, 1896. Edible. Commonly known as the Chantarelle.

Cantharellus cinnabarinus Schw.

Lee, 7, 1896.

Cantharellus floccosus Schw.

Winston, 6, 1896.

Cantharellus infundibuliformis (Scop.) Fr.

Winston, 6, 1896.

Cantharellus Petersii B. & C.

Described from Alabama specimens in Ann. Mag. Nat. Hist. (III), 4:294 as follows:

"Pusillus; pileo depresso subzonato stipiteque gracili dealbatis; plicis distantibus decurrentibus; interstitiis venosis. Amongst moss at the base of trees, Alabama, Hon. J. M. Peters."

"Pileus 1 inch across, depressed, white, opake, with one or two concentric furrows; stem 1 inch high, 1 line thick, white like the pileus; folds moderately broad, distant, decurrent; interstices wrinkled."

"Resembling somewhat the white variety of C. aurantiacus, but a smaller plant with broader folds."

Alabama, Peters. Distributed in Ravenel, Fung. Car. exsic. 5:12, from material collected in Alabama by Peters.

Claudopus nidulans (Pers.) Pk.

Lee, 12, 1895; 11, 12, 1896. Two forms: one with a fine velvety pileus and the other strigose.

Clitocybe ectypoides Pk.

Lee, 11, 1896.

Clitocybe inversa Scop.

Lee, 7, 1896.

Clitocybe laccata Scop.

Mobile, 12, 1895; Lee, 12, 1895; 1, 3, 10, 12, 1896.

Clitocybe ochropurpurea Berk.

Alabama, 9, 10, 1864 (Peters). Peters coll. as *Agaricus tyrianthus*; Lee, 11, 12, 1896.

Clitopilus abortivus B. & C.

Lee, 10, 1896.

Collybia albipilata Pk.

On dead cones of Pinus, Lee, 12, 1896.

Collybia dryophila Bull.

Alabama, 8, 9, 1864 (Peters) Peters coll.; Lee 1, 1896.

Collybia luxurians Pk.

Under brush heap, Lee, 7, 1896. Described in Bull. Torr. Bot. Club. 24:141 as follows:

"Pileus thin, convex or subcampanulate, often irregular from its mode of growth, obtuse or umbonate, glabrous, moist, brown; lamellae narrow, close, whitish; stems cespitose, equal, flexuous, hollow, brown, thinly clothed above with a minute grayish pulverulent villosity which is often more dense and tomentose toward the base; spores elliptical, .00025–.0003 in. long, .00016 broad. Pileus 2–4 in. broad; stem 3–4 in. long, 2–3 lines thick."

"This is a large cespitose and luxuriant appearing species, but as the specimens were not accompanied by notes of the characters of the fresh plant it can only be imperfectly described. The pileus was said to be very moist when fresh and it was probably hygrophanous. In the dried state it is a dull, reddish brown, closely approaching Mars' brown. Its margin is more or less wavy, lobed and striate. The species is apparently related to *C. confluens*, but it is a much larger plant with a darker colored pileus. Its place is probably among the Confertipedes."

Collybia platyphylla Fr.

Lee, 7, 1896.

Collybia radicata Relh.

Alabama, 9, 1864 (Peters), Peters coll. Tuscaloosa, 5, 1896; Lee, 7, 1896.

Collybia stipitaria Fr.
Alabama, 9, 1864 (Peters) Peters coll.
Collybia zonata Pk.
Alabama, 9, 1864 (Peters) Peters coll. mixed with the preceding species.
Coprinus atramentarius (Bull.) Fr.
Lee, 3, 1896. Edible. Commonly known as an ink-cap from the black deliquescent gills.
Coprinus comatus Fr.
Lee 4, 1896. Edible. Known as the shaggy or maned ink-cap.
Coprinus plicatilis (Curt.) Fr.
Alabama (Peters), Peters coll. no. 13 as *C. picaceus*.
Cortinarius delibutus Fr.
Lee, 10, 1896.
Cortinarius iodes B. & C.
Lee, 10, 11, 1896.
Cortinarius porphyropus Fr.
Lee 11, 1896.
Cortinarius purpurascens Fr.
Lee, 11, 1896.
Crepidotus applanatus Pers.
On Hicoria, Alabama (Peters), Peters coll. no. 8, under the name of *Panus flabelliformis*.
Crepidotus applicatus Pk.
Lee, 5, 1896.
Crepidotus fulvo-tomentosus Pk.
Lee, 5, 1896.
Deconica coprophila Bull.
On horse dung, Lee, 10, 1896.
Flamula flavida Pers.
Alabama, 10, 1864 (Peters), Peters coll.; Lee, 12, 1896.
Flammula sapinea Fr.
Mobile, 6, 1896; Lee, 10, 1896.
Flammula Underwoodii Pk.
On trunks of Pinus, Lee, 11, 1895.
Described from specimens collected in Alabama in Bull. Torr. Bot. Club, 23:415, as follows:

"Pileus convex or nearly plane, often irregular from its crowded mode of growth, squamulose or furfuraceous, yellowish-brown; lamellae rather broad, close, adnate or slightly decurrent, yellow; stem tapering downward, radicating, longitudinally streaked with brownish hues, yellow at the top; spores elliptical, ochraceous, .00024 to .0003 in. long, .00016 to .0002 broad; plant cespitose; pileus 1 to 4 in. broad; stem 2 to 4 in. long, 3 to 6 lines thick."

"Pine trunks. Alabama, November. Underwood."

"The species is apparently related to *Flammula sapineus*, from which its densely cespitose habit and brownish streaked stem will easily separate it."

Galera tenera Schaeff.

Alabama, 10, 1864 (Peters). Peters coll.

Gomphidius rhodoxanthus Schw.

Lee, 7, 10, 12, 1896.

Heliomyces decolorans B. & C.

Alabama (Peters); distributed in Ravenel, Fungi Car. exsic. 5:7, from material collected in Alabama.

Described from Alabama material in Ann. Mag. Nat. Hist. (III), 4:295 as follows:

"Albus, exsiccatione rufus; pileo glabro rugoso sulcato; stipite rigido nitido; lamelles latis decurrentibus. On dead wood, Alabama, Hon. J. M. Peters."

"Pileus 1 inch or more across, white at first as well as the gills, but changing in drying to a deep tawny brown, smooth, wrinkled, sulcate; stem 2 inches high, shining, more permanent in color, but sometimes becoming rufous; gills broad, distant, decurrent; interstices wrinkled."

"The change of color is exactly that which takes place in *Hygrophorus eburneus*."

Hygrophorus conicus (Scop.) Fr.

Alabama, 10, 1864 (Peters). Peters coll. no. 12.

Hypholoma modestum Pk.?

Lee, 7, 1896. Specimens probably referable to this species.

Hypholoma perplexum Pk.

Lee, 11, 1896.

Hypholoma sublateritium Schaeff.
Lee, 12, 1895.
Inocybe vatricosa Fr.
On pine chips. Lee, 1, 1896.
Lactarius chelidonium Pk.
Lee, 7, 10, 11, 1896.
Lactarius deceptivus Pk.
Lee, 7, 1896.
Lactarius Indigo (Schw.) Fr.
Lee, 7, 11, 1896.
Lactarius insulsus Fr.
Lee, 7, 10, 1896.
Lactarius piperatus (Scop.) Fr.
Hale, 5, 1896; Winston, 6, 1896; Lee, 7, 10, 11, 1896.
Lactarius scrobiculatus (Scop.) Fr.
Lee, 10, 11, 1896.
Lactarius subdulcis (Bull.) Fr.
Lee, 7, 1896.
Lactarius theiogalus (Bull.) Fr.
Lee, 10, 11, 1896.
Lactarius vellereus Fr.
Lee, 10, 11, 12, 1896.
Lactarius volemus Fr.
Winston, 6, 1896; Lee, 7, 1896.
Lentinus Lecontei Fr.
Lee, 1891 (Atkinson). Scarcely distinguishable from *L. strigosus.*
Lentinus lepideus Fr.
On pine wood, 5, 6, 7, 10, 12, 1896.
Lentinus Ravenelii B. & C.*
"Alabama (Beaumont)."
Lentinus strigosus Fr.
Lee, 2, 4, 1896; Tuscaloosa, 5, 1896; Winston, 6, 1896. Rather common.
Lentinus tigrinus (Bull.) Fr.
Alabama, 1895 (Peters). Peters coll.; Lee, 4, 1896.
Lentinus Underwoodii Pk.
On Quercus, Macon, 7, 1896.

Described from material collected in Alabama, in the Bull. Torr. Bot. Club, 23:414, as follows:

"Pileus fleshy, tough, convex or nearly plane, the glabrous surface cracking into areola-like scales which are indistinct or wanting toward the margin, whitish or slightiy tinged with buff or pale ochraceous, flesh white; lamellae moderately close, decurrent, slightly connected or anastomosing at the base, somewhat notched on the edge, whitish, becoming discolored in drying; stem stout, hard, solid, eccentric, squamose, colored like the pileus; spores oblong, .0005–.0006 in. long, .0002–.00025 broad; plant cespitose; pileus 3-6 in. broad; stem 1.5-3 in. long, about 1 in. thick."

"Wood of oak. Tuskegee, Alabama. July. Prof. L. M. Underwood."

"This differs from *L. magnus* in its cespitose habit, eccentric stem. longer spores, less distinctly areolate-squamose pileus and in its habitat. The lamellae are connected at the base very much like those of *Pleurotus ostreatus*."

Lentinus ventricosus Pk.

On the ground, Lee, 12, 1895; 11, 1896.

Described from Alabama specimens in Bull. Torr. Bot. Club, 23:414, as follows:

"Pileus fleshy, nearly plane above, gl abrous, shining, white the thin margin involute, flesh whitish; lamellae narrow, close, decurrent, serrate on the edge, whitish; stem short, thick, ventricose, smooth, solid, abruptly narrowed or pointed at the base, annulate, white, tinged within with isabelline; spores .0004 to .0005 in. long, .0002 to .00024 broad; pileus 4 to 6 in. broad; stem 1.5 to 2 in. long, nearly as broad in the thickest part."

"Auburn, Alabama. December. Underwood."

"A species well marked by its white glabrous pileus and its short ventricose annulate stem."

Lepiota acutesquamosa Weinm.

Alabama, 10, 1864 (Peters). Peters coll.

Lepiota mammaeformis Underw.

At the base of Broussinetia, Lee, 7, 1896.

Described from Alabama material in Bull. Torr. Bot. Club, 24:82, as follows:

"Pileus thin, white, with a dull brownish strongly umbonate disc, 5-8 cm. in diameter, mealy squamulose, the margin strongly sulcate-striate, somewhat incurved; gills rather narrow, moderately close; stem 12-18 cm. long, flexuous, hollow, tapering upward from an elongate thickened base, over 1 cm. at its greatest thickness, the narrow distant annulus often finally deciduous."

Growing cespitosely from near the base of a decaying *Broussinetia* on the streets of Auburn, Alabama, July 1896. The gills turn darker in drying and the umbo becomes strikingly prominent."

Lepiota Morgani Pk.

Lee, 7, 1896. A remarkably handsome species, with greenish spores; said to be edible.

Lepiota procera Scop.

Lee, 11, 1896. Edible.

Mycena epipterygia Scop.

Lee, 12, 1896.

Marasmius Rotula (Scop.) Fr.

Alabama, 9, 10, 1864 (Peters). Peters' Coll.; Lee, 5, 1896.

Marasmius viticola B. & C.

On Vitis, Alabama (Peters). Peters' Coll. under the names of *Merulius* and *M. fœtidus.*

Naucoria semiorbicularis Bull.

Lee, 6, 7, 1896; Mobile, 6, 1896.

Nyctalis asterophora Fr.

Parasitic on *Lactarius*, Alabama, 1863, (Peters). Peters' Coll.

Described from Alabama specimens in Ann. Mag. Nat. Hist. (III), 4; 295 as follows:—

"Pileo depresso subcoriaceo tenni* sulcato striato rufo; slipite brevi insititio fusco pruinoso, furfuraceo; lamellis pallidis distantibus; interstitiis lævibus. On dead vine branches, Alabama, Hon. J. M. Peters."

"Pileus $\frac{3}{4}$ of an inch broad, dry, subcoriaceous, depressed, sulcate-striate, pale rufous; stem 1 inch high, dark brown, pulverulent; gills distant, pale, slightly adnate, moderately broad, ventricose; interstices even."

"The stems are sometimes confluent."

Omphalia pubescentipes Pk.

Lee, 12, 1896. Described from Alabama material in Bull. Torr. Bot. Club, 24: 141, as follows:

"Pileus thin, convex, umbilicate, glabrous, reddish-tawny, sometimes paler on the margin; lamellae moderately close, decurrent, whitish; stem slender, pubescent, tawny with a tawny mycelioid tomentum at the base; spores elliptical, .00025 in. long, .00016 broad. Pileus 2–4 lines broad; stem about 1 in. long, .5 line thick."

The downy or pubescent stem is the distinguishing character of this species.

Panaeolus sphinctrinus Fr.

On dung, Lee, 3, 1896.

Panus levis B. & C.

Lee, 10, 1896, (Burton).

Panus stypticus (Bull.) Fr.

Lee, 11, 12, 1895.

Panus dealbatus Fr.

On Fraxinus, Alabama (Peters). Distributed in Ravenel, Fungi Car. exsic. 5:9, from material collected by Peters in Alabama. The plant does not seem to be mentioned by Saccardo.

Pholiota sabulosa Pk.

In sandy soil, Lee, 12, 1895. Described in Bull. Torr. Bot. Club, 23: 414, from Alabama material, as follows:

"Pileus convex or nearly plane, glabrous, pale, yellowish-brown; lamellae andate, subdistant, yellowish-brown; stem short, equal or slightly tapering downwards, hollow, colored like or a little paler than the pileus, paler above the slight subevanescent annulus; spores subelliptical, brownish ferruginous, .0003 to .00004 in long, .0002 to .00024 broad; pileus 9 to 12 lines broad; stem about 1 in. long, 1 to 2 lines thick."

"Sandy soil. Alabama, December. Underwood."

"In the dried specimens the pileus is pale-tawny and the lamellae are brownish ferruginous."

Pleurotus applicatus Batsch.

On bark, Lee, 11, 1895.

On Vitis, Lee, 11, 1896.

Pleurotis niger Fr.

Alabama, 8, 1855, (Peters). Peters' Coll. under the name of *Agaricus ater.*

Pleurotus sapidus Kalchb.

On various dead trunks, Mobile, 12, 1895; Lee, 1, 11, 1896. Rather common. Edible.

Pluteus cervinus Schaeff.

Lee, 1891 (Atkinson), 2, 5, 1896.

Pluteus Curtisii Berk.

Alabama, 9, 10, 1864 (Peters). Peters' Coll.; possibly only a form of the last.

Psilocybe foenisecii Pers.

Lee, 7, 1896.

Psilocybe subericaea Fr.

In low ground, Lee, 1, 1896.

Russula adusta (Pers.) Fr.

Lee, 11, 1896.

Russula albella Pk.

Lee, 10, 11, 1896.

Russula brevipes Pk.

Lee, 12, 1895; 10, 1896.

Russula chamaeleontina Fr.

Lee, 11, 1896.

Russula emetica Fr.

Lee, 11, 12, 1896.

Russula foetens (Pers.) Fr.

Lee, 10, 1896.

Russula lepida Fr.

Lee, 10, 1896.

Russula pusilla Pk.

Lee, 12, 1895.

Russula virescens (Schaeff.) Fr.
Lee, 7, 1896. Edible.
Schizophyllum commune Fr.
On standing trunks and branches, Mobile, 12, 1895; Lee, 2, 6, 1896; Winston, 6, 1896.
Stropharia bilamellata Pk.
Lee, 7, 1896.
Tricholoma cuneifolium Fr. (?)
In sandy soil.
Lee, 1, 1896. Referred with some doubt to this species.
Tricholoma equestre L.
Lee, 11, 1896.
Tricholoma leucocephalum Fr. (?)
Lee, 10, 1896.
Tricholoma Russula Schaeff.
Lee, 11, 12, 1896.
Tricholoma terreum Schaeff.
Lee, 1, 1896.
Tricholoma tricolor Pk.
Lee, 11, 1896.
Xerotus viticola B. & C.
Alabama (Peters). Peters' Coll. as *Xerotus nigrita.*

ORDER GASTRALES.

FAMILY PHALLACEAE.

Clathrus columnatus Bosc.
Lee, 11, 1896 (C. F. Baker).
Dictyophora duplicata (Bosc.) E. Fischer.
Winston, 6, 1896.
Mutinus caninus (Huds.) Fr.
Lee, 11, 1896 (C. F. Baker.)
Phallus Ravenelii B. & C. var. ?
Lee, 5, 1896. A single specimen which possibly belongs here, but which differs quite materially from the ordinary forms of *P. Ravenelii* in size and in the mode of attachment at the base, as well as in tapering upward from an enlarged base instead of downward almost to a point.

Phallus rubicundus Bosc.

Alabama, (Peters). Peters coll. Specimen lacking a pileus; the slender stem (12 cm. long, 1.5 cm. thick in the dry specimen) possesses the characteristic red color of the species. Hale, 5, 1896. Only a fragmental specimen which may be referred here. Fully developed specimens of this and all other members of the family in various stages of growth are a great desideratum. The specimens should be preserved in alcohol.

FAMILY LYCOPERDACEAE.

Astraeus hygrometricus (Pers.) Morg.

Lee, 12, 1895; Mobile, 11, 1895; Winston, 6, 1896. Very common in sandy soil.

Bovista minor Morg.

Lee, 12, 1895. A single specimen.

Bovistella Ohiensis (E. & M.) Morg.

Lee, 12, 1895; 4, 7, 10, 11, 12, 1896; Winston, 6, 1896. The most common puff ball of Eastern Alabama.

Calostoma cinnabarinum (Desv.) Mass.

Alabama (Atkinson).

Calostoma Ravenelii (Berk.) Mass.

Lee, 3, 1896. A very distinct species.

Calvatia craniiformis (Schw.) Fr.

Lee, 7, 11, 1896.

Calvatia cyathiformis (Bosc.) Morg.

Lee, 10, 1895; 1, 7, 9, 1896.

Calvatia fragilis (Vitt.) Morg.

Lee, 7, 1896.

Catastoma circumscissum (B. & C.) Morg.

Mobile, 12, 1895. A single specimen.

Catastoma pedicellatum Morg.

Lee, 7, 9, 1896.

Geaster fimbriatus Fr.

Winston, 6, 1896.

Geaster limbatus Fr.

"Alabama (Peters);" Lee, 3, 1896; Winston, 6, 1896.

Geaster minimus Schw.

Lee, 2, 1896.

Geaster saccatus Fr.

Alabama (Peters.) Peters coll.

Lycoperdon asterospermum Dur. & Mont.

Lee, 7, 1896.

Lycoperdon cepaeforme Bull.

Lee, 7, 1896. Also collected in Alabama by Atkinson, *fide* Morgan.

Lycoperdon eximium Morg.

Lee, 7, 1896.

Lycoperdon gemmatum Batsch.

Lee, 7, 1896.

Lycoperdon Peckii Morg.*

Alabama (Atkinson), *fide* Morgan.

Lycoperdon pedicellatum Pk.

Tuscaloosa, 5, 1886; also collected in Alabama by Atkinson, *fide* Morgan.

Lycoperdon pusillum Batsch.

Lee, 7, 1896.

Lycoperdon pyriforme Schaeff.

Lee, 12, 1895; 2, 6, 10, 11, 1896.

Lycoperdon separans Pk.

Lee, 3, 6, 7, 1896.

Lycoperdon Turneri E. & E.

Lee, 7, 1896.

Tylostoma fimbriatum Fr.

Lee, 10, 1896; Macon, 12, 1896 (G. W. Carver).

FAMILY NIDULARIACEAE.

Crucibulum vulgare

Lee, 12, 1895; 7, 1896.

Sphaerobolus epigaeus B. & C.*

"On red earth, Alabama (Peters)."

Described from material collected in Alabama, in Grevillea, 2:34, as follows:

"Major globosus furfuraceus e myceli filiforme oriundus."

"Springing from a white thread-like mycelium, which incorporates itself with the soil and its accompanying moss. Globose, externally furfuraceous, splitting very irregularly."

Sphaerobolus stellatus Tode.

Alabama (Peters.) Peters coll.

FAMILY HYMENOGASTRACEAE.

Octaviania compacta Tul.

Mr. Morgan refers here with some doubt, a specimen collected, Lee, 7, 1896.

Polysaccum crassipes D. C.

Lee, 10, 1895 (an old specimen); 7, 1896. Not uncommon and a well marked addition to our flora. Some of the specimens were five or six inches in length including the root-like base, and from three to four inches in diameter.

Polysaccum pisocarpium Fr.

Lee, 7, 1896. Not uncommon.

Rhizopogon rubescens Tul.

Winston (P. P. Payne). Peters coll. no. 68; Lee, 12, 1895; 3, 12, 1896.

Scleroderma flavidum E. & E.

Mobile, 12, 1895; Lee, 3, 9, 12, 1896. Verry common.

Scleroderma Geaster Fr.

Lee, 12, 1895; 7, 1896.

Scleroderma verrucosum (Bull.) Pers.

Lee, 7, 1896.

Scleroderma vulgare Hornem.

Alabama (Atkinson).

SUMMARY.

	Genera.	Species.
MYXOMYCETES.		
Plasmodiophorales	1	2
Myxogastrales	20	33
PHYCOMYCETES.		
Chytridiales	1	3
Mucorales	2	2
Entomophthorales	1	1
Peronosporales	3	16
Fungi Imperfecti.		
Hyphales.		
Mucedinaceæ	11	18
Dematiaceæ	16	123
Stilbaceæ	2	2
Tuberculariaceæ	7	15
Melanconiales	8	19
Sphaeropsidales.		
Sphærioideaceæ	23	83
Nectrioidaceæ	1	1
Leptostromaceæ	7	12
Excipulaceæ	1	1
ASCOMYCETES.		
Gymnoascales	2	9
Perisporiales.		
Erysiphaceæ	6	25
Perisporiaceæ	6	18
Hypocreales	12	22
Sphæriales	42	85
Dothideales	2	6
Hysteriales	12	28
Phacidiales	5	11
Pezizales	32	47
Helvellales.		
Rhizinaceæ	2	2
Geoglossaceæ	3	3
Helvellaceæ	1	1

BASIDIOMYCETES.

Ustilaginales	6	15
Uredniales	15	103
Tremellales.		
Auriculariaceæ	1	2
Tremellaceæ	5	10
Pilacraceæ	1	2
Dacryomycetaceæ	3	8
Hymeniales.		
Tomentellaceæ	4	33
Clavariaceæ	2	8
Thelephoraceæ	5	31
Hydnaceæ	7	37
Polyporaceæ	9	90
Boletaceæ	4	26
Agaricaceæ	39	116
Gastrales.		
Phallaceæ	4	5
Lycoperdaceæ	9	25
Nidulariaceæ	2	3
Hymenogastraceæ	4	8
	349	1110

44 familes—349 genera—1110 species.

ADDENDA.

To the list of works treating of Alabama Fungi, given on pages 123–127 should be added the following:—

BERKELEY, M. J. and CURTIS, M. A. Centuries of North American Fungi. Ann. Mag. Nat. Hist. (III), 4: 284-296. 0 1859.

Includes descriptions of three Alabama species collected by Peters.

BERTOLONI, ANTONI. Miscellanea Botonica XVII. Mem. Accad. Sci. Bologna, 7 : 341-362. 1856.

Describes and figures *Thelephora lobata* collected in Alabama by Dr. Gates.

APPENDIX.

Suggestions to Collectors of Fleshy Fungi.

The collection and preparation of fleshy fungi for scientific purposes is so different from the collection of other plants, and the value of the collection depends so much on the character of the field notes that it is thought desirable to make a few suggestions with the view to secure more certain and complete information regarding these ephemeral plants, concerning whose life history and distribution in America so little is definitely known.

The more conspicuous forms of the fleshy fungi, group themselves botanically into some four orders, one of which contains forms that are quite diverse among themselves. Two of these orders are readily recognized by those who are able to examine the spores, since these are contained in membranous sacs imbedded in a more or less cup-shaped disc or honey-combed receptacle. The species of these two orders that are in any way conspicuous are not very numerous. They consist of the cup-fungi (*Pezizales*) and the morels and gyromitras (*Helvellales*). A third order contains the forms that are everywhere common, and when mature are familiarly known as puff-balls, smoke-balls or snuff-boxes, according to the portion of the country you happen to be in; these are the *Gastrales*, or as they have usually been called by a longer name the Gasteromycetes. The fourth order of fleshy fungi contains forms of which the common mushroom or toad-stool is the ordinary type, though forms of various types are known, some club-like (coral fungi) or variously provided with gills, teeth or pores. The families of this order (*Hymeniales*)* that are likely to be noted as conspicuous fleshy forms may be distinguished as follows :

* Hitherto commonly known by the longer term Hymenomycetes.

Fungi with a cap (pileus) and central stem, or bracket like, with the spore-bearing surface normally underneath.

Spores borne on radiating gills. AGARICACEAE.

Spores borne on the interior of pores.

Pores separating more or less readily from the pileus. BOLETACEAE.

Pores not readily separating from the pileus. POLYPORACEAE.

Spores borne on teeth projecting downward in growth. HYDNACEAE.

Fungi club-shaped or forming masses of erect branches rising from a common base; spores borne on the upper portions. CLAVARIACEAE.

Nearly all of these families contain members that are more commonly woody or corky rather than fleshy, the *Polyporaceae* notably so. Some few forms of the *Clavariaceae* might perhaps be confused with the *Helvellales*, but the latter can always be distinguished microscopically by bearing the spores in sacs. The special suggestions for each of these families are much the same, but we will first give them more in detail for the more common family of *Agaricaceae*, and then add a few special supplementary suggestions for the other families.

In collecting any fleshy fungi, care should be taken to obtain all of its fleshy structure, because some very important characters are derived from the basal parts. *They should never be gathered for scientific purposes by breaking them off above the ground.* The entire basal portion should be removed with a knife or small trowel.

Of course the date of collecting and locality will be added to the specimen by any intelligent collector, but it is always desirable to add the local environment of the specimen by stating in what soil it grows—sand, clay, or leaf-mold—and whether the plant grows in open pastures, marsh, grassy woods or deep forest; sometimes the character of the timber, especially pine land, is to be noted; also whether it grows singly or in clusters. But above all these matters of environment, certain data concerning the physical properties of the fresh plant are absolutely essential to a correct understanding of the species. Dried specimens of fleshy fungi without notes are often worse than useless, for they suggest many times highly interesting and often undescribed species without sufficient data to enable one to characterize them properly; species of fleshy fungi had better be left undescribed than be named exclusively from the character of the dried plant.

The summary of characters to be noted in the AGARICACEAE can be tabulated as follows:

1. TASTE.—Bitter, acrid, peppery, mealy, nutty? (One need feel no fear in tasting any of the fleshy fungi, for they are cleanly, and the only inconvenience ever experienced is the peppery taste of certain species of *Lactarius* and *Russula*, which is temporarily about as unpleasant as tasting a particle of red pepper, but otherwise harmless).

2. SURFACE OF PILEUS.—Dry, hygrophanous (moist), or viscid?

Smooth, granular, scaly, shining, striate, umbonate?

Color and diameter?

3. GILLS.—Color when young, and when mature?

Close or distant?

Narrow or wide?

4. SPORES.—(Best collected by removing the pileus and placing it gills downward on paper or glass under a tumbler or bell jar. If a microscope is at hand to examine the spores they can be best collected on a slide).

Color, shape and size? The last two, of course, only possible to those who have a microscope.

4. STEM.—Fleshy throughout, or with a cartilaginous rind?

Hollow, solid or stuffed?

Size, including length and thickness?

Shape; cylindric, tapering, radicate or bulbous?

5. VOLVA and VEIL, if present; character and position?

To these notes a simple sketch of the fully expanded plant, preferably in colors, will be a very valuable addition.

A good supply of dried specimens should accompany the notes; the more the better.

The specimens should be dried as quickly as possible after being collected as they are the favorite food of certain insect larvae, and if left over night will often be found to have changed into disgusting heaps of corruption by morning. Drying is best accomplished in an open receptacle like a wire basket in a current of hot air. Suspension over a hot stove is commonly practiced, and they may even be dried in bright sunshine, but in some cases the colors fade worse when exposed to strong sunlight.

In order to further facilitate the field study and identification of the agarics, we add the following synopsis of the American genera. It will be found that certain aberrent species will not be determined readily by its use, though it will probably be useful and reasonably certain in the majority of cases.

SYNOPSIS OF THE AGARICACEÆ.

1.—Plant fleshy, soon putrescent.	2
Plant tough, leathery or woody, reviving or persistent.	13
2.—Juice milky, white or colored.	LACTARIUS.
Juice watery.	3
3.—Stem central or nearly so.	4
Stem lateral, eccentric or wanting.	12
4.—Spores white.	5
Spores rosy or salmon colored.	16
Spores yellowish brown or rusty brown.	19
Spores dark brown or purplish brown.	24
Spores black.	27
5.—With a volva* and annulus.	AMANITA.
With a volva but no annulus.	AMANITOPSIS.
Volva wanting; annulus present.	6
Both volva and annulus wanting.	7
6.—Gills separate from the stem; annulus often movable; pileus usually scaly, sometimes densely so.	LEPIOTA.
Gills united with the stem; pileus usually smooth (scaly often in *A. mellea*, a common species).	ARMILLARIA.
7.—Gills thin, their edges acute.	8
Gills in the form of shallow folds, their edges obtuse.	11

* The volva will appear either as a cup at the base of the stem, or as separable floccose scales on the pileus.

8.—Gills decurrent on the stem; stem fleshy. CLITOCYBE.
—stem with a cartilaginous rind. OMPHALIA.
Gills adnate, not decurrent; stem with a cartilaginous rind. COLLYBIA.
—stem fleshy; pileus often bright colored. 9
Gills sinuate; stem fleshy. TRICHOLOMA.
—stem with a cartilaginous rind. 10

9.—Plant rigid, the gills usually brittle. RUSSULA.
Plant with waxy gills. HYGROPHORUS.

10.—Pileus membranous, more or less striate. MYCENA.
Pileus very thin, without pellicle. HIATULA.

11.—Gills decurrent; plant terrestrial. CANTHARELLUS.
Gills adnate; plant parasitic on other Agarics. NYCTALIS.

12.—Spores white (violet tinted in one species). PLEUROTUS.*
Spores rosy or salmon-colored. CLAUDOPUS.
Spores yellowish brown. CREPIDOTUS.

13.—Gills normally toothed on their edges; stem central, eccentric or lateral. LENTINUS.*
Gills entire; stem central. 14
—stem lateral or wanting. 15

14.—Gills simple; pileus firm and dry. MARASMIUS.
—pileus somewhat gelatinous. HELIOMYCES.
Gills branched. XEROTUS.

15.—Gills simple; plant leathery. PANUS.*
Gills deeply splitting, villous. SCHIZOPHYLLUM.
Gills channeled or crisped, smooth. TROGIA.
Gills anastomosing at least at the base; plant corky. LENZITES.

16.—Volva present; annulus wanting. VOLVARIA.
Volva wanting; annulus present. ANNULARIA.
With neither volva nor annulus. 17

17.—Gills separate from the stem. PLUTEUS.
Gills adnate or sinuate; stem fleshy ENTOLOMA.
—stem with a cartilaginous rind. 18
Gills decurrent on the stem; stem fleshy. CLITOPILUS.
—stem with cartilaginous rind. ECCILIA.

18.—Pileus torn into scales. LEPTONIA.
Pileus papillose, subcampanulate. NOLANEA.

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* Some species of *Lentinus* with entire gills can scarcely be distinguished from *Panus;* some of the more fleshy forms of the latter are quite close to some forms of *Pleurotus*.

19.—Annulus continuous. PHOLIOTA.
Annulus arachnoid, filamentous or evanescent, often not apparent in older specimens. 20
Annulus wanting. 21

20.—Gills adnate; plants terrestrial. CORTINARIUS.
Gills decurrent; plants mostly epipyhytal. FLAMMULA.
Gills almost separate from the stem. BOLBITIUS.

21.—Gills decurrent; stem fleshy; gills easily separating. PAXILLUS.
—stem with a cartilaginous rind. TUBARIA.
Gills not decurrent; stem fleshy. 22
—stem with a cartilaginous rind. 23

22.—Pileus fibrillose or silky. INOCYBE.
Pileus smooth and viscid. HEBELOMA.

23.—Margin of pileus incurved when young. NAUCORIA.
Margin of pileus always straight; pileus viscid; gills free. PLUTEOLUS
—pileus not viscid; gills attached. GALERA.

24.—Veil remaining on the stem as an annulus. 25
Veil remaining attached to the margin of the pileus, often not apparent in very old specimens. HYPHOLOMA.
Veil inconspicuous or wanting; gills free. PILOSACE.
—gills decurrent. DECONICA.
—gills adnate or sinuate. 26

25.—Gills separate from the stem. AGARICUS.
Gills united with the stem. STROPHARIA.

26.—Margin of pileus incurved when young. PSILOCYBE.
Margin of pileus always straight. PSATHYRA.

27.—Stem dilated above into a disc which bears the radiating gills. MONTAGNITES.
Pileus of the normal form. 28

28.—Pileus leathery or horny. ANTHRACOPHYLLUM.
Pileus fleshy, membranous or deliquescent. 29

29.—Gills deliquescent, melting to an inky fluid. COPRINUS.
Gills not deliquescent; annulus present. ANELLARIA.
—annulus wanting. 30

30.—Gills decurrent; spores fusiform. GOMPHIDIUS.
Gills not decurrent; spores globose-ovoid. 31

31.—Pileus striate; stem with a cartilaginous rind. PSATHYRELLA.
Pileus not striate; stem fleshy. PANAEOLUS.

Since there is no available manual for the identification of American species, it may be advantageous to add references to the most complete synopses of members of the family as they have seen issued in scattered publications. Notes as to the extent of the genera and edible characters are also added in some cases. For convenience of reference the genera are arranged alphabetically.

AGARICUS.—Includes among some 12 American species, *Agaricus campestris*, and several others that are edible. Over 70 species known from all parts of the globe.* Peck. Reg. Rep. 36:41-49 (synopses and descriptions of seven species.

AMANITA.—Includes among its 20 American species some of the most poisonous as well as some of the best edible species. Easily recognized by its white spores, volva (which appears either as a cup at the base of the stem or as separable floccose scales on the pileus), and veil, the last character distinguishing it from the next genus. (45).* Morgan, Jour. Mycol. 3:25-33 (description of 28 species).† Peck. Reg. Rep. 33:38-49 (descriptions of 14 species).

AMANITOPSIS.—One edible species, *A. vaginata*, occurs in this country together with others. The genus was formerly included with *Amanita* and the citations of synopses are to be sought under that genus.

ANELLARIA.—One species only known from the United States. (3).

ANNULARIA.—No species yet found with us. (6).

ANTHRACOPHYLLUM.—A single tropical species occurs in South Carolina.

ARMILLARIA.—*A. mellea* is our common edible species, and five others are reported from this country. (6.). Peck. Reg. Rep. 43:40-45.

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*I have included in parentheses under each genus the approximate number of species described from the entire world. This will indicate something of the extent of the group which contains all told some 5,000 described species. Over 200 new species of *Agaricaceae* were described during the year 1895.

†Including 9 species of *Amanitopsis*.

BOLBITIUS.—4 American species mostly small and inconspicuous. (25).

CANTHARELLUS.—Among our 22 species, *C. cibarius*, otherwise known as the chantarelle, is edible. (76). Peck. Bull. N. Y. State Mus. Nat. Hist. 2:34-43 (description of 10 species).

CLAUDOPUS.—Five American species. (10). Peck. Reg. Rep. 39:67-69.

CLITOCYBE—Several of our 40 species said to be edible. (234). Peck, Reg. Rep. 48:172-177 (describes 4 edible species); Morgan, Journ. Cinn. Soc. Nat. Hist. 5:66-70 (describes 13 species).

CLITOPILUS.—At least two of our 14 species are reported as edible. (30). Peck, Reg. Rep. 42:39-46.

COLLYBIA—33 American species. (213). Some species are regarded as poisonous. Peck, Reg. Rep. 23:78-80 (describes 7 species); Morgan, Jour. Cinn. Nat. Hist. 6:70-73 (describes 12 species).

CORPINUS—Known as "ink caps," of which several of our 32 species are edible; *C. comatus* and *C. atramentarius* are the largest and best known. (170). Peck, Reg. Rep. 48:143-147 (describes three edible species); Morgan, Journ. Cinn. Soc. Nat. Hist. 6:173-177 (describes 13 species).

CORTINARIUS.—A large genus of handsome species poorly known in America, tho nearly 60 species have been reported as occurring here. (350). Many species occur late in the season. *In collecting, two points are absolutely necessary to note:* (1) Is the pileus dry, hygrophanous or viscid? and (2) The color of the *young* gills. It is only in the young condition that the cobwebby veil is clearly seen. Peck, Reg. Rep. 23:105-112 (descriptions of 21 species).

CREPIDOTUS.—About 15 species with us. (65). Peck, Reg. Rep. 39:69-73 (descriptions of 11 species).

DECONICA.—Only a single species reported from the United States. (9).

ECCILIA.—Three species in the United States. (18).

ENTOLOMA—12 species reported from America. (80).

FLAMMULA.—11 species reported from America. (75). Quite easily recognized by their ochraceous spores and their habit of growing on old wood.

GALERA.—12 species reported from America, (49). Peck, Reg. Rep. 46:61-69.

GOMPHIDIUS.—Three of the seven known species occur in the United States.

HELELOMA.—18 species reported from this country. (65) Peck. Reg. Rep. 23:95, 96 (describes 6 species).

HELIOMYCES.—A single American species reported from Alabama. (10).

HIATULA.—A single species of this delicate tropical genus reported from North Carolina. (16).

HYGROPHORUS.—At least two species of the 28 reported from America are edible. (160). Peck, Reg. Rep. 23:112-114 (describes 7 species).

HYPHOLOMA.—15 species reported from America. (60). Some are reputed poisonous and some edible. Morgan, Journ. Cinn. Soc. Nat. Hist. 6:113-115 (describes 7 species).

INOCYBE.—Eight species American. (120). Morgan, Journ. Cinn. Soc. Nat. Hist. 6:104-106.

LACTARIUS.—Readily distinguished by the flow of milk from the gills and stem when wounded. In collecting it is very essential that the taste of the fresh specimen be noted. Nearly 50 species are reported from America. (110). Contains many edible and some suspicious species. Peck. Reg. Rep. 38:111-133 (descriptions of 40 species).

LENTINUS.—27 species American. (204). Some of the species are likely to be confused with *Panus*, and others perhaps would be taken for some of the species of fleshy genera. Morgan, Journ. Cinn. Soc. Nat. Hist. 6:194-196 (describes 10 species).

LENZITES.—17 American species of this genus are recorded. (69). Some of the species form a transition to *Daedalea* among the *Polyporaceae*, and it is probable that some of them belong with that family.

LEPIOTA.—At least three of the 28 American species are edible. (200). Peck, Reg. Rep. 35:160-164 (describes 18 species).

LEPTONIA.—6 American species reported. (45).

MARASMIUS.—*M. oreades*, often called the "fairy ring champignon" is a common edible species; many of our 59 species are very small, some of them minute. (350). Peck, Reg. Rep. 23:124-126 (describes 8 species); Morgan, Journ. Cinn. Soc. Nat. Hist. 6:189-194 (describes 17 species).

MONTAGNITES.—A single species is reported from Texas. (3).

MYCENA.—52 species occur with us. (251). Some are reputed edible. Peck, Reg. Rep. 23:80-84 (describes 12 species).

NAUCORIA.—19 species are reported from the United States. (136). Peck, Reg. Rep. 23:91-93 (describes 7 species).

NOLANEA.—7 American species. (58).

NYCTALIS.—We have a single species of this curious parasite growing on large species of *Lactarius*. (10).

OMPHALIA.—About 26 American species. (160). Peck, Reg. Rep. 45: 32-42. (Describes 21 species).

PANAEOLUS.—5 or more species occur in the United States. (30). Peck, Reg. Rep. 23: 100-102.

PANUS.—14 American species (78). Forster, Jour. Mycol. 4: 21-26.

PAXILLUS.—Of our ten species *P. involutus*, is regarded as edible. (31). Peck, Bull. N. Y. State Mus. Nat. Hist. 2: 29-33 (describes 5 species).

PHOLIOTA.—About 20 species are reported from this country. (100). Some species of this genus are edible. Morgan, Journ. Cinn. Soc. Nat Hist. 6: 101-104 (describes 11 species).

PILOSACE.—A single species reported from America. (6).

PLEUROTUS.—Easily recognized as fleshy species with white spores and with lateral stems or no stems at all, usually growing like brackets from stumps, logs and standing trunks; several species are edible. 23 species are reported from the

United States. (220). Peck, Reg. Rep. 39 : 58-67 (describes 17 species).

PLUTEOLUS.—Five of the eight known species are reported from America. Peck, Reg. Rep. 46: 58-61.

PLUTEUS.—11 American species reported. (65). Peck, Reg. Rep. 23 : 87, 88 (describes three species).

PSATHYRA.—Two American species. (56).

PSATHYRELLA.—7 American species. (50). Peck, Reg. Rep. 23 : 102, 103 (describes three species).

PSILOCYBE.—11 species reported as American. (59).

RUSSULA.—A few of our species are said to be edible; others are regarded as poisonous. In collecting it is always essential to note the taste and odor of the fresh specimen and the color of the gills. Our species are not well understood, although 30 have been reported from the country. (100). Macadam, Jour. Mycol. 5 : 58-64, 135-141 (paper never completed but descriptions of 25 species are included.)

SCHIZOPHYLLUM.—A single species is everywhere common. (7).

STROPHARIA.—Seven species are reported from this country. (65). Morgan, Journ. Cinn. Nat. Hist. 6 : 112, 113 (describes three species).

TRICHOLOMA.—Some 50 species are known from America, several of which are edible. (200). Peck, Reg. Rep. 44 : 38-64 (descriptions of 46 species).

TROGIA.—We have a single interesting little species in this country. (6).

TUBARIA.—Two species reported from this country. (17). Morgan, Journ. Cinn. Soc. Nat. Hist. 6 : 109, 110.

VOLVARIA.—7 American species. (35). Some of the species are edible.

XEROTUS.—Genus mostly tropical. Two species within our limits. (29).

The BOLETACEAE are easily recognized among fleshy, fungi by their layer of pores which take the place of gills and which are quite easily separable in most cases both from the substance of the pileus and from each other. The color of the spores should always be determined in the manner indicated for the agarics, and the taste of the fresh specimen is essential. In addition the colors of the pileus, flesh and pores should be noted, and if there is any difference in color between the young pores and those of the mature plant this fact should be noted also. In certain species the flesh or pores or both will change color rapidly or slowly when wounded; in some instances the change is to a bright blue. This changing condition should be noted in any given species. Any peculiarity of shape of stem or markings on the stem like veining, reticulation or glandular dots should be carefully noted. If a veil is present, its character will be important as will the relation of the pores themselves to the stem, whether adnate, free or merely depressed around it. Finally the character of the pileus should be noted whether viscid, hygrophanous, or dry.

Specimens need to be dried rapidly and after the drying has once commenced it should be carried to the end without stopping.

The four genera can be distinguished by the following synopsis:

Stem central or eccentric.
- Pores very easily separating from the pileus. BOLETUS.
- Pores less readily separating from each other and from the pileus.
  - Fleshy; pores arranged in radiating rows. BOLETINUS.
  - Tough; pores uniform; pileus densely floccose. STROBILOMYCES.

Stem lateral; pores separate from each other forming tubes. FISTULINA.

Several of the species of *Boletus* are edible, a few are poisonous; one entire group known as the *Luridi*, recognized by the red mouths of the pores, is generally suspected. Over a hundred species are known from the United States, and the South especially contains many undescribed forms. The descriptions of most of the species are easily accessible in Peck, Boleti of the United States. (Bull. N. Y. State Mus. No. 8*).

* Can be obtained of the State Librarian of New York for the small sum of twenty cents.

Our species of *Boletinus* and *Strobilomyces* are few in number, five of the former and only two of the latter, said to be edible. *Fistulina* contains the "beefsteak fungus," common in certain regions on chestnut stumps, and two or three other less known species.

The Polyporaceæ contain mostly woody or leathery forms. A few fleshy species belonging to the genus *Polyporus* are edible when young but soon grow tough. The same suggestions given for the *Boleti* will apply to the fleshy species of this genus.

The Hydnaceæ are represented by several genera more or less conspicuous. The fleshy species belong to the genus *Hydnum* and a number of them are edible. Some 30 species are described by Morgan, Journ. Cinn. Soc. Nat. Hist. 10 : 7-14, including a number of the edible species. In collecting them the taste, odor, and colors when fresh should be carefully noted.

Among the Clavariaceæ, or coral fungi, the members of two genera are fleshy and some of each genus are edible. *Clavaria* has branches that are circular in section and *Sparassis* has flattened branches. They sometimes form masses several inches in extent. None of the species are poisonous, so far as known, though not all are edible. *Sparassis* is represented in America by four of its six species, while of over 200 species of *Clavaria* some 50 species occur in the United States. Morgan, Journ. Cinn. Soc. Nat. Hist. 11 : 86-90 describes 20 species occurring in Ohio; and Peck, Reg. Rep. 24: 104, 105, gives a synopsis (without descriptions) of 20 species occurring in New York State. In collecting, the color of the spores, taste, odor and color of the fresh plants should be carefully noted.

The student of edible fungi will find valuable assistance in Peck, Report of State Botanist of the State of New York (extract from Regent's Report 48), a work recently issued and containing descriptions and colored plates of about sixty of our edible mushrooms.

ERRATA.

Distance from the printer made it impossible for either of the writers to see more than one proof so that numerous minor mistakes have entered into the bulletin. A few of the more glaring are here corrected:

Page 122, 8 lines from the bottom for *fungus* read *fungous*.

Page 129 footnote, for *naturalichen* read *naturlichen*.

Page 131, 5 lines from the top, for *amylovorous* read *amylovorus*.

Page 135, line 10 from bottom, for *puriannulatum* read *pluriannulatum*.

Page 137, line 5, for *Enothera* read *Oenothera*.

Page 144, line 8, for *Rhyncospora* read *Rhynchospora*.

Page 147, line 15, and elsewhere, for *Azederach* read *Azedarach*.

Page 155, a * should follow *Macrosporium Cheiranthi.*

Page 188, line 4, for *Dlatrypella* read *Diatrypella*.

Page 194, line 6 from bottom, for *reselal* read *rosella*.

Page 198, line 14, for *Lephodermium* read *Lophodermium*.

Page 206, line 8, for *flavada* read *flavida*.

Page 224, lines 8 and 16, for *Corticum* read *Corticium*.

Page 225, line 16, for *Corticum* read *Corticium*.

Page 226, line 3, for *akesii* read *Oakesii*.

Page 232, line 17, for *beevissimo* read *brevissimo*.

Page 232, line 18, for for *sinereo–* read *cinereo–*.

Page 245, line 16, for *species* read *form*.

Page 198, first line, for *Hysteriographuim* read *Hysterographium.*

Page 198, line 14, for *Lephodermium* read *Lophodermium.*

Page 207, line 11, for *Corebella* read *Cerebella*.

Page 218, line 12 from bottom, for *vacclnorum* read *vaccinorum.*

Page 220, line 3, for *Caroliniamm* read *Carolinianum*.

Page 258, line 8 from bottom, *Flamula* read *Flammula*.

Page 260, line 5, for *Lactarlus* read *Lactarius*.

Page 164, line 7, for *Pleurotis* read *Pleurotus*.

Page 272, line 7 is wrongly indented. It is co-ordinate with lines 3 and 4, not with lines 5 and 6 as printed.

Page 278, line 19, for *Corpinus* read *Corprinus*.

Page 279, line 8, for *Heleloma* read *Hebeloma*.

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BULLETIN No. 81. MAY, 1897.

ALABAMA

Agricultural Experiment Station

OF THE

AGRICULTURAL AND MECHANICAL COLLEGE,

AUBURN.

MEAT INSPECTION.

C. A. CARY, Veterinarian.

MONTGOMERY, ALA.:
THE BROWN PRINTING COMPANY, PRINTERS
1897.

☞ The Bulletins of this Station will be sent free to any citizen of the State on application to the Agricultural Experiment Station, Auburn, Alabama.

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MEAT INSPECTION.

BY C. A. CARY.

INTRODUCTION.

Sanitary science has been greatly extended since the advent of the bacterial origin of many diseases. It is now a well established fact that some parasitic diseases are common to man and many of the domestic animals. In some instances a disease may not always manifest the same symptoms or pathological lesions in a man that it does in animals, and the disease, wherever found, may be caused by the same micro-organism. Yet, such a disease is transmissible from animals to man or from man to animals. The common illustrations of such diseases are found in tuberculosis and anthrax. It is now a positive fact that during the past five or six years a sufficient number of cases of anthrax, tuberculosis, swine plague, hog cholera, etc., have been observed in this State to justify a system of thorough and efficient meat inspection in the larger cities and, if practicable, in the smaller cities and towns of the State. There is no occasion for alarming statements; meat inspection only means that one of the numerous ways of transmitting or spreading the cause of disease can and should be checked.

It is not only the aim of the meat inspector to cut off one of the ways of transmitting the germs of disease to man' but also to eliminate from the food of man the poisonous chemical compounds, known as *ptomaines*, *leucomaines* and *organic ferments* that may be developed in the body of an animal during disease or may be developed in decomposing meat. Many of these chemical compounds are very poisonous and they can not always be destroyed by cooking the meat as can the germs of disease. For instance, in the disease known as tetanus (lock-jaw) the tetanus bacillus develops, or in some way produces, a chemical substance called *tetanin* which is a very powerful poison; in fact, it will kill a healthy man or horse in a short time if a comparatively small quantity of it is injected into the circulation. It is in the same way that many other poisonous chemical compounds are developed in the body of animals during disease. All of these chemical substances do not possess the same degree of poisonous potency; but the power of the poison will vary in almost every case or kind of germ, by which it is produced or with which it is associated. Many animal parasites are common to man and the domestic animals. *Trichina spiralis* has been found in this State; also the cystic stage of many of the tape worms, especially of *tænia solium*, have been observed in Alabama. It is obvious to any well informed medical man that thorough and efficient meat inspection is a practical means of preventing many diseases in the human family. The writer uses the words "thorough" and "efficient" because there is a tendency on the part of the powers, who appoint inspectors, to appoint political favorites, regardless of their qualifications. That day is passed when a man can be an expert in more than one thing. It is a great mistake to think that a druggist, a carpenter, a horse-trader, a liveryman or a butcher can make an efficient meat inspector without two or more years of specific preparation. A man, through ignorance or a desire for gain, can deceive himself. For example, I have seen butchers, let us hope through ignorance, pass carcasses to the market that were absolutely unfit for human food and in many instances dangerous; and no doubt in some cases produced sickness in the consumers that could not be accounted for by the family physicians;

because they knew not the condition of the meat their patients had eaten.

In a prominent city of the United States, the writer found the inspector sitting in a chair watching the animals pass by him. No inspection of the carcass was made at the slaughter. A glance at the animals as they passed to the slaughter is almost equivalent to no inspection. A practical inspection law and honest, competent inspectors always mean thorough and efficient meat inspection.

Hog Cholera.

Synonyms.—Swine Fever (England), Swine Pest (Germany).

Symptoms.—In hog cholera, the skin is usually red on the nose, the ears, the abdomen, on the inside of the front limbs, on the inside of the thighs, on the skin of the groins and around the anus. Sometimes red spots may appear on the skin of any region of the body. This redness of the skin varies from a light red tint to a deep bluish red or purple. It may be confined to spots or it may become diffuse and extend over considerable skin surface.

It is well to note here that the skin may be covered with red spots or diffuse red patches in some cases of American swine plague (Salmon and Smith), in infectious pneumonia (Schütz) and in the European swine plague (Löffler, Schütz).

In some chronic cases of hog cholera skin eruptions may appear over the head, neck, body and limbs. In such cases the redness of the skin may be very slightly marked.

Diphtheritic ulcers may appear on the tongue, on the inside of the cheeks, on the palate, the gums and the tonsils. These ulcers are covered with grayish-white or yellowish-gray scab-like material; in some cases they have a greenish tint.

The chronic case may cough from time to time; the respirations may be normal, but they are accelerated and labored in acute cases. The conjunctiva of the eye is red and the eye lids may be stuck together with dried mucus.

The temperature in chronic cases may be normal (101° to 104° Fah. according to Kilborne), but in acute attacks it may be 3 to 5 degrees above the normal. In acute cases the appetite is entirely or partially lost, and the bowels are constipated; in a short time diarrhœa appears and the excrements are liquid and fetid, occasionally mixed with blood. In chronic cases the appetite may remain good; yet the animal may have diarrhœa. The color of the excıement always depends upon the character of the food eaten. In hogs fed corn it is yellow; in those which are fed slops and mixed foods, the excrement is grayish or black. Vomiting is rare in hog cholera; but more common in swine plague.

In acute cases some animals become weak, greatly depressed in vigor; lie quietly, huddled together, hide under litter, and toward the end of the disease lose control of the hind limbs. Friedberger and Fröhner state that death is preceded by convulsions and Kilborne states that "death ensues quietly. Rarely convulsive kicking is observed." It is well to note that all of the foregoing symptoms are not distinctly marked in each hog but that the symptoms will vary in intensity and some of them may not appear or be overlooked on account of their being slightly marked and of short duration. It is difficult, many times impossible, to make a positive diagnosis with only an ante-mortem examination. The mortality, in hog cholera, is very high; 80 to 90 per cent., of those attacked die (Salmon and Smith).

POST-MORTEM APPEARANCES:

In acute cases.—Salmon and Smith suggest that acute cases might be embraced under the general head *hemorrhagic type*; because the chief morbid changes that occur are hemorrhagic in character. (The hemorrhagic spots or patches that are so common in these cases result from the escape of blood from small blood vessels or capillaries; they vary from a scarlet red to a black red in color. They also vary in size and are spoken of as "blood extravasations," "ecchymoses," "petechiæ," "hemorrhagic spots or patches." These changes are most distinct immediately after the death of the animal.)

The spleen is usually enlarged, engorged with blood; it may be twice as large and long as the normal spleen.

The mucous membrane lining the stomach is very red and sometimes there may be blood on its surface. This red or bloody portion of the mucous lining is usually confined to a large patch in the base or fundus of the stomach. There may be numerous hemorrhagic (bloody) spots or large patches in or beneath the mucous membrane lining the small and large intestines; these spots may be so numerous as to give the lining membrane a dark red color. Occasionally food in the intestines is found encased in sheets of blood clots, a result of hemorrhage on the surface of mucous membrane. Hemorrhagic spots are quite frequently found beneath the external covering or serous coat of the intestines. These blood spots are occasionally found beneath the serous lining of the thorax and abdomen; under the serous membrane (peritoneum) near the kidneys, over the diaphragm (midrif) under the serous membrane (pleura) that lines the walls of the thorax, blood extravasations may occasionally appear, that are nearly one inch in diameter. Sometimes in the kidneys there are extensive hemorrhagic changes. When a kidney is cut into halves, large blood extravasations will appear in the central or medullary portions and small red spots (engorged glomeruli) will be observed in the cortical or outer part of the kidney. In some cases numerous blood spots will be observed under the serous (pleura) coverings of the lungs, and on cutting into the lung tissue small hemorrhagic spots may be seen in all parts of the lungs. In rare cases hemorrhagic changes may involve one or more lobes of the lungs. The subcutaneous connective tissue may be filled with small hemorrhages. These are found mostly in the subcutis over the abdomen but may appear in any part of the surface of the body. Occasionally in the subcutis, around the mammary glands of sows that have suckled pigs, may be seen more or less large, bluish black patches of pigment, a result of the irritation and inflammation induced by the "rooting" of the pigs when sucking. Occasionally small blood collections may be found in the surface muscles and in various tissues of the body. Some authorities suggest that hemorrhages may be found in the brain and spinal cord. However, few records have been made upon the trequency of these lesions in the brain and spinal cord. As a rule the lymphatic glands of the large intestines, of the stomach, of the peritoneum, those in the pelvis, at the root of the lungs and along the posterior part of the aorta in the thorax, and sometimes lymphatic glands in other parts of the body, are more or less filled with extravasated blood. Sometimes the extravasations may be confined to the outer cortex or be infiltrated throughout the entire gland. These glands may have a light red color or be almost black.

In chronic cases.—These cases are the ones that are most commonly observed in the slaughter houses and are always more fully described in the literature on hog cholera than acute cases. As a rule, the post-mortem appearances are more definite and distinct in chronic than in acute cases. However, chronic and acute cases may be found in the same herd; and both chronic and acute post-mortem appearances may be found, in some instances, in the same hog.

In some chronic cases ulcers may appear in the mouth. They are usually found on the sides of the tongue along about its upper third, in the corners (commissures) of the mouth, on the tonsils and on the inside of the cheeks. These ulcers are usually circular or oval in outline and have a grey, dry, dead appearance, resembling very closely the diphtheritic ulcers that are so constant and prominent in the intestines.

In rare cases there are a few (two or three) ulcers found in the stomach.

In the lower or terminal part of the small intestine, its lining mucous membrane presents small circular ulcers, which are produced by a diphtheritic inflammation that destroys the mucous membrane in spots and the dead (necrotic) parts of the membrane become detached leaving the depressed red ulcers. Occasionally, these ulcers may be more extensive or larger, especially near the end of the ileum. As a rule, these ulcers are formed earlier and heal more rapidly than those of the large intestines. The diphtheritic

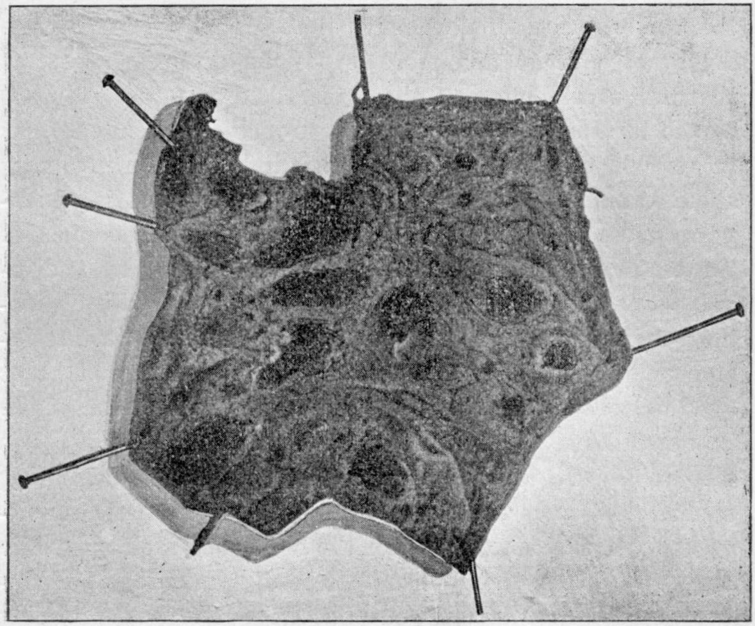

FIG. 1. Diphtheritic ulcers in large intestine of hog cholera (after Detmers).

inflammation that produces the death of the mucous membrane is said to be "a diffuse superficial necrosis (death) of the mucous membrane, accompanied by the coagulation of a thin layer of croupous or fibrinous exudate. Sometimes only the superficial parts (the villi propria mucosa, and crypts of Lieberkühn) are destroyed, but in other cases the entire thickness of the mucous membrane is destroyed, and included in the slough."

In four days or more after the manifestation of the disease, diphtheritic ulcers appear in the mucous membrane of the large intestine. They are found most commonly in the cæcum (blind pouch) the first part of the colon and in the rectum. They vary in size and outline; may be small (one-fourth to one-half inch in diameter) or involve large patches; may be circular, oval or irregular in outline. The greater the number and more extensive the outline, the greater the degree of infection and more severe the disease. It seems that the development of these ulcers have never been observed in their early stage. It is propable that they appear as a result of a diffuse diphtheritic inflammation involving spots or patches of the superficial parts, or the entire thickness of the mucous membrane. The death or necrosis of the mucous membrane usually begins in small spots and involves the surface; it extends in depth until the entire thickness of the mucous membrane is involved, and, in rare instances, it may involve the middle (muscular) and outer (serous) coats of the intestine, leading to perforation of the bowel and thus producing peritonitis and death. The necrosis also extends regularly in all directions around the beginning spot; this increases the size of the ulcer, maintains its circular outline and accounts for the alternate black and white concentric rings of old ulcers. The diphtheritic or fibrinous exudate, first thrown out on the surfrce, is probably soon detached, but the fibrious exudate in the dead parts of the mucous membrane remains until the death of the animal or the entire dead part of the ulcer is detached and the healthy healing (cicatrization) process begins. The diphtheritic ulcers are greyish, yellowish, greenish or black in color. Sometimes, in ten or twenty days after the beginning of the disease, the dead parts of some of the ulcers are cast off and the healing begins.

The epithelium grows gradually from the margin of the ulcer; but if the glands (Lieberkühn's, solitary glands or Peyer's patches) have been destroyed they are never restored. After healing is completed (in recovered cases) "a smooth shining depressed scar marks the seat of the original ulcer." These scars are somewhat difficult to find and thorough search must be made after the intestines have been carefully washed.

Some authorities (Salmon and Smith) assert that the ulcers(?) immediately around the opening of the small intestine into the cæcum are very constant and characteristic. McFadyean says: "Not infrequently, especially in old pigs, these crypts (Lieberkühn's glands) in the mucous membrane around the ileo-cæcal opening contain masses of what appears to be inspissated (dried) secretion, which may be squeezed out of them under slight pressure between the finger and thumb; indeed this condition is so common that it can hardly be considered an abnormality, and in many cases it has nothing to do with swine fever."

In some instances, the liver is involved. Near the center of each lobule begins a necrosis which extends to its border. These dead specks in many of the lobules may be mistaken for miliary tubercles and to the naked eye appear as "greyish opaque specks about the size of a mustard seed." "These necrotic areas contain large numbers of the swine fever (hog cholera) bacillus in pure culture" (McFadyean).

The lymphatic glands of the mesentery are usually swollen and frequently exhibit morbid changes that are similar to those that take place in lymphatic glands when effected with tuberculosis. In these cases, the caseous centres in the lymphatic glands are surrounded by a connective tissue envelope. Friedberger and Fröhner state that caseous centres may occasionally appear in the lungs; these centres are located in or near the surface of the lungs and produce an exudative pleurisy which results in adhesions of the lungs to the walls of the thorax, the diaphragm and the pericardium. The spleen, in chronic cases, is usually not involved but may sometimes be swollen or enlarged. The liver, kidneys, heart and muscles may show degenerative changes.

American Swine Plague.

Symptoms:—Inasmuch as the lungs are most frequently involved, the breathing is more labored and oppressive, and the cough is more aggravated and painful than in hog cholera. In other respects the symptoms are not noticeably different from those manifested in hog cholera. In fact, Dr. Salmon states that in some instances, both hog cholera and swine plague may be present in the same hog.

Post-Mortem Appearances:—Since the germs are distributed evenly throughout the blood in swine plague and rarely plug up capillaries and cause them to burst or rupture as in hog cholera, hemorrhagic spots or patches are seldom observed in swine plague. However, hemorrhagic inflammatory changes may be seen in the mucous membrane of the stomach and intestines, especially the large intestines. This may lead to fibrinous exudative deposits on the surface of the large intestines. According to Dr. Salmon, there is no distinct hemorrhagic changes in the skin; and in only a few cases, have swellings (under the skin along the neck) been observed. These swellings are very common in the German swine plague and are due to an infiltration of yellow lymph in the subcutaneous connective tissue.

In American swine plague, the chief or characteristic lesions are found in the lungs. They may be inflamed and exhibit large numbers of small, pale, points or dots where the tissue is dead. Cheese-like masses from one to one-half to two inches in diameter may also be found in the lungs.

The serous membranes, which line the abdomen and thorax, and are reflected over the organs in these cavities, are usually inflamed. As a result of the inflammation in these serous membranes, fibrinous inflammatory deposits are found on their surfaces.

Dr. Salmon briefly states the difference between hog cholera and the American swine plague as follows: "We find the most characteristic lesions of hog cholera to consist of :

(1) Hemmorrhages, particularly in the subcutaneous, sub-mucous and subserous connective tissue; in the lymphatic glands and in the various organs of the body.

(2) Ulcerations of the large intestines.

(3) Callapse of lung tissue, and, less frequently, broncho-pneumonia."

"The most characteristic lesions of swine plague are:

(1) Inflammation of the lungs; numerous small necrotic points in these organs, or a few larger cheesy masses.

(2) Inflammation of serous membranes with fibrinous deposits.

(3) Congestion of mucous membrane of intestine, or inflammation of the same with fibrinous deposits."

All cases of hog cholera or American swine plague should be rejected at the ante-mortem inspection or condemned and tanked at the post-mortem examination.

Tuberculosis of Cattle.

Symptoms.—Inasmuch as this disease in cattle develops very slowly and may exist for months without presenting any marked changes in the apparent health of the animal, it becomes extremely difficult for an expert to make a clinical diagnosis in all cases, except those in the advanced stages.

1. *Pulmonary Tuberculosis.*—This form involves chiefly the lungs; it is the most common form of tuberculosis and is sometimes designated consumption. It is also the most serious and dangerous to the health of the diseased animal and as a means of spreading the tubercle bacilli to other animals. The broken down nodules or tuberculous abscesses in the lungs, in many cases, empty virulent masses into the bronchi and this germ ladened material is scattered here and there by coughing. It dries and floats about into the air; is carried into the air passages where the bacilli may begin to multiply or it may become mixed with the food and infect another animal by way of the digestive tract.

In the early stages there may be a slight cough; it is dry and short; occurs in the morning at time of eating or drinking or when turned from a warm stall out in the cold air. If, in the early stages, the temperature is taken regularly, one may find sudden and temporary rises in temperature of 1 to 3 degrees Fah.

With exercise the animal may exhibit shallow breathing which is slightly increased in rapidity. If it is a cow, she may have frequent and long periods of heat and be very difficult to get with calf.

In the second stage the animal may become sensitive to pressure over the region of the kidneys; pressure on the ribs or over the kidneys may cause groaning and coughing. The cough is dry, hoarse, wheezy, frequent and painful. Sometimes the cough is moist, and yellow purulent material (sputa) may be thrown out of the mouth and nostrils during paroxyisms of coughing. That part of the sputa which drops into or remains in the throat (pharynx) after coughing may be swallowed. The hair is rough, dull and stands more erect than usual; the skin is dry and closely adheres to the tissue beneath it. During exercise the breathing becomes irregular, hurried, short, interrupted and difficult or labored. If the changes in the lungs are extensive or if tubercles develop over considerable pleural surface, striking over these places in the rib region may give a dull sound. If the muscles are not too thick over the thorax, by placing the ear in contact with the rib region, one may detect the bubbling of air through purulent matter in the small bronchi. As a rule, percussion (striking) and auscultation (listening) are very indefinite and in the majority of cases the expert is baffled. The appetite may be poor and variable. Rumination is irregular and slow and gaseous distention of the abdomen may appear. The secretion of milk may become diminished; the milk may be "watery" and have a faint bluish tint; yet these changes are not always distinct.

In the last stage the development of the disease becomes rapid. The animal becomes emaciated; the skin very dry and "bound down to the bones;" the hair is dull and bristling. The eyes sink back into their sockets; they are watery and the lids are covered with scaly matter. A yellow bad smelling discharge may trickle from the nostrils. The breathing is short, irregular and quick; the elbows may be thrown outward in order to aid expansion of the thorax and the animal remains standing most of the time. The cough is weak, frequent and painful. The stethoscope and other instruments will now reveal, to a greater or less degree, the location of large pleural or lung lesions. Percussion may locate extensive dull areas. Sometimes an extra resonance may be manifested in some places; this is due to the pus cavities which have empted their pus into the bronchi. Rattling cavernous sounds, irregular murmurs and splashing sounds may be heard without great difficulty by applying the ear to the thorax. As a rule, during this stage the disease becomes more and more general, extending to various organs of the body. Consequently, numerous symptoms may appear. As a rule, the animal dies from asphyxia (suffocation) and exhaustion.

Abdominal Tuberculosis:—When the intestines and mesentery are involved the animal may have repeated attacks of colic and of diarrhœa alternating with obstinate constipation. If the peritoneum is involved, the genital organs become tuberculous; this leads to frequent and long periods of heat;

such a cow rarely becomes pregnant, and, when she does, the full term of pregnancy will rarely be completed.

Uterine tuberculosis may be manifest by a purulent discharge; this may be injected into some small susceptible animal or examined under the microscope for the bacilli. From a clinical standpoint it is impossible in a majority of cases to make a clinical diagnosis of abdominal tuberculosis.

Tuberculosis of the Udder:—A slightly hard diffuse swelling, without heat or tenderness of the udder indicates a tubercular change in that organ. As a rule, only one-quarter of the udder is involved. In the early stages the milk is normal, but it gradually becomes more and more watery and yellowish in color; then it may contain small coagulated clots which contain tubercle bacilli. Later the milk becomes more and more purulent and then the cow may cease to give milk. The toughness and hardness of the udder may increase until it becomes almost as hard as wood. At the same time the mammary lymphatic glands become enlarged, hard and nodular.

The lymphatic glands in any part of the body may be involved. The superficial ones may be detected, if involved in tuberculous changes. The glands below the ear, back of the lower jaw, back of the throat (pharynx), along the neck, in front of the shoulder, in front of the stifle, etc., may become enlarged and hard in tuberculosis.

When time is not an important item, the discharge from the nostril, purulent sputa, the purulent or yellowish milk, or the discharge from an open gland or joint may be injected into the peritoneal cavity of a guinea pig and in from one to three weeks typical lesions of tuberculosis will have developed. Or these materials may be examined microscopically to determine whether the germs are present or absent in the discharge. Also the tuberculin test may be employed; this is the most accurate means of determining the presence or absence of tuberculosis in all kinds of cases.

Symptoms of Tuberculosis of the Pig:—Sometimes local or general tuberculosis in the hog is indicated by changes in the condition of the animal, which vary according to the part involved.

Primary pulmonary tuberculosis is very rarely found in the hog. It is usually preceded by abdominal tuberculosis. In the first stage the cough is dry and short, and later it becomes painful and is frequently followed by vomiting. Respirations are, at first, slightly difficult and accelerated and gradually become, more difficult and hurried, and finally become painful. The abdominal organs are usually the primary seat of tuberculosis. The fattening of the hog is first checked; then it gradually becomes more and more emaciated; the skin becomes dirty; the visible mucous membranes become pale; constipation may alternate with diarrhœa. The animal becomes weak and shy, hides in the litter. The abdomen becomes pendulous and sensitive to pressure. Sometimes a glandular tumor may be found in the space between the branches of the lower jaw, under the throat or along the under surface of the neck. The lymphatic glands, which lie beneath the parotid glands, that are located below the base of the ears, may become swollen and lift up the parotid gland. Hence, a distinct, but not painful, swelling is observed in the parotid region. The sublingual, posterior pharyngeal (throat) and superior neck lymphatic glands are usually involved in connection with the lymphatic glands under the parotids. When all are involved a chain of swellings or knots are found extending from one ear around to the other. Sometimes these hard knotty enlargements may appear at the base of the neck, behind the shoulder or in the groins. These hard tumors may adhere to surrounding tissues and occasionally become soft, and form abscesses which erupt and dischage a small amount of thick, grumous pus. The bones are frequently involved; enlargement in the bones near the joints may lead to constant lameness, and finally to a fistulous opening which discharges a bad smelling pus indicative of destruction of bone. The foregoing changes usually appear very slowly and are not always distinct. The tuberculin test may be applied to the hog; but remember that the normal temperature of the hog may vary from 101 to 104 degrees Fah.

Symptoms of Tuberculosis in Birds:—The most prominent symptom is the progressive wasting of the bird. The breast bone is very sharp, a result of the wasting of the breast muscles. The diseased bird (chicken, turkey, etc.,) are listless and dumpish; the comb is soft and pale. Sometimes the infected bird becomes lame and this lameness may be due to a swelling about some joint, or to an open joint which discharges pus that contains numerous tubercle bacilli that may be examined microscopically.

Dogs and cats may have tuberculosis. They obtain it by eating tuberculous meat or milk or other food contaminated with tuberculous sputa or dust. Or, they may contract it by living in close contact with tuberculous persons. The sheep and the goat rarely have tuberculosis.

Post-Mortem Appearances—Morbid or Pathological Anatomy of Tuberculous Cattle.

According to Nocard tuberculosis may attack any of the organs of the body but appears more frequently in some tissues or organs than in others. The following organs or tissues are most frequently involved in the order in which they are named: The lungs, the lymphatic glands, serous membranes (pleuræ, peritoneum, etc.), the liver, the intestine, the uterus, the spleen, the marrow of the bones, the joints, the udder, the skin.

Characteristic Appearances of Tuberculous Lungs:—Usually the diseased lungs are bulky and heavy, and only partially collapse. They may weigh from 40 to 70 lbs. The surface of the lungs may be covered with nodules that vary in size and outline and are composed of collections of tuberculous lesions. Sometimes these nodules are hard and tough, and creak when cut with a knife; the freshly cut surface is intensely yellow, with softened places between the rough and tough parts. Somewhat hard grains are felt when the cheesy matter, from the softened places, is rubbed between the fingers. The larger nodules, may, when cut open, exhibit a yellow, thick, grumous, mortar-like material; this would indicate that the tuberculous nodule had partially undergone caseous and calcareous degeneration.

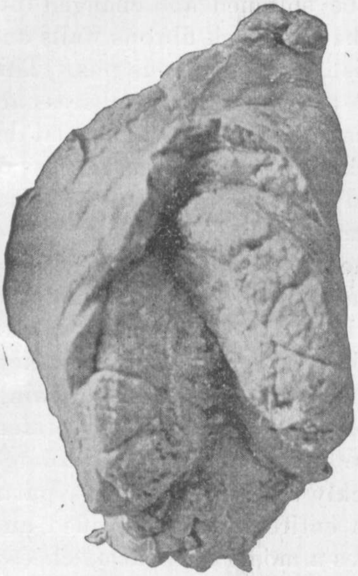

FIG. 2. Section of a lung tubercle from Vermont cow "Sadie's Delight." The tubercle is the bean-shaped mass standing out from the cut. It contained caseous and calcareous matter. (Borrowed cut from Vermont Station.)

The small tubercles or nodules are sometimes surrounded by a thick capaule of very tough white fibrous tissue; the tubercle may be surrounded by healthy pink colored lung tissue or the surrounding lung tissue may become more or less solidified (hepatized).

If a nodule or tubercle is of recent formation or growth, it appears as a small round body about the size of a millet-seed; it is translucent, grayish and homegenous and at its border may be seen a narrow inflammatory zone. These miliary tubercles are usually observed when an animal is slaughtered during the course of generalized tuberculosis. As the tubercle develops there appears in its center a yellowish white point which gradually increases in size as the nodule grows larger. The outer parts of the tubercle become more dense and form a more or less thick, tough, fibrous membrane around the tubercle. The yellowish cheesy material in the center of this tubercle is rapidly infiltrated by lime salts. In rare instances these tubercles remain isolated; but as a rule other tubercles develop near the primary one and all may be enclosed in the same fibrous sheath. When the disease has existed for some time, these accumnlated tubercles may be softened and changed into large, tuberculous abscesses, having thick fibrous walls and containing yellowish or greenish thick, grumous pus. This pus will not smell badly until the walls of the abscess are broken and the pus partly escapes into a bronchus and decomposition begins. The walls of a tuberculous abscess or cavity are always irregular and tortuous in outline. Sometimes the abscess cavity is crossed by thick, tough bands, covered by fleshy buds. These are arteries or nerves or bronchi that are involved in the tubercles. Sometimes numerous round tubercles, as large as a hazel-nut or walnut, may be found in the lungs; they have a firm consistency, are dirty white in color and are free from central softening. Local centres of caseous pneumonia may develop by preference in the anterior lobe of the lung; they are slate colored or yellowish in color and quickly undergo caseous or purulent softening. Sometimes an entire lung is solidified and a freshly cut surface resembles a moderately firm, cheesy mass. This gray mass contains irregular cavities, filled with bad smelling pus and mucus; these cavities appear to follow the bronchi and are very propably dilatations of the smaller bronchi.

Sometimes the bronchus that runs to the anterior lobe becomes obstructed; this cuts off the inspired air from that lobe; it collapses and becomes engorged with impure blood which gives it a purple red tint. The small bronchi may be slightly dilated and filled with a thick mixture of mucus and pus.

The smaller bronchi are often surrounded by collections of miliary tubercles; they at first compress the bronchi and finally obstruct them. The bronchi beyond the obstruction dilate and become filled with mucus and pus. Sometimes the bronchi become involved in chronic inflammation; their lining mucus membrane becomes thickened and folded and contain yellow muco-pus. Occasionally yellowish gray granulations are found in the lining mucous membrane of the bronchi; and sometimes the mucous membrane of the bronchi may be covered with deep, irregular ulcers. Similar nodules and ulcers may appear in the trachea and larynx. The nodules may be isolated, close together or arranged in lines; they quickly soften in their centres, erupt and form irregularly bordered ulcers which have hard margins; branches from these ulcers may contain specks of bright yellow tuberculous material. The bronchial and posterior mediastinal lymphatic glands (see plates) which collect lymph from tuberculous lungs may become infected. When tuberculous these glands may be enlarged, hard and knotty; a freshly cut surface will exhibit a number of yellow, hard, calcified miliary tubercles. These tubercles or nodules increase in number and unite into one dry fibrous mass which becomes infiltrated with lime salts; this dry mass may occupy from one-third to three-fourths of the gland. Finally all this mass softens and the gland becomes a fibrous sack filled with thick grumous, yellow, cheesy material.

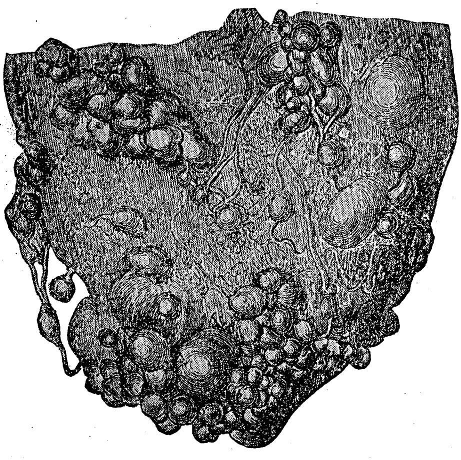

FIG. 3. A portion of a tuberculous lung (bovine). [After Virchow.] (Borrowed from Vermont Station.)

Tuberculosis of the Serous Membranes:—In some cases the pleura the peritoneum, the synovial membranes and the meninges of the brain and spinal cord may become tuberculous; while the organs may remain free from tuberculous invasion. In the serous membrane very small, transparent pinkish gray and round granulations develop. Around each granule is an abnormally vascular zone and a growth of new connective tissue progresses until small, round, flat tumors are developed; they project more or less from the serous surface and are united to it only by a small pedicle that is usually quite long and very small, strong or tough. These tuberculous tumors or nodules have a shining surface like mother-of-pearl; they are hard and whitish and are sometimes scattered over the surface of the serous membrane or may be collected in masses like bunches of grapes; or they may grow to considerable size. At first these nodules are soft but soon undergo calcareous infiltration. Their contents are then hard, firm, dry and they are enclosed in a thick, tough, fibrous case. These pearly masses are found chiefly on the pleura and peritoneum; they are not so distinct on the synovial membranes of the joints and tendons; and in the coverings of the brain and spinal cord they rarely develop beyond the earliest stage or the gray miliary tubercle. Miliary tubercles may also appear on the pericardium. Sometimes the serous surfaces of the epicardium and pericardium may be changed into a thick layer of tuberculous material; this mass is firm, yellowish white and rarely does it become caseous.

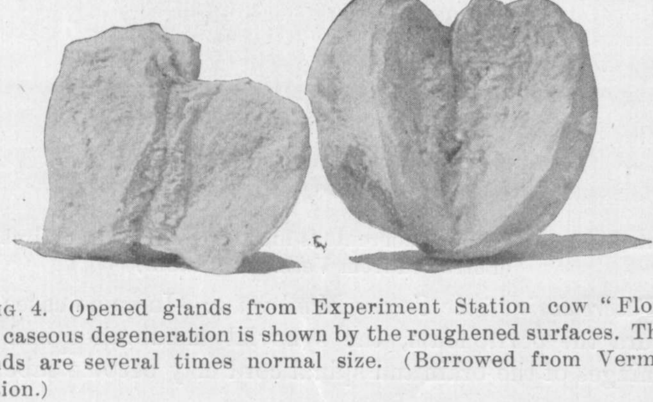

FIG. 4. Opened glands from Experiment Station cow "Floss." The caseous degeneration is shown by the roughened surfaces. These glands are several times normal size. (Borrowed from Vermont Station.)

Tuberculosis of the Lymphatic Glands.—It is not uncommon to find the tuberculous changes in the body limited to one or more lymphatic glands. Occasionally the posterior pharyngeal gland is the only one in which tuberculous lesions may be found (Smith). As a rule, more than one gland is involved. Usually certain groups are involved: for example, the lymphatic glands beneath the parotid gland and along the superor posterior border of the lower jaw, the posterior pharyngeal, the superior and inferior cervical (neck) lymphatic glands may be involved entirely or partially (see plate); the bronchial and mediastinal may be alone tuberculous, and the abdominal lymphatic glands (sublumbar, mesentiric, hepatic, intestinal, etc.,) may alone be tuberculous. These glands may be tuberculous when the organ with which they are attached and connected by lymphatic vessels are almost or entirely free from tuberculous lesions. The reasons why the lymphatic glands are tuberculous without the organs being involved is not readily explained. However, it is very probable, that the tubercle bacilli get into the lymphatic vessels and are carried to the lymphatic glands; when one gland is destroyed, the bacilli invade another and thus a closely connected group of glands becomes tuberculous. At first the lymphatic gland is enlarged, indurated (hardened) and filled with small knotty tubercles that are yellow and calcified; the regular tuberculous changes may proceed until the "dry fibrous mass" is formed and later central caseous softening appears, forming an abscess, a fibrous sack of grumous, yellow, mortar-like, semi-liquid material.

Tuberculosis of the Organs and Glands of the Abdomen.—The peritoneum and the lymphatic glands are most frequently tuberculosis. The liver, the uterus and its appendages and the spleen are next involved in frequency in the order named.

Miliary tubercles are sometimes found in the mucous or submucous tissue of the small intestine and the cæcum. These tubercles are occasionally found in the mucous or submucous tissue of the small intestine and the cæcum. These tubercles may be isolated or in groups; they very

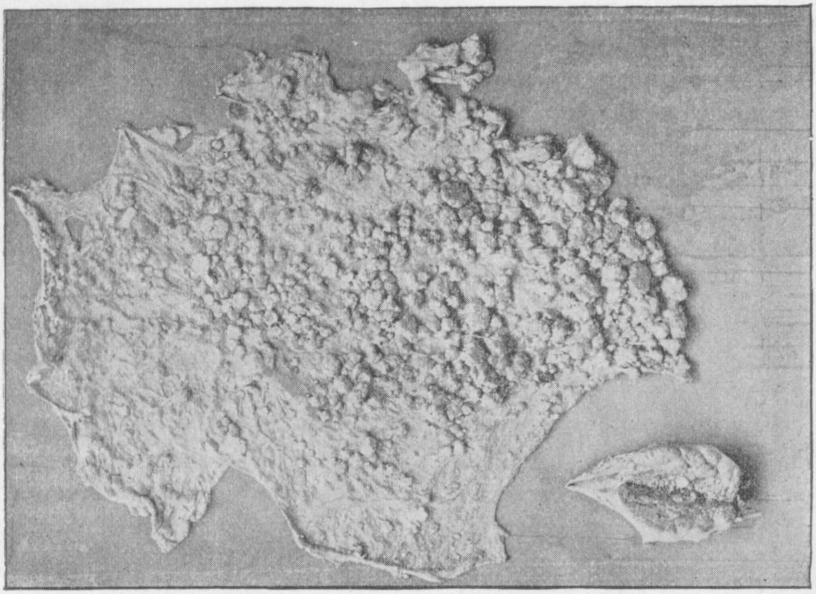

FIG. 5. An aggravated case of tuberculosis of the omentum (covering of the abdominal viscera); also a tuberculous gland. (Borrowed from Vermont Station.)

quickly undergo softening and empty their purulent contents into the alimentary canal; small ulcers, which have little or no inclination to heal, mark the place of the tubercles. These ulcers appear as if they were punched out with an irregular punch; their margins are always thick and hard. The isolated ulcers are at first very small but gradually increase in size. They are usually found involving the solitary glands and Peyer's patches; yet they are not limited to these lymph glands. Frequently the mesenteric lymphatic glands may be tuberculous when there are no visible tuberculous lesions in the intestine.

Tuberculous lesions in the liver usually appear as more or less large masses scattered through its substance. These masses may be numerous and greatly increase the weight of the liver. The tubercles in the liver, as a rule, undergo central softening more rapidly and completely than in other organs.

Tuberculous lesions of the uterus may be found in the mucous or submucous tissue. Sometimes one horn may be involved. The tuberculous uterus may become so large as to suggest the presence of a fœtus. The mucous membrane may be crowded with miliary tubercles that usually undergo caseous and muco-purulent softening, an d finally erupt then the cavity of the uterus becomes filled with yellow grumous muco-pus and the surface of the mucous membrane is covered with ulcers. Sometimes the tubercles do not undergo caseation; the mucous membrane becomes thick, hard and white; these infiltrated tubercles have numerous giant cells, and very few tubercle bacilli. In the kidney the tubercles develop in the fibrous capsule or in the subcapsular layer of connective tissue. The spleen is very rarely tuberculous. It may be filled with a great number of minute gray granulations (miliary tubercles); but usually the tuberculous changes in the spleen are few, comparatively large, hard, calcified and are surrounded with a tough fibrous capsule.

The marrow of the bones may contain numerous gray granulations. Sometimes the yellowish white, somewhat firm, round nodules, as large as a pea or a walnut, may be found in the breast bone, the bodies of the vertebræ, or in the articular ends of the long bones. These lesions are usually developed in the cancellated or spongy bone tissue, but the neighboring compact bone tissue may be irritated, thickened and a layer of subperiosteal bone developed. Occasionally these tuberculous lesions may soften and form fistulous openings into the articulation or discharge their contents externally.

In the udder, the tuberculous change usually begins by an increase in the growth of the interlobular connective tissue. This tissue is filled with minute miliary tubercles which are at first gray but may become yellow and caseous and scattered here and there in various numbers. Later these tubercles may become softened or infiltrated with lime salts. The mammary glandular tissue is gradually destroyed by the pressure of the greatly developed interlobular connective tissue. The excretory milk ducts are dilated in places by masses of yellow caseous material which is very rich in tubercle bacilli; the walls of the ducts may be filled with minute yellow granulations.

Tuberculosis of the testicles, vagina, spermatic cord, prostrate gland, the tongue, the subcutaneous connective tissue, and intra-muscular connective tissue, may occasionally occur. However, tuberculosis does not appear in all of the foregoing locations in any one animal. It is very rarely that any one of these places are involved. In generalized tuberculosis or acute miliary tuberculosis, many of the abdominal organs (liver, spleen, kidneys, etc.), the lungs and the pleura may be filled with an infinite number of very small (as large as a millet seed) transparent gray granulations (miliary tubercles). If all of these tubercles have reached the same stage in their development, it signifies that the generalization occurred through the blood vessels, thus infecting many of the organs at about the same time.

Post-mortem Appearances of Tuberculosis in the Hog.—Miliary tuberculosis is the most common form in the pig; these gray granulations quickly become yellow and caseous. If generalization occurs the lungs and abdominal organs are filled with miliary tubercles; these are translucid, or have opaque centres, and are very like the gray granulations in cattle. Inasmuch as the pig is usually infected by eating infectious material, the digestive apparatus and the lymphatic glands along the digestive tract are usually first and most frequently involved. The tonsils and the submaxillary, the parotid, the post-pharyngeal, the superior cervical, the mesenteric, the sublumbar and the intestinal lymphatic glands may become distinctly tuberculous before the organs manifest any distinct signs of the disease. Ulcers and miliary tubercles of the mucous membrane are occasionally found in the small intestine and the cæcum; sometimes tuberculous infiltrations may involve the mucous membrane, the muscular and serous coats of the intestine. The liver is usually involved; yellow, caseous miliary tuberculous centres may be scattered through the s ubstance of the liver, or there may be round, yellowish white, tough tubercles, as large as a pea or hazel-nut; these tubercles may, upon inspection, appear as if they were composed of fibrous material, with a small, soft centre. The periton eum and the pleura are occasionally filled or covered by nume rous fine miliary tubercles which have no tendency to undergo other changes. The lungs may be involved similar to the tuberculous lesions in the liver, but as a rule the lungs contain numerous miliary tubercles only in acute generalized t uberculosis. In acute generalized tuberculosis, the liver, the spleen, the kidneys, the marrow of the bones, and the mammary glands, are filled with miliary tubercles. In some cases the disease may be localized in one or more of the ly mphatic glands. The post-pharyngeal or the submaxillary lymph atic glands and the tonsils are most frequently tuberculous; they become enlarged, hard and knotty; they undergo a true fibrous change; are hard to cut out, and when cut with a knife the tissue creaks and the section appears very like old fibrous tissue. In these tuberculous glands there may be small soft spots or somewhat large pus collections. Nocard says bacilli may not be found in these soft materials by microscopic examinations; yet they are p resent; because, when a guinea pig or rabbit is inoculated into the peritonial cavity with this material, tuberculosis develops.

The slow growing glandular changes have been considered as scrofula of the pig and sometimes the tuberculous changes in the bones are called scrofula. As a rule, most of the so-called cases of scrofula in the pig are true cases of tuberculosis.

Post-mortem Appearances of Tuberculosis of Birds.—The tuberculous changes are found almost entirely limited to the digestive apparatus; and the liver is the organ that is most frequently involved. It is greatly enlarged and filled with tubercles, varying in size. In some cases the tubercles appear as small hard, white or yellow nodules, varying in size from a millet seed to a pea; in other cases the tuberculous lesions in the liver may be as large as a hazel-nut or walnut, white and fibrous, hard or softened in the centre. The liver tissue between the tubercles may appear normal, yet is more friable and liable to rupture. The spleen is involved in the order of frequency next to the liver. It may be filled with very small white granulations (tubercles) or it may contain hard calcareous nodular masses which are sometimes very large. Sometimes granular or nodular masses may become so large in the intestine as to obstruct the canal. Occasionally the tnberculous lesion in the intestine may be in the form of an infiltration of all three coats of the intestinal wall; ulcers may appear on the mucous surface that are more or less deep. The peritoneum is occasionally the location of white and hard miliary tubercles. The lungs are rarely tuberculous in birds. In the lungs of birds masses of miliary tubercles will at first develop and these will develop into small white caseous masses. The joints and their surrounding tissue may become tuberculous; these may be hard or soft; the joints may be ulcerated and have an opening discharging infected and broken down tissue material.

According to some authorities many of the diphtheritic membranes that develop in the mouth, pharynx, nose and eyes are tuberculous lesions and always contain tubercle bacilli. Also, certain horny, warty tumors that develop in the skin of the face, head, neck or feet are tuberculous because they contain numerous tubercle bacilli.

In all tuberculous lesions of birds, the tubercule bacilli are numerous; they collect in tufts or clusters. According to Nocard the tubercle bacilli in birds is a little longer than those in tuberculous mammals. The bacillus from birds is more vigorous; grows more rapidly and will withstand a higher temperature than the bacilli from mammals. However, the bacilli have the same peculiarities in reference to the culture media upon which they grow, and also in regard to their staining. Yet avian tuberculosis cannot be transmitted by inoculation to mammals and the mammalian form cannot be transmitted to birds. Some authorities believe that tuberculosis of birds is entirely distinct from tuberculosis in mammals. Nocard, however, believes that the bacillus of avian tuberculosis is a variety of the bacillus of mammalian tuberculosis.

STAINING THE TUBERCLE BACILLI.

Many times a microscopic examination will confirm the presence of the exciting cause (*bacillus tuberculosis*) in the muco-pus products of a tuberculous lesion. However, there are cases where no bacilli can be detected by the microscope, and yet when some of the tuberculous material is injected into the guinea pig or rabbit, the disease is produced and the bacilli may be discovered by microscopic examination. Hence, if the microscopic examination fails to find the bacillus, the proof is not absolutely positive that the disease is not tuberculosis.

Ziehl's method is one of the very best and the simplest for staining tubercle bacilli, especially cover glass smears. His staining solution is made as follows:

Carbolic Acid (5 per cent. solution)..	90 parts.
Alcohol (90 per cent.)...............	10 parts.
Fuchsin..............................	1 part.

Mix thoroughly and filter before using.

A very small quantity of the suspected tuberculous material (sputa, purulent nasal discharge, pus from a tuberculous articulation, pus from any tuberculous abscess, etc., etc.) is spread over an absolutely clean cover glass (No. 0 or No. 1) and slowly dried over an alcohol lamp or a Bunsen burner; when dry it is passed two or three times through the flame to fix it on the cover glass. The cover glass is plunged into alcohol and then into the staining solution, or the staining solution is placed on the cover glass with a dropper. The cover glass is now held over a flame until the vapor begins to rise; this heating may be repeated as often as the stain on the cover glass cools, and the staining continued from four to ten minutes. Or the cover glass may be floated (smear side down) on the surface of the staining solution in a watch glass, and the solution may be kept warm in the incubator or on a paraffine water bath for thirty to sixty minutes. The cover glass is next washed in distilled water and decolorized, in a 33 per cent. nitric acid or a 20 per cent. sulphuric acid solution.

The decolorization (usually takes five or ten seconds) should be continued until all or nearly all of the visible color is removed from the cover glass. Next it is washed in distilled water; dried over the flame and mounted in balsam. A 1–12 in. oil-immersion objective and a substage condenser are necessary to make an accurate examination of the prepared slide. Some prefer to make a double stain by using gentian violet or Bismarck brown just after the decolorizing acid is washed from the cover glass smear. This gives the pus cells and other bacteria a brown or a blue color, while tubercle bacilli stand out in contrast, a distinct red color. Tubercle bacilli are in length from $\frac{1}{2}$ to $\frac{2}{3}$ the diameter of a red blood corpuscle, and their breadth is about 1–15 of their length. They are very slender and usually straight, but may be curved. In recent or new tubercles they appear as solid rods, but in old lesions, sputum and muco-pus they appear to be made up of ovoid grains, closely adhering to one another. It is very probable that short or broken chains of micrococci (streptococci) are sometimes mistaken for tubercle bacilli.

In cases where it is impossible to detect the tubercle bacilli by microscopic examination, a small quantity of the muco-pus or tuberculous material may be injected into the peritoneal cavity of a guinea pig. In a short time the inoculated guinea pig will begin to grow thin, and if killed in fifteen or twenty days after the inoculation, tuberculous lesions will be found in the spleen, liver, etc. Villemin and others claim that the lesions will always be the same in the spleen, no matter what is the origin of the tuberculous material (from animal or man) with which the guinea pig is inoculated. The spleen is always greatly enlarged in all directions; in the early stages it is always filled with a great number of minute tuberculous granules; later its surface will appear "marbled;" surface lines are formed where the spleen substance has undergone caseous degeneration. These lines are said to "design variable arabesques of curious and asymmetrical shape." In old cases, the liver will exhibit similar changes, except that they are less distinct than those in the spleen.

If the tuberculous material be injected into the subcutaneous connective tissue of a guinea pig, it will become tuberculous; but the disease will develop more slowly than by the peritoneal method of injection. When the tuberculous material is injected into a vein general tuberculosis very quickly appears. The lungs, liver, spleen, marrow of the bones and all other vascular organs very quickly become filled with a great number of miliary tubercles; the tubercles in the liver, spleen and marrow of the bones contain numerous tubercle bacilli. To the naked eye these organs appear enlarged, engorged with blood, and very friable. In fifteen or twenty days the intravenously inoculated guinea pig will die from a veritable tuberculous septicaemia; during this time it will lose from one-third to one-half of its weight.

In all cases, no matter what is the source of the tuberculous material (from man or other mammals) and no matter if the microscopic examination of the tuberculous material fails to discover tubercle bacilli, a microscopic examination of the tuberculous material from the inoculated guinea pig, always discovers the bacillus.

HISTOLOGY OF TUBERCULOUS LEGIONS.

There are three kinds or forms of tuberculous lesions:

(1) Miliary tubercles, or small gray granulations, which vary from one-two hundred and fiftieth to one-twenty fifth of an inch in diameter, are gray, translucid, and occasionally have a light tinted centre.

(2) The yellow, hard, calcified mass, varying from the size of a pea to that of a walnut or apple.

(3) A yellowish opaque infiltration of the tissues.

Nocard sums up the anatomical characteristics of the tuberculous granulation, as follows:

(1) "The nodular form of the mass."

(2) "The tendancy of the central portion to become caseous."

(3) "The frequent occurrence of giant cells in the centre."

(4) "The concentric arrangement of the peripheral cellular elements."

(5) "The complete absence of vessels."

"The miliary tubercle" consists of the aggregation of a certain number of elementary granulations in a single fibro-cellular envelope, the toughness of which gradually increases.

'Tubercular masses,' whether small or great, are collections of a variable number of caseous, calcareous or softened miliary tubercles surrounded by a more or less thick and tough fibrous shell."

"The 'caseous infiltration' of the tissues is the result of the development of a considerable number of tuberculous follicles, whose peripheral elements, having no tendency to undergo fibrous transformation, remain in a cellular state and retain their concentric arrangement, until they are attacked, like the centre of the follicle, by caseous degeneration. This latter form of lesion rarely undergoes calcification."

CONDEMN TUBERCULOUS ANIMALS OR CARCASSES.

The German inspectors condemn the carcass of an animal when tuberculous lesions are found in the thorax and in the abdomen, or when there is generalized tuberculosis. By a direct vote of the Inter-National Veterinary Congress of 1896, it was decided that it was safest and best to condemn the entire carcass of a tuberculous animal no matter how much localized or generalized the lesions may be. Since it is very difficult to fully determine the extent of the tuberculous lesions without great expense and considerable time and, in many cases, without almost entirely ruining the carcass for beef, the only practicable and safe method is to *condemn the entire carcass when it is tuberculous in any degree.*

The following cuts were taken from Bulletin No. 7, of the Bureau of Animal Industry, Dep't of Agriculture, Washington. Prepared by Theobold Smith.

FIG. 6.—*Dorsal aspect of the bovine lungs.*

The lungs are laid so that the dorsal (or upper) surface is shown. The various lobes are drawn apart so that their outlines may be distinctly seen. The lobes are named in the text as follows:

a, a_1, right and left caudal lobes, respectively.
b, b_1, right and left ventral lobes.
c, c_1 the two portions of the right cephalic lobes, denominated first and second cephalic lobes.
c_2, left cephalic lobe.
e, trachea.
x, region most frequently involved in the earliest stages of pulmonary tuberculosis. The lesions in this stage are, as a rule, embedded in the lung tissue so as to remain invisible from the surface.

FIG. 7.—*Ventral aspect of the bovine lungs.*

The letters correspond to those on Fig. 6.

a, a_1, right and left caudal lobes.
b, b_1, right and left ventral lobes.
c, c_1, first and second right cephalic lobes.
c_2, left cephalic lobe.
d, azygos or median lobe (belonging to the right lung). This lobe is involved in the most advanced cases only.
e, trachea.
x, usual location of the earliest lesions of tuberculosis.

FIG. 8.—*Trachea and bronchial tubes of the bovine lungs showing attached bronchial glands.*

a, a_1, air tubes supplying the right and left caudal lobes.
b, b_1, air tubes supplying the right and left ventral lobes.
c, c_1, branches of the right supernumerary bronchus supplying the first and second cephalic lobes of the right lung.
c_2, air tube supplying the left cephalic lobe.
d, branch to azygos lobe.
e, trachea.
A, left bronchial lymph gland.
B, right tracheal lymph gland.
C, lymph gland at root of right supernumerary bronchus.
D, gland in the angle between bronchi; not always present.

The minute intra-pulmonary glands, situated along the main bronchi, are not shown.

FIG. 9.—*Dorsal aspect of the bovine lungs showing the position of the posterior mediastinal glands.*

a, a_1, caudal lobes.
b, b_1, ventral lobes.
c, c_1, c_2, cephalic lobes.
e, trachea.
f, œsophagus.
g, muscular pillars of the diaphragm.
h, posterior aorta cut through just beyond the arch and reflected so as to uncover the left bronchial gland A, resting against the root of the left bronchus.
i, caudal margin of the ligament of the lungs (*ligamentum latum.*)

The mediastinal glands are shown, most of them resting on the œsophagus. The aorta fat, and pleural layers which inclose the posterior mediastinal space laterally, are removed.

a, the large caudal gland resting below œsophagus on the pillars of the diaphragm. This gland may be left in the body when the lungs and heart are removed unless special care is taken.

The remaining mediastinal glands are arranged in two sets, on the right and the left margin of the œsophagus. In this animal there is but one gland in the left chain. *a* is the gland most frequently diseased and in many cases enormously enlarged.

a', the most cephalic of the mediastinal series.

FIG. 10.—*Section through the median plane of the head of a cow to show location of the (left) retropharyngeal gland.*

a, brain cavity.
b, nasal septum.
c, lower jaw, sawn through.

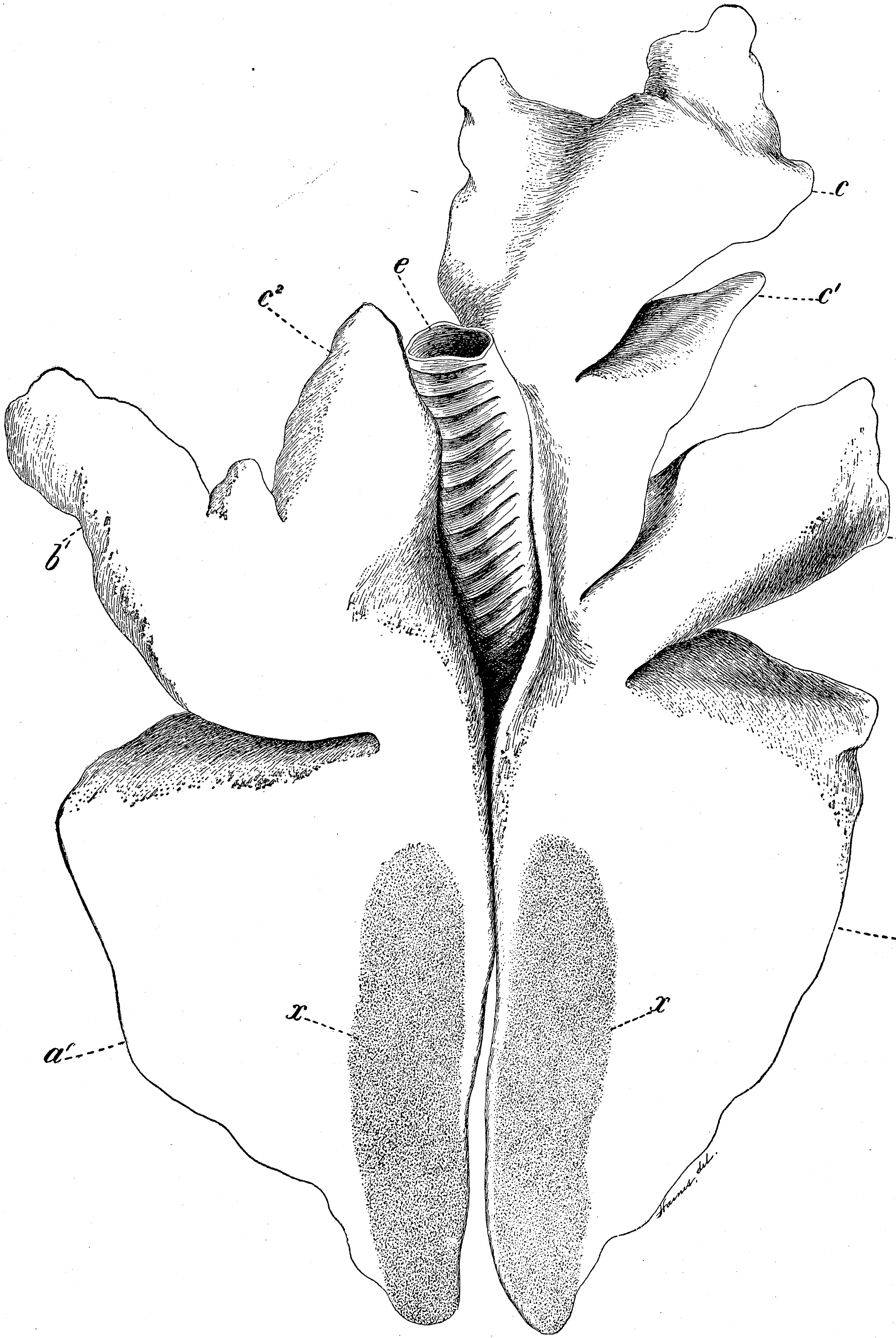

Fig. 6.—Dorsal Aspect of the Bovine Lungs.

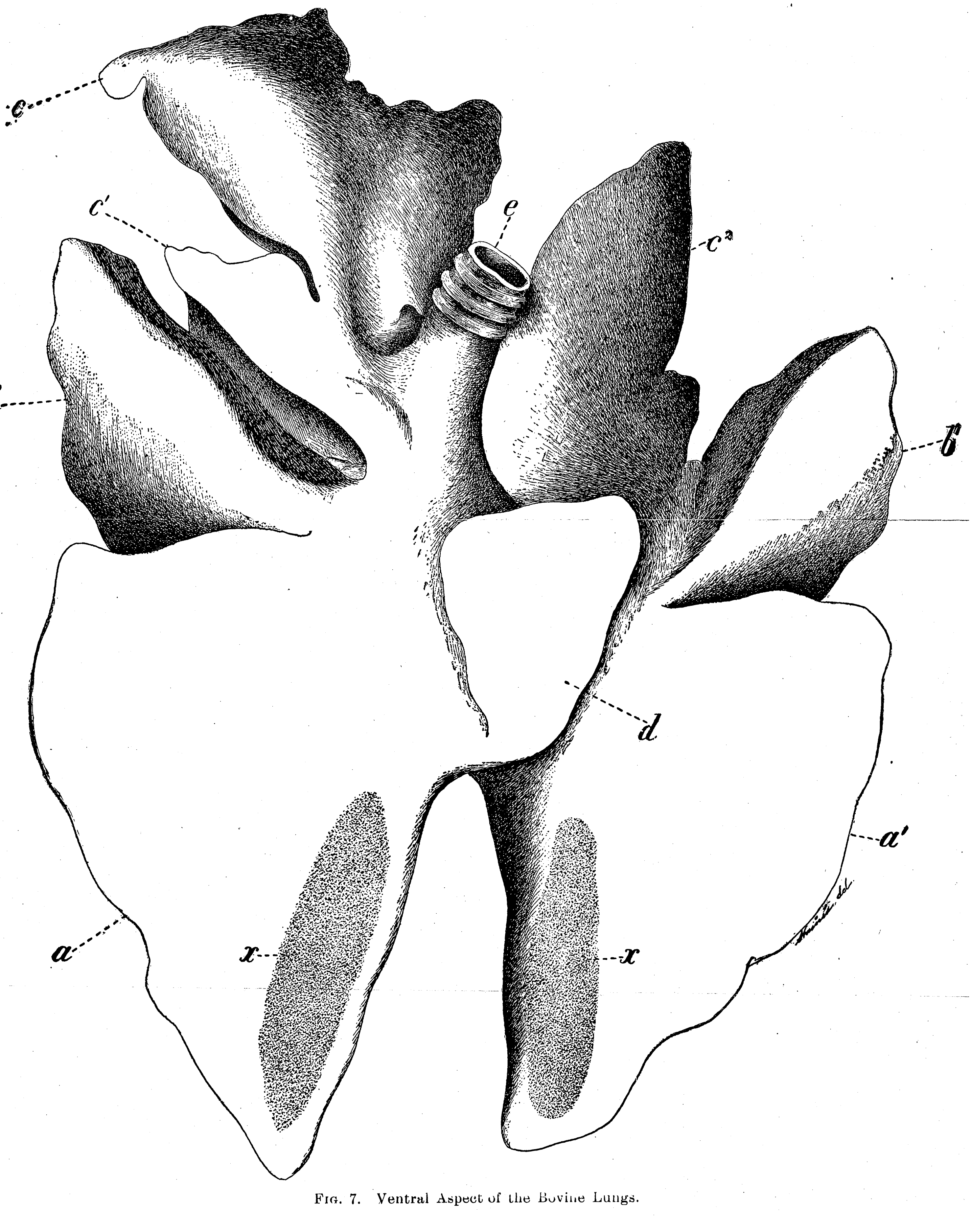

FIG. 7. Ventral Aspect of the Bovine Lungs.

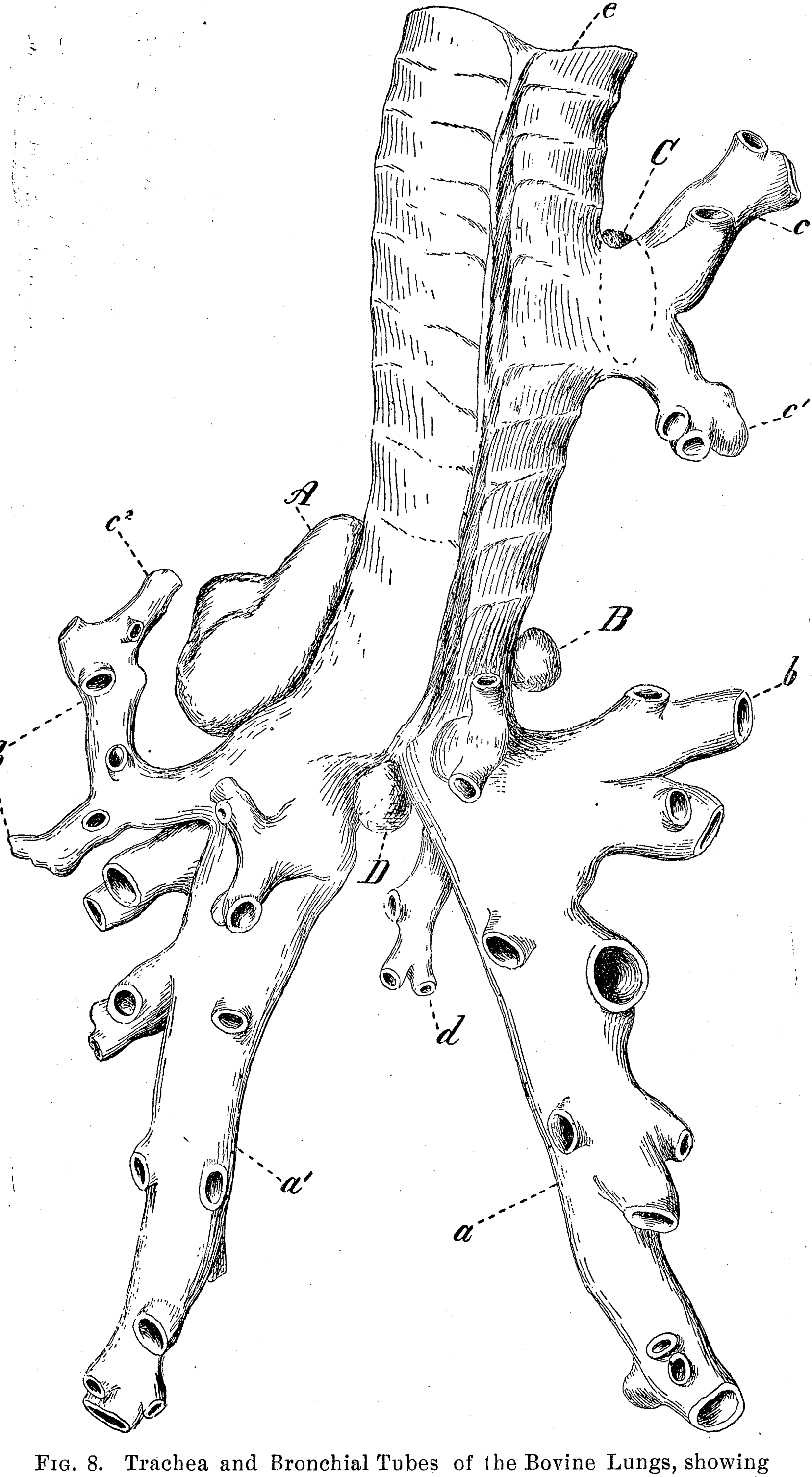

FIG. 8. Trachea and Bronchial Tubes of the Bovine Lungs, showing Attached Bronchial Glands.

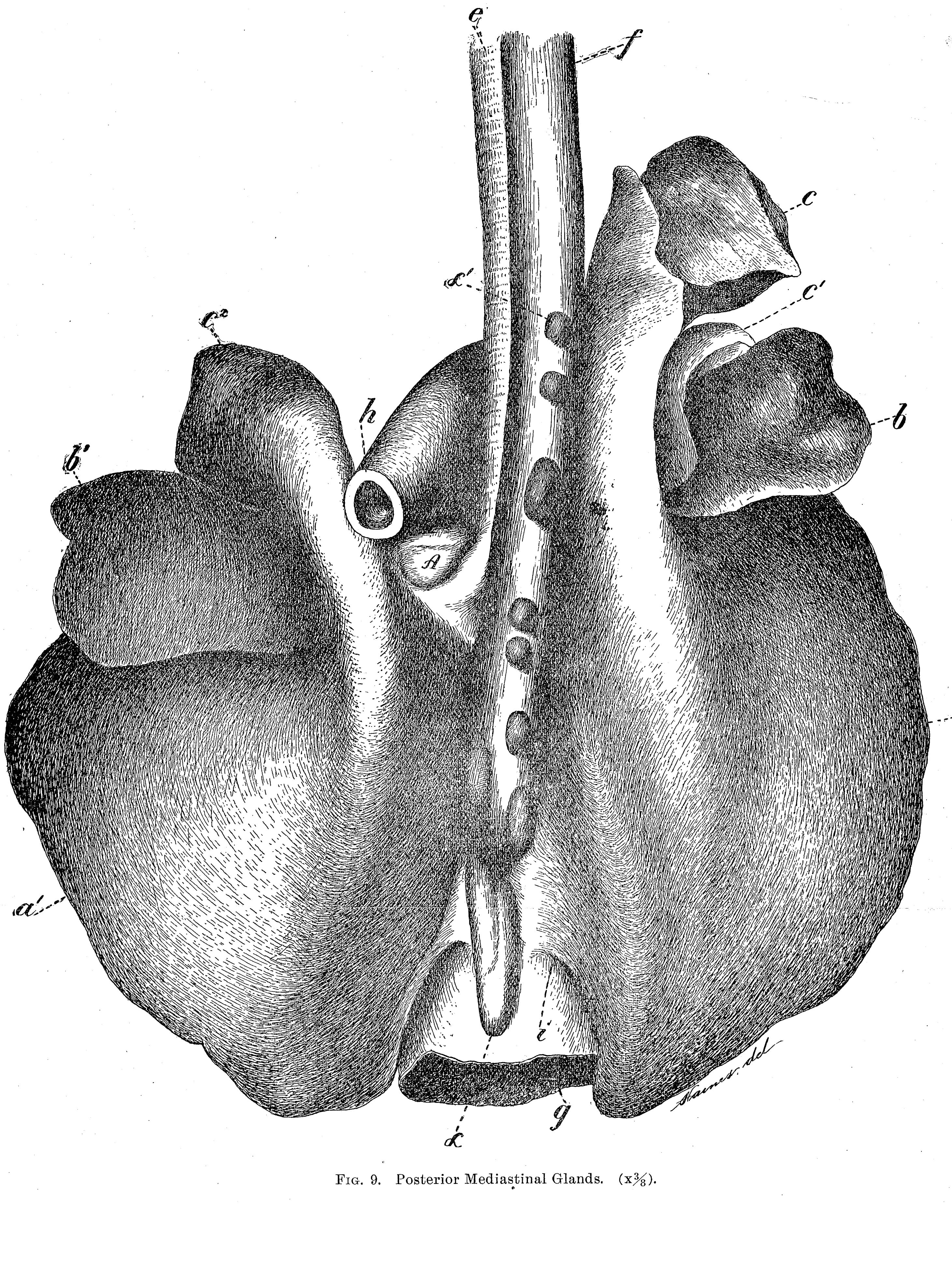

Fig. 9. Posterior Mediastinal Glands. (x⅜).

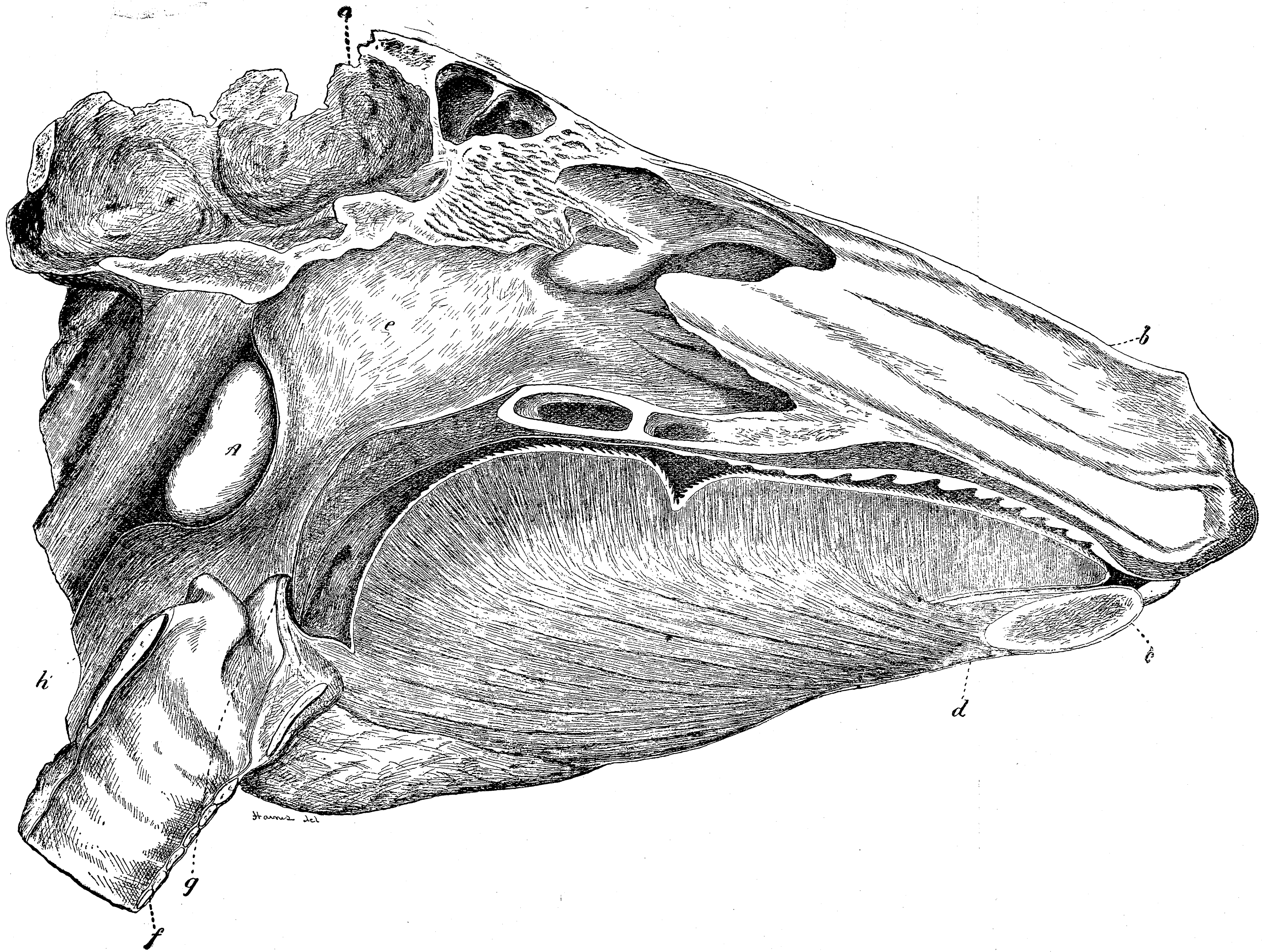

FIG. 10. Section through the Median Plane of the Head of a Cow to show location of (left) Retropharyngeal Lymph Gland.

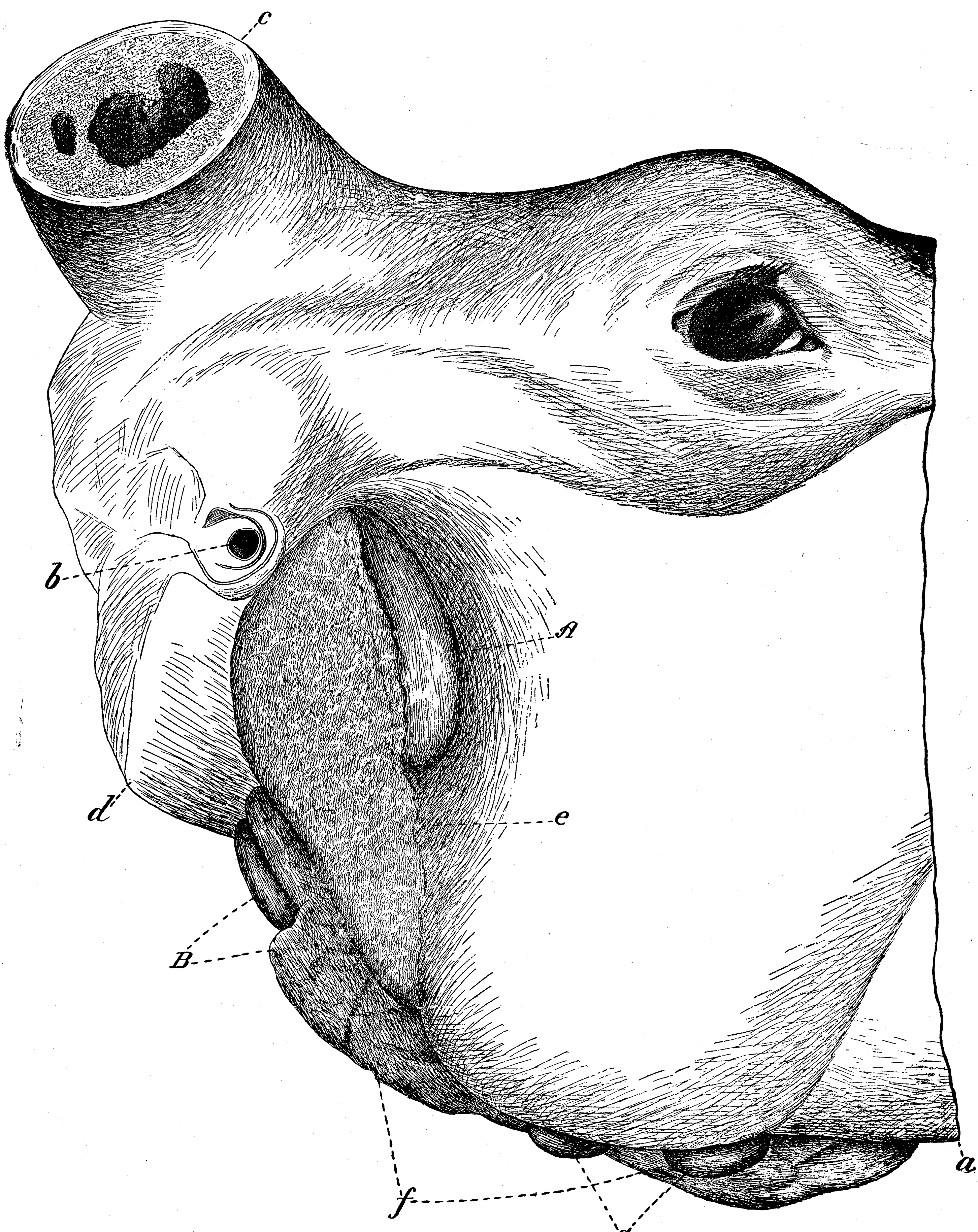

Fig. 11. Lateral Aspect of Posterior Half of a Steer's Head to Show Location of Lymph Glands.

d, tongue.
e, posterior nasal passage.
f, trachea.
g, epiglottis, resting against soft palate.
h, œsophagus.
A, left retropharyngeal gland, in this case enlarged to twice the normal size by tuberculous deposits.

The opening into the left tonsil is shown as a dark spot under the soft palate. The tonsil itself is situated beneath the mucous membrane, where the cut surface of the palate appears and projects slightly above this, so as to lie in part under the mucosa of the posterior nasal passage.

FIG. 11.—*Right lateral aspect of posterior half of a steer's head with skin and superficial fat removed to show location of lymph glands.* (x⅔.)

a, lower jaw.
b, ear passage.
c, horn, sawn through near base.
d, styloid process of occipital bone.
e, parotid salivary gland.
f, submaxillary salivary gland.
A, right parotid lymph gland, partly hidden under the anterior border of the parotid salivary gland.
B, right post-maxillary lymph glands, the greater portion concealed beneath the submaxillary salivary gland.
C, right submaxillary lymph glands between ramus of lower jaw and submaxillary salivary gland.

ACTINOMYCOSIS.

Synonyms.—Lumpy-jaw, Big-jaw, Big-head in cattle.

Symptoms.—This disease is caused by a plant parasite called the ray fungus or cauliflower-like fungus (*actinomyces bovis*). This plant parasite gains admission to the system by way of the mouth, the stomach, the intestines, and sometimes by way of the respiratory apparatus. It is said to grow upon plants, especially *hordeum murinum* (Brazola). Fragments of this grass are supposed to penetrate the mucous membrane and thus inoculate the animal. It may be that an ulcer or wound is present before the infection occurs. The infection extends by direct invasion of the tissues surrounding the point of inoculation; later it extends by way of the lymphatics and the blood vessels.

It may attack the lower or the upper jaw, the tongue, the throat (pharynx), the larynx and the lymphatic glands and tissues lying near these parts or organs. It also may involve the lungs, the liver, the spleen, the kidneys and the intestines. The parts most frequently attacked are the lower jaw, the tongue, the upper jaw, the pharynx and the lymphatic glands near the lower jaw and throat. The lungs are also frequently attacked; and the skin may be, in rare instances, involved.

As a rule, a large hard swelling first appears somewhere along the lower jaw, in the intermaxillary space, on the side of the face or in the throat, the mouth or the tongue. These hard tumor-like growths continue to enlarge and finally break open or erupt through the skin or into the mouth or throat; then discharge pus-like material for an indefinite time. These lesions may or may not interfere with mastication or swallowing; if they do, the animal will become more or less emaciated. The parasite may extend to the lymphatic glands and also to the lungs and digestive tract. When the pus-like material is discharged into the mouth, throat or larynx, the digestive tract and the lungs are liable to become secondarily infected. However, there are instances where the internal organs (lungs, etc.) may be primarily involved. The tongue becomes so large and hard that it has been called the "wooden tongue;" in such cases the mastication and swallowing are very difficult. When the pharynx or larynx are involved the breathing may be more or less difficult, and the animal may have a cough. When the lungs and other internal organs are involved, the symptoms are very similar to those of tuberculosis. In fact, a physical ante-mortem examination would not enable one to determine whether the animal is tuberculous or actinomycotic in cases where the lungs or other internal organs alone were involved. As in tuberculosis the animal having actinomycosis may be apparently healthy, fat and apparently in condition for beef. Or the actinomycotic animal may exhibit all the various degrees from a slight local infection to severe general infection.

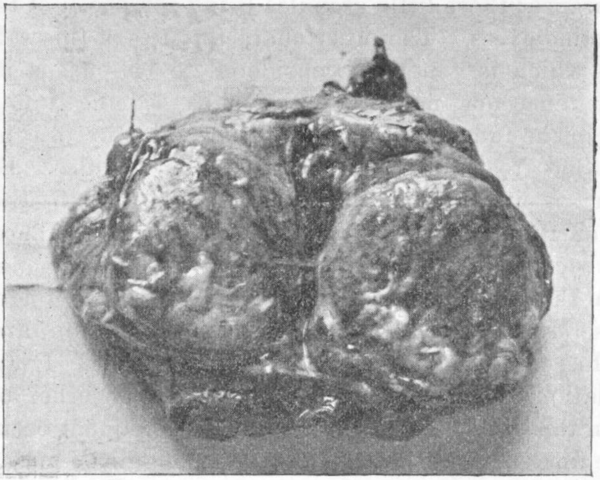

FIG. 12. Actinomycotic tumor from lung of an Ox. Tumor cut open, divided into right and left halves. Lung tissue surrounding the base of each half.

In pigs the actinomycotic tumors may be found involving the lower jaw, the larynx, the mammary glands, the bones and the lungs. Abscesses are formed in the invaded tissues; these break or open upon the external surface as a rule, but may occasionally erupt internally.

Post-Mortum Appearances.—In this connection I can not do better than give the opinion of Dr. Trumbower, State Veterinarian of Illinois, who has had more experience in both ante-and post-mortem examinations of actinomycosis than any other American veterinarian. The following was kindly furnished the writer by Dr. Trumbower:

"The rapid development of the parasite causes absorption of the structure invaded, and penetrates in various directions until it forms a rupture on the external part of the body or into an internal organ or cavity; until the strepto-cocci or the staphylo-cocci obtain admission to the channel thus made by this parasitic growth, no true pus formation occurs, and the contents of the tumor are always of a characteristic color without odor; the color is generally described as a sulphur yellow, having a more or less granular appearance; these little granules being composed of tufts of the actinomyces. The other characteristics of this soft material, which is generally considered to be pus, is its peculiar tenaceous nature; occasionally calcification tak place in the fungus tufts so that the actinomycotic nodu somewhat resembles miliary tubercular nodules. By t power of its rapid multiplication or growth the gans surrounding the point where it gained entrance may soon become invaded; thus if we have the tumor located within the lower maxilla, or at the base of the tongue, we may soon have the lymphatic glands in that region involved, and thus the actinomyces gain entrance to the lymphatic circulation, and in this manner are carried to other organs within the body. This accounts for the frequent occurence of the disease in the lungs, the liver, inguinal, mesenteric and other lymphatic glands. As a rule, the disease is confined to the head or neck, but it is impossible to state to what extent an animal is effected without a post-mortem examination, for we commonly find mild cases of head affection, even when the animal is apparently in a good state of health, where the lungs or liver are largely involved by this disease.

My guide, in condemning carcasses as unfit for human food, is principally based upon the condition of the lymphatic glands; more so than when the disease is only located within the lung tissue. I believe that when the lymphatic glands become involved, two or three or more in a chain, that it must gain entrance to the circulation, and it is then impossible to state what portion of the carcass might be free from this growth, for lymphatic glands within the muscular structure may be affected, but cannot possibly be discovered by anyone without tracing out the lymphatics throughout the body, and thereby ruining the carcass for market. In cases where the upper or lower jaw is affected wheter he discharge is external; that is, where there is an external rupture discharging the contents of the tumor, the lymphatic glands near by not being invaded, then I pass the carcass as being fit for market.

If, however, the head has been largely involved, and the rupture has been into the mouth or the nasal chambers so that the discharge was being swallowed, or inhaled into the lungs, then I make a close examination of the internal organs, and if I find them at all affected I condemn the whole carcass; the head, however, is always rejected, no matter how slightly it is affected. In some cases we may not find any disease of the head whatever, but the fungus has gained entrance in some other portion of the body through the presence of a wound or other injury. So long as the disease is localized and none of the lymphatic glands affected, only that part of the carcass should be rejected; I have seen such local effects in almost every part of the body."

A microscopic examination of the pus-like material will always give a positive diagnosis. The white, gray or sulphur yellow granules or sand-like particles in the pus always contain bunches or clusters of actinomyces. These small, sulphur yellow particles may be stained with eosin in a watch glass; then placed upon a slide and covered with a small drop of glycerine; next drop a cover glass over them, pressing it down so as to mash and spread out the stained particles into a thin layer. The mount is now ready for examination under the microscope; use a $\frac{1}{2}$ or $\frac{1}{4}$ inch objective. Weigert employs a double staining process, using orseillin and gention violet. Isreal uses orceine and Baranski employs picrocarmine.

Inasmuch as actinomycosis is usually confined to the head and may be said, in one sense, to be a local disease, many of the European inspectors condemn only the parts involved—the head as a rule. However, Dr. Trumbower's methods appear to be the safest and most practicable. Whenever the actinomycotic abscess opens into the mouth, pharynx, larynx or any part of the digestive or the respiratory tract, the entire carcass is condemned. Also when the lymphatic glands are involved or there are antinomycotic tumors in the lungs or the lesions have become generalized, the entire carcass is condemned. In cases where the antinomycotic lesions are positively localized and the abscesses have erupted only upon the external surface, the infected parts may be cut away and the balance of the carcass used for food.

ANTHRAX.

This disease is caused by a plant (*bacillis anthracis*). This parasite may gain an entrance to the system by way of the digestive tract (mouth, stomach, intestine) by way of the skin and by way of the respiratory passages. The first mode of infection is very common, while the last two ways are very rare. Anthrax attacks man and many of the lower animals. The susceptibility of animals occurs in the following order: Cattle, sheep, goat, horse, stag, antelope, deer, camel, cat, rabbit, guinea pig, mouse, hare, dog, pig, and fox. The black rat and fowls are almost insusceptible. Ostertag claims that the sheep is the most susceptible of all animals to anthrax.

Symptoms of Anthrax.—The clinical symptoms will vary greatly according to the mode of infection and to the susceptibility of the species of animal. In the acute form the animal may die so suddenly that few, if any, symptoms will be noted. There are, however, in cattle, two somewhat distinct forms of anthrax. The acute form where no external swelling appears. In this form, the temperature is elevated (104 to 107 degrees Fah.); the pulse rate may be as high as 80 to 100 per minute; the animal ceases to eat and to ruminate. The animal may be dull and stupid, and this is followed by uneasiness, kicking, and pawing, and champing of the jaws. The nostrils may become dilated and the breathing labored; the visible mucous membranes become bluish. When the bowels are first involved the animal will show signs of abdominal pain, and the bowel discharges may become covered or mixed with blood and mucus. Finally the animal grows very weak; blood vessels rupture and produce spots of blood in the visible mucous membranes, and may lead the bloody discharges from the nose, the mouth, the vagina, and the rectum. Many times the urine contains blood, a result of the rupture of blood vessels in some part of the urinary apparatus. These cases may live from one to seven days, terminating in death or recovery.

The disease may be attended with external swellings; these appear under the skin and are usually doughy and more or less extensive; in the early stages of the disease they may be somewhat firm, hot, tender, and later pass into the soft, cool swellings.

Post-Mortem Appearances of Anthrax.—The body is liable to undergo rapid decomposition; the blood is very black and "tar-like" in color. Hemorrhages appear in nearly all the organs. Soft, yellowish gelatinous and black hemorrhagic infiltrations may be found under the peritoneum, the pleura and the skin. The spleen is greatly enlarged and sometimes partially disintegrated; the liver and kidneys may show signs of inflammatory changes. If the intestines are involved, the first part of the small intestine (duodenum) is more frequently attacked than any other portion. The crucial test is to find the *bacillus anthracis* in the blood or in the tissues of the spleen, the liver, the intestines, or in the hemorrhagic infiltrations of the mesentery. The *bacillus anthracis* is very readily stained with fuchsine or methyl blue. A cover glass smear can be stained in a weak aqueous solution of either of these stains; decolorize with alcohol and water; then dry over the flame and mount in balsam. It is then ready for microscopic examination. This bacillus is so large that it may be observed moderately well by a one-sixth or a one-eighth inch dry objective; yet it is far more satisfactory to examine it under a one-twelfth inch oil immersion objective. The average length of the bacillus is about two times the diameter of a red blood corpuscle; its width is about one-eighth of its length. These bacilli are straight and rod-like in form; occasionally they may be curved; many times a number of them are loosely united end to end, forming a filament or jointed thread. As a rule, the end of a bacillus appears indented, or as if it were cut off at right angles to its long axis. Spores are sometimes observed in the body of the bacillus; these spores do not take up stain very quickly, and consequently appear as an unstained spot in the bacillus. Spores may be stained by special methods. The bacillus will grow on almost any of the artificial culture media. It grows best at a temperature of 85 degrees Fah., and in contact with air or oxygen. In case the smears from the suspected animal do not show the bacillus in its true or most common form, or they are not sufficiently pure or isolated to make a diagnosis positive, roll or plate cultures can be made and the bacillus very readily isolated; or the house mouse may be inoculated with some of the infected material; it will die in a short time, and from its spleen or liver you may obtain the bacillus.

All anthrax carcasses should be condemned, regardless of the extent of the lesions. The carcass, hide and all its contents should be thoroughly cooked or rendered, or burned. There is no pathogenic germ that will live outside of the animal body and retain its virulence longer than the *anthrax bacillus*, especially its spores. It is questionable whether an anthrax carcass should be rendered, especially not in any other way than in the improved, modern, closed rendering tanks.

TEXAS FEVER.

This disease is caused by small animal parasite (*Pyrosoma bigeminum*) which lives within the red-blood corpuscles. In fact, it destroys the red-blood corpuscles in great numbers. Sometimes these parasites will destroy three-fourths to four-fifths of the red-blood corpuscles, before the infected animal dies. This parasite, in some respects, is similar to the parasite that is said to cause malaria in men. "Texas fever" has various names in different sections of the country where it frequently appears. It is often called Spanish fever, acclimation fever, red-water, black-water, distemper, murrain, dry-murrain, yellow murrain, and bloody murrain (Salmon and Smith).

Symptoms.—This parasite is carried from the diseased to the healthy animals by the cattle tick (Boöphilus bovis). Hence the presence of the ticks upon the animal is one of the prominent symptoms. The period of incubation varies from 12 to 90 days. The temperature becomes elevated (104 to 107 degrees Fah.); this fever continues until death or recovery begins. The bowels are usually constipated during the high fever, but in the last stages they may become loose and the fæces may be colored yellow with bile. The urine remains normal until near the fatal termination, then it may become deeply stained with the coloring matter of the blood. Sometimes this red colored urine may be observed in cases that recover. The animal may live from three days to several weeks after the beginning of the attack.

Post-mortem Appearances of Texas Fever.—Red colored urine may be found in the bladder. The spleen is greatly enlarged; the liver is yellowish in appearance, enlarged, and engorged with bile; the bile in the gall bladder is flaky, thick and in an excessive quantity; there may be ecchymoses (blood spots) on the external and internal surfaces of the heart. The blood is thin and watery, a result of the great reduction in the number of the red-blood corpuscles.

The diagnosis is made positive by the discovery of the animal parasite in the blood by the aid of the microscope. Cover glass smears of blood from the kidneys, the liver, the skin, the spleen or the heart muscles should be made. Theobald Smith advises that a very small quantity of the blood be picked up with a platinum loop and placed a little to one side of the centre of a clean cover glass; another clean square cover glass, held between the thumb and finger of the right hand, is then drawn over the droplet of blood so as to spread it out in a very thin layer; the smear is then dried over a flame and then it is passed through the gas flame somewhat slower than usual four times, or the smears are to be kept in dry-air oven at a temperature of 110 to 120 degrees C. for one and one-half to two hours; the smears are now ready for staining. "The cover glass is either allowed to float on a filtered solution of Löffler's alkaline methyl blue, or else the staining fluid is dropped upon the cover glass and allowed to remain from one and one-half to two minutes. It is thereupon washed in distilled water and dipped into a one-third per cent. solution of acetic acid for an instant to remove any diffuse stain in the red corpuscles: hastily the acid is washed away in distilled water. It is then ready for examination in water or for drying and mounting in xylol balsam. Care must be taken to make the action of the acetic acid solution momentary, otherwise the decolorization may go too far (Smith)." The stained smear should be examined with a one-twelfth inch oil immersion objective. Certain corpuscles will be found to contain two pear shaped bodies, with their tapering ends close together and directed towards each other. These intraglobular parasites are not all pear-shaped and in pairs. Some of them may be single and somewhat irregular in outline. About 10 per cent. of the red corpuscles from the blood of the skin contain these parasites, while 80 per cent. of the red corpuscles from the blood of the kidneys may contain the parasite.

The carcasses of all Texas fever cases are condemned by the U. S. inspectors. This is, no doubt, the proper and safe course to follow.

MALIGNANT CATARRH OF CATTLE

This is an infectious disease that is probably due to an undiscovered germ. It certainly appears very like a specific infectious disease. As a rule it involves the mucous mem brane of the nasal passages of the sinuses (cavities) of thhead, of the throat and of the mouth. It may involve the digestive tract, the kidneys, the bladder, the respiratory apparatus and sometimes manifest cerebral (brain) symptoms. "From the entrance of the nose to the smallest bronchi the mucous membrane may exhibit all grades of inflammation—catarrhal, crupous and diphtheritic." This produces a variable discharge from the nose; at first it is watery, then thicker and sometimes streaked with blood, and later it may become very foul smelling. Usually this disease is ushered in by a chill, a depressed head with a nasal discharge, and an overflow of tears from the eyes. The eyelids become swollen; the conjunctiva inflamed; the cornea may become clouded and inflamed and the iris will occasionally become involved. The temperature rises (104 to 107 degrees Fah.). The symptoms will vary according to the parts involved.

Post-mortem Appearances.—The mucous membrane of the nose is swollen, brownish or bluish red; small hemorrhagic spots may be present over the nasal membranes or they may be covered with yellowish white crupous membranes. The turbinated bones and the ethmoid cells may show signs of beginning necrosis (death of the part). The mucous membranes of the sinuses are thickened and covered with a purulent (pus) exudate; the cavities in the horns are filled with pus and the matrix of the horns is inflamed. Catarrhal hemorrhagic, crupous or diphtheritic lesions may be observed in the pharynx, larynx, trachea, and bronchi. The mucous membrane of the mouth is swollen and bluish around the teeth. The stomach and intestines may show a diffuse red color and exhibit ulcers and diphtheritic exudates. Pryer's patches and the solitary glands may become ulcerated; but, according to Bollinger, the intestines never become perforated. The kidneys may become inflamed and undergo fatty degeneration.

According to the U. S. government inspector's rules, all malignant catarrh carcasses are condemned. It is evident that all acute cases should be prohibited from passing to the slaughter,—condemned "on foot." Usually all cases which show sufficient pathological lesions at the slaughter to make a positive diagnosis, should be condemned and tanked.

MISCELLANEOUS SUGGESTIONS.

There are many other diseases that may be occasionally found at the slaughter that should be condemned. We would describe them in full here, but our space is limited. Among them are the following: Acute pneumonia in any form; long standing cases of pleurisy; enteritis (inflammation of the bowels or intestines); peritonitis; acute inflammation of the liver; acute inflammation of the kidneys; in fact, almost any acute or chronic inflammatory disease would justify condemnation, especially long existing cases.

Poisoning of any kind—medicines, wild plants, snake-bites, dog-bites, or the absorption of poisonous gases—should always be met with a positive condemnation.

Animals that have tetanus (lock-jaw), rabies, septicæmia, pyæmia, or malignant tumors (sarcomas and carcinomas) should be condemned without reserving any part of the carcass for food.

In cases of drowning, suffocation, or burning, it is generally best to condemn the entire carcass. It is, however, sometimes possible to save part of the carcass in a case of burning, if the animal is immediately killed and the burned part cut away and destroyed. In cases where animals are wounded, they should be killed at once; then the carcass, if otherwise healthy, is edible. But when animals have carried an open wound for several days before they are killed, the inspector will be required to pass upon the condition of the carcass. Generally speaking, if the wound is large and of long standing, the entire carcass should be condemned. Broken limbs and bruises of recent origin may be cut away and the remainder reserved for food if the carcass is otherwise healthy. Pregnant cows that are within one month of delivery should be prohibited from going to the slaughter. Cows that have recently (2 to 4 weeks) given birth to a calf should be rejected. At the slaughter, the uterus may be found inflamed; if there is reason to believe that this inflammation has existed some time and that the inflammatory products have been absorbed, the entire carcass should be condemed. Boars should always be rejected. Bulls that are poor or that have recently been in service should be rejected. In fact, it is best to reject all bulls; however, some people appear to prefer bull beef; consequently, bulls must be passed if otherwise all right.

Calves under 30 days old and pigs or other animals under 14 days old are considered "unripe" or unfit for food. Hence, they should be rejected until they reach the ripe age. No doubt, some animals may become too old to make wholesome and healthful meat. The inspector must judge the meat of aged animals accordiug to its condition.

PUTRIFYING OR DECOMPOSING MEATS.

When meat is kept at room temperature for 24 hours or more, it begins to undergo decomposition. This is due to septic organisms. In warm weather it occurs very rapidly, especially when the meat is not kept upon ice or in an ice chest. The signs of decomposition are the changes in the odor, a decrease in the firmness or solidity of the meat and an increase in the moisture of the meat. Of course, the toughness is decreased or the meat becomes more friable. As a rule, it is easy to distinguish the bad odor in a case where meat has decomposed to a great degree; but when the meat that has just begun to decay or when the odor has been changed by some deodorant, the inspector must then examine the consistency, the toughness or friability and the degree of moisture. The color of decomposing meat is usually paler than normal healthful meat of the same kind; it may have a green tint. However, the color of fresh meat will vary with the age and kind of animal. Veal is lighter in color than beef. An intense yellow may be due to the food containing a large quantity of margarine and olein, or it may be a result of the bile coloring the tissues in diseases of the liver or bile ducts. In the former case the yellow coloration is largely confined to the fat, while in the latter case the bile tinges all the tissues—especially the white ones—a distinct yellow.

Experience is the very best instructor in learning how to recognize decomposing meats. The smell, the color, the consistency, the variations in moisture can be learned only by experience. In condemning decomposing meats one must be guided by the degree of the decomposition; however, if the putrifaction is distinct or well advanced, the meat should always be condemned.

COURSE OR ORDER OF POST-MORTEM EXAMINATIONS.

The following is the order or course, with slight modification, given by Ostertag:

For Cattle—

1. Skin (wounds, actinomycosis, anthrax swellings, parasitic skin diseases, etc.)
2. Head:
   (a) Outer appearance (actinomycosis, tumors).
   (b) Nasal openings, lips, hard palate (mouth diseases.)
   (c) Tongue (actinomycosis, stomatitis).
   (d) Inner surface of cheeks or masseter muscle. (Tape worm cysts, etc.)
   (e) Lymphatic glands, intermaxillary, laryngeal, subparotid, base of ear, etc. (tuberculosis, actinomycocis).
   (f) Sinuses, frontal, maxillaries, ethmoid cells. (Malignant catarrh).
3. Liver, its appearance and consistency, cut into the portal lymphatics, and if necessary cut open the lobes (degeneration, inflammation, parasites, tumors, abscesses, tuberculosis).
4. Heart, appearance after opening the pericardium, open the right and left ventricles (degeneration, hemorrhages, endocarditis, measles or tape worm cysts, echinococcus cysts, etc.)
5. Lungs, consistency, cut into them in various direc-

tions, cut into the mediastinal and bronchial lymphatic glands, (tuberculosis, echinococcus cysts, small round worms, blood and food materials in the bronchi; actinomycosis, etc.)

6. Spleen, its consistency, cut into it and the lymphatic glands (engorgement, echinococcus cysts, tubercles, etc.)

7. Kidneys, cut them into halves, cut open the renal lymphatic glands, etc., (degeneration, inflammation of the kidney and of the pelvis of the kidney, parasites, tubercles.)

8. Stomach, internal and external surfaces (inflammation, tumors, parasites, actinomycosis, secondary tuberculosis).

9. Intestines, (inflammation, intestinal anthrax tuberculosis, parasites, etc.)

10. Mesentary, cut open the lymphatic glands of the mesentary (hemorrhages, parasites, tuberculosis.)

11. Omentum, (hemorrhages, tuberculosis).

12. Testicles—Uterus,—cut them open, (inflammation, tuberculosis).

13. Bladder, appearance, press out the contents (red, cloudy urine, etc.)

14. Examine the quarters:—

(a) External appearance, (amount blood, hemorrhages, swellings, tumors, tape-worm cysts, broken bones); note the consistency of the udder and cut open the lymphatic glands around it, (mammitis, tuberculosis).

(b) Internal surface, peritoneum, pleura (hemorrhagic spots, inflammation, tumors, tuberculosis, etc).

The surfaces of the diaphragm should also be examined for similar changes.

(c) The vertebræ, pelvis, and breast-bone, (fractures osteo-myelitis, tuberculosis).

The brain should always be examined when brain symptoms are observed before the slaughter of the animal at the ante-mortem examination.

For Calves: The post-mortem examination of calves is similar to that of cattle, special attention should be given to the condition:—

1. Of the stomach (peptic ulcers).
2. Of the small intestine (hemorrhagic enteritis).
3. Of the mesenteric and portal lymphatic glands (beginning tuberculosis.)
4. Of the naval (omphaloplebitis).
5. Of the articulations (polyarthritis, septic and suppurative).

For Sheep: Examine the liver (tape worms, tape worm cysts, liver, flukes); the spleen (anthrax); the brain (tape worm cysts); lungs (nemotodes); stomach (nematodes); œsophagus (coccidia).

For Swine: Examine the intestines, the vertebræ, the pelvis, the breast-bone; they are usually examined in the same order and manner as for cattle. The liver, lungs, heart, trachea and tongue should be examined in the order in which they hang after removal from the carcass. The following special observations should be made:

1. Examine closely the abdominal muscles, the pillars of the diaphragm, the intercostal muscles, the laryngeal muscles for cysticercus cellulolosæ (tape worm cysts or measles).
2. Examine the lungs (swine plague changes, etc.)
3. Examine the smaller bronchi for *strongylus paradoxus.*
4. Examine the skin for red spots or red patches hemorrhagic spots.
5. Examine the mammary glands (actinomycosis).
6. Examine the feet (foot and mouth diseases).
7. Examine the muscles (hemorrhages, cysts and calcareous deposits).
8. Examine the cæcum and ileum for diphtheritic ulcers in hog cholera.
9. Examine the intestines for parasites.
10. Examine the liver for flukes, echinococcus cysts; round worm (*stephanurus dentatus, ascaris lumbricoides*).

ANIMAL PARASITES OF DOMESTIC ANIMALS.

TAPE-WORM CYSTS OR MEASLES OF CATTLE.

Synonyms.—*Cysticercus bovis, cysticercus inermis, cysticercus taenæ saginatae.*

The mature tape-worm is found in man and is called *taenia saginata.* It is said that cattle become infected by eating plants that have been fertilized by non-sterilized human excrement, or by drinking water that has been poluted by sewage.

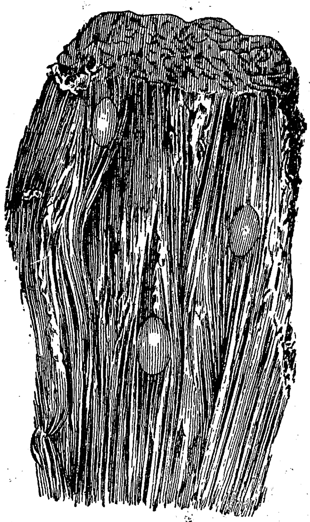

Fig. 13. Measle worm in muscles of cow—natural size.

The cysts are very small (see cut), varying in size from that of a pin-head to that of a pea; at one part of the bladder cyst is a small yellowish spot about the size of a millet seed; this spot contains the scolex (head and neck) of the tape-worm; it may be pressed out and examined under a low power microscope. These cysts are imbedded in the fibrous tissue of the muscles; and are found most frequently in the masseter muscles, the heart, the tongue, the neck and breast muscles, and sometimes many or nearly all the muscles of the body may be infected. If persons eat the cysts without thorough cooking, the mature tape-worm will develop in the alimentary canal from the scolex (head and neck) found in the yellowish white spot in the cyst.

Walley advises the condemnation of the entire carcass in all cases of measly beef; this is the safest plan but there are cases where only a few cysts can be found, and in some cases they are all confined to one locality or region. In such cases it would be sufficient to cut away and tank the parts involved.

Note.—All of the cuts 13-25 were kindly loaned to us by the North Carolina Experiment Station.

MEASLES OF PIG OR PORK MEASLES.

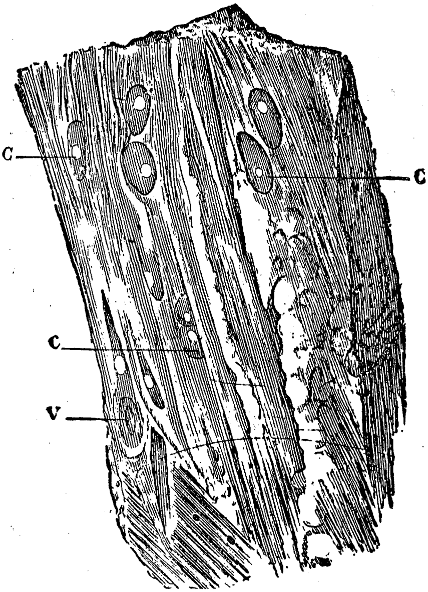

Fig. 14. Measle worm in muscle of pig; cc measles, v cell from which worm has escaped—exact size.

The *cysticercus cellulosœ* is the cystic stage or larval form of the *tœnia solium* of man. These cysts are eliptical or spherical, and about one-fourth of an inch in diameter. The cysts are composed of a transparent connective tissue membrane; at one point in the wall of the cyst is the invaginated scolex, which may be evaginated or pressed out for examination. The head contains a double crown of hooks (24 to 28). Pork cysts are tougher than beef cysts. Mea-

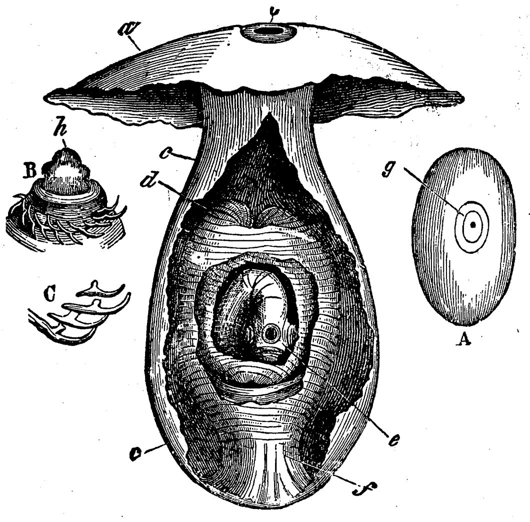

Fig. 15. Measle worm—much magnified. *A*. cell containing worm; *B*. head of worm; *C*. hooks from head; *c*. cell; *A*. highly magnified and cut away to show worm.

sles of pork are also more liable to involve all the organs of the body. In fact there is no part of the body, except the fat, that may not be involved.

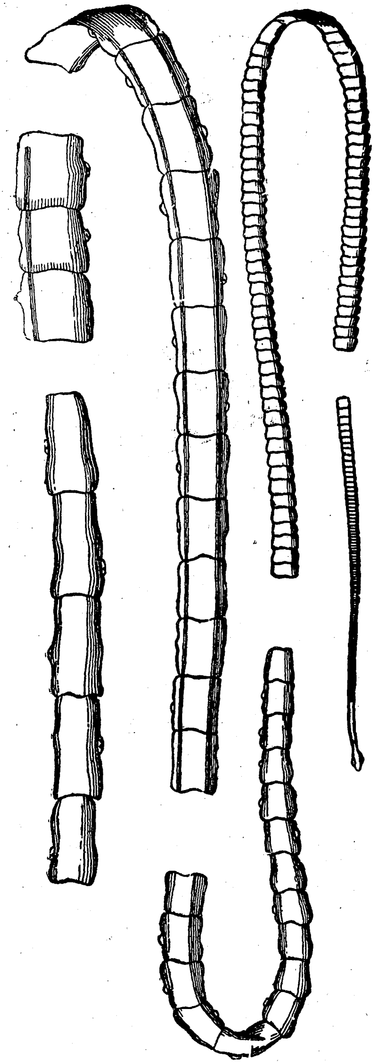

FIG. 16. Tape worm. (Taenia solium)—natural size.

As a rule, it is best to condemn all cases of pork measles; however, some very slightly infected cases might be partially saved by cutting away all infected parts and cooking thoroughly all the apparently non-infected parts. *More than one per cent.* of the hogs slaughtered at Montgomery during the first three months of this year were infected with *cysticercus cellulosæ* (measles).

CÆNURUS CEREBRALIS.

This is the cystic stage of the *tænia cœnurus.* The adult tape-worm is usually found in the alimentary canal of the dog. It is claimed that the segments of the adult tape-worm pass into the alimentary canal of the sheep or other animals with the food; the shells of the ova are dissolved by the gastric juice and the embryos are set free; they penetrate tissues and by some method (possibly in the blood current) reach the brain or spinal cord. In the brain or on the surface of the brain or spinal cord, they develop the vesicles or cysts which sometimes become very large. These cysts produce the disease known as "gid" or "turnsick." The derangement in the action of the brain is a result of the pressure of the cysts upon the brain or nerve centres. As a rule, these cysts call only for condemnation of the head and other parts that are involved. There have been a few cases recorded where man has been infected but these cysts are most commonly found in sheep and occasionally in the ox, the goat, the horse and rarely in man.

THE BLADDER WORM.—*Cysticercus Tenuicollis.*—This is the larval form or cystic stage of the *tænia marginata* of the dog. The cystic stage is found in the ox and sheep and sometimes the pig. The cysts are large bladder-like vesicles located in the peritoneum and sometimes the pleura and pericardium. They gain entrance to the abdomen by way of the liver. Some cysts have been seen as large as a hen's egg.

The organs or parts involved are cut away and condemned and the balance of the carcass is passed.

Cysticerus pisiformis is the cystic stage of the *tænia serrata* of the dog. The cysts are developed in the peritoneum ; the embryos pass through the liver and thus produce serious lesions in the body of the rabbit.

ECHINOCOCCUS VETERINORUM.

The echinocci are the cystic forms of the *tænia echinococcus* of the dog. The cysts are found most frequently in the liver and lungs of the pig, the ox, sheep, and goat, and sometimes in man. The wall of the echinococcus cyst possesses two distinct membranes; the external one is quite thick and is composed of a number of concentric layers ; the internal one is the germinal membrane and is very thin. The cysts may contain a number of heads of the *tænia echinococcus.*

In all cases the parts or organs involved are cut away and condemned. This parasitic cyst has been observed at the new Montgomery slaughter house quite frequently. During the first three months of 1897, two and one-half per cent., of all the hogs slaughtered contained echinococcus cysts—the liver being most frequently infected.

TAPE WORMS.—The adult tape-worms are not very frequently found in meat-producing domestic animals. The *tœnia expansa* (lately classed as *Moniezia expansa* by Stiles) may be found in cattle and sheep, goats and deer.

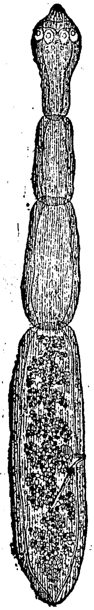

Fig. 17—Tape worm. (Tænia echinococcus,) magnified.

A B

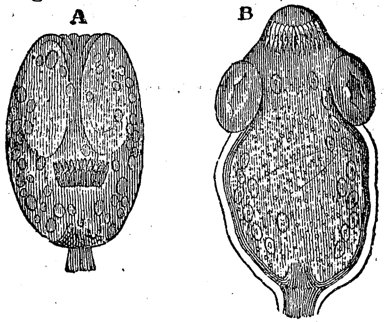

Fig. 18—Echinococcus veterinorum. *A*. Immature. *B*. Full grown, natural size.

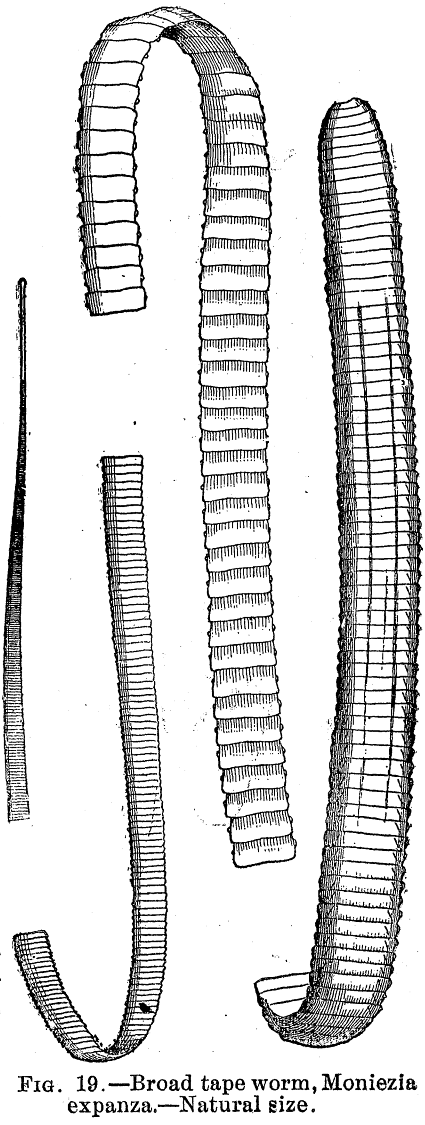

FIG. 19.—Broad tape worm, Moniezia expanza.—Natural size.

Tœnia denticulata or *Moniezia denticulata* may be found in cattle.

Tœnia fimbriata or *Thysanosoma actinoides*, Dies. may be found in the intestines and liver ducts of sheep.

The preceding tape-worms are probably the most common adult forms found in cattle and sheep in America. Many others may be studied by referring to "Bulletin No. 4. A revision of the Adult Cestodes of Cattle, Sheep and Allied Animals" by Stiles and Hassel of the Bureau of Animal Industry.

LIVER FLUKE—DISTOMA HEPATICUM.

This parasite is flattened and leaf-like in outline ; about one inch long and one-third to one-half an inch broad; pale brown in color; at its head end it has a conical neck. This parasite is most frequently found in the liver ducts of sheep in European countries but in Alabama, and in most of the Southern States, it is observed most frequently in the liver ducts of cattle. This is due to the fact that few sheep are bred in the South. The writer has observed these flukes in the pig in one case at the Montgomery slaughter house.

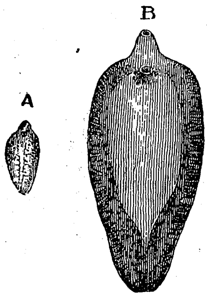

Fig. 20.—Liver fluke worm. *A*, young; *B*, adult form—natural size.

The eggs pass from the biliary ducts to the intestines and thence to the ground; under favorable temperature and moisture the little cap of the "shell" opens and a young embry comes forth ; it is covered with fine hair-like projections that enable it to swim about in the water. It must meet a water snail (Limnæus truncatulus, Raillet) in one or two days or die. If it meets the water snail it bores into the snail and lodges in the respiratory cavity where it contracts into an oval mass (sporacyst) and rapidly develops. This sporacyst divides into five to eight rediæ (about one-twelfth of an inch long; the rediæ escape from the sac and then each redia

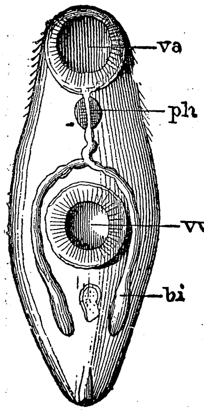

Fig. 21.—Cercaria of fluke worm. *va.* head sucker; *vv*, abdominal sucker; *ph*, throat; *bi*, intestines

in its turn develops from 15 to 20 cercariæ within itself and these escape through an orifice under the neck of the redia. The cercariæ escape from the body of the water snail and then each one becomes encysted; at this stage it may swallowed by a sheep, an ox, or goat; and the cyst will be broken open in the stomach or small intestine and finally the parasite makes its way into the biliary ducts where it develops into a mature fluke. About 75 flukes may develop from one egg. Yet many are lost in the round of life before they reach maturity.

There are other species of flukes some of which may be present in this State.

A liver infected by flukes should be condemned. Only a few cases have been observed at Montgomery .

NEMATODES OR ROUND WORMS.

Trichina Spiralas.—As a rule, the adult form of this parasite is found in the intestines and the larval form is found mainly in the muscles. The adult male is one-twentieth of an inch long and the female one-tenth to one-sixth of an inch long. The larvæ in the muscles are about one-twenty-fifth of an inch long. In the mucles the larvæ are encysted usually in the sarcolemma; there may be from one to four larvæ in a cyst. In these cysts, they may retain their vitality for a long time; in the pig from 8 to 11 years and in man for 24 years or more.

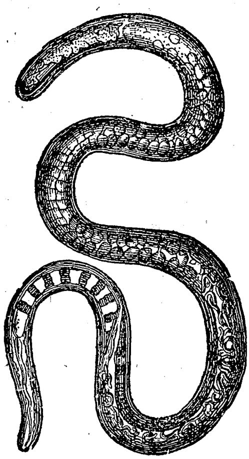

Fig. 22.—Pork worm. Female—mature form much enlarged. (*Trichina Spiralis.*)

The embryos are found in the intestines of man or some vertebrate animal; the adult female brings forth living embryos—not eggs. These embryos begin to be "born" in about seven days after the infected meat has been eaten; the juices of the stomach and intestines dissolve the cysts and set free the larvæ which soon develop into adults that begin to produce embryos. The embryos soon begin to migrate or emigrate and this period continues for nine or ten days they pass through the intestinal walls and then into the involuntary muscles of the body where they become encysted. It requires from one to four months from the time of eating the infected meat until the encysting stage is completed.

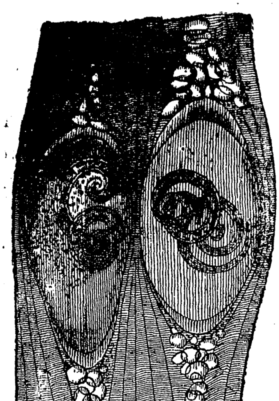

Fig. 23.—Pork worm—encysted form in muscle magnified.

Many times the capsule of the cyst becomes infiltrated with lime salts; this may occur in three months or one and a half years; it hides the trichina. The trichina themselves may become infiltrated with lime salts or may undergo fatty degeneration.

During the period of migration of the embryos the host experiences the pains of trichinosis, a disease something like rheumatism; in many cases it causes death in man and it is possible that it may kill hogs. The hog becomes infected by eating infected meats. Man contracts the disease by eating infected pork. The encysted larval stage has been observed in man, the rat, mouse, hog, guinea pig, rabbit, dog, horse, calf, bear, mole, fish, etc.

All pork should be examined microscopically for trichina. Bausch and Lomb of Rochester, N. Y., make a "trichina microscope" which is very useful and cheap. They also make a "compressor" that is handy and useful. Small pieces from the psoas muscle, from the muscular pillars of the diaphragm, from the inner aspect of the shoulder should be examined. Small pieces of these muscles are "teased" out upon the compressor glass and then pressed into a thin layer in the compressor. Now they are ready for examination under a two-thirds inch objective. Some inspectors examine pieces from 10 different muscles of the body. In Prussia, 1 hog in every 1,000 is found to be infected with trichina; in America the per cent. is said to be 3 to 4 per 1,000. The number of cases observed in this State have not been sufficient to give the percentage of cases. However, sufficient cases have been found at Montgomery to justify a microscopic examination of all the work.

It is well to note here that none of the big packing houses of the North or West have the pork that they sell in the South inspected microscopically for trichina. It would be best for Alabama to pass a law excluding all such pork from her markets. As it is, the people of Alabama consume the meat, from these large packing houses, without any assurance that it is pure and healthy.

Measly pork should be condemned. Some assert that it could be passed if it is well cooked under the supervision of the inspector; this, however, is objectionable because the quality of the meat is very poor and the numerous cooked larval trichina in such meat are not stimulating to the appetite nor very nutritious. It is stated by some that when the trichina cysts and the trichina are calcified the meat is innocuous; this would be true if all the parasites were dead. It is always questionable whether all are dead or not. Then the great amount of lime salts in the muscles would seriously interfere with the quality of the meat.

Hence, as a rule, it is best to condemn all pork infected with trichina.

KIDNEY WORM—*stephanurus dentatus.*

This nematode is very common and is found in the fat around the kidneys, in the substance of the kidneys and in the liver. Out of 964 hogs examined at the Union Slaugter House in Montgomery, during January, February and March, 1897, 302 were infected with this parasite. As a rule, it was confined to the fat, but in many instances it had penetrated the kidneys and liver doing considerable injury to these organs. The male is about one inch, and the female is about one and a half inches long. It was suggested at one time these nematodes were important factors in the cause of hog cholera; but it is now quite certain that they have nothing to do do with the production of that disease. It has also been suggested that they produce paralysis of the hind limbs in hogs; this has not been verified; it is simply a theory.

The parts infected should be cut away and condemned; the balance of the carcass should be passed if otherwise in proper condition.

PARASITIC WORMS INFECTING THE LUNGS.

Strongylus micrurus.—This is a hair-like round worm, 1 to 3 in. long. It is found in the wind-pipe and small air tubes of the lungs. These parasites cause difficult breathing, coughing, an extra flow of mucus from the air passages and sometimes suffocation in calves.

The parts infected should be condemned and if the calf is greatly emaciated and shows signs of this disease at the *ante-mortem* examination it should be prohibited from going to the slaughter.

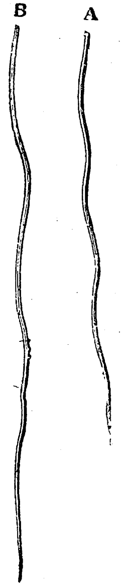

FIG. 24. *Strongylus micrurus.* A. male. B, female—natu ral size.

Strongylus filaria.—This is a very small nematode worm; the female is about $\frac{1}{3}$ of an inch, and the male $\frac{1}{4}$ of an inch long. They infect the small air tubes in the lungs of sheep.

Strongylus rufescens or *Strongylus ovis-pulmonalis.*—The male is about 1 inch and the female about $1\frac{1}{2}$ in. long. These hair-like round worms infect the extreme ends of the air tubes in the lungs of sheep and there break down the tissues and become encysted, producing tubercular enlargements that might be mistaken for the tubercles of consumption or tuberculosis. The finding of the parasite will always prevent one from calling the disease tuberculosis.

These parasites produce trouble similar to that caused by the small worms in the lungs of calves. The disease is sometimes called *verminous pnemonia.*

If the sheep is in good condition, the parts infected should be cut away; but if it is in poor condition, ematiated and weak, condemn it at the *ante-mortem* examination.

Strongylus paradoxus.—The male is one in. and female 1 to $1\frac{1}{2}$ inches long. They are small hair-like round worms found in the air tubes of the lungs of the pig.

Condemn the parts involved. About 25 per cent. of the cases examined at the Union Slaughter House in Montgomery were infected.

Strongylus commutatis.—This is a small round worm found in the bronchi (air tubes) of the lungs of rabbits and hares.

ŒSOPHAGOSTOMA COLUMBIANUM.

This is a small nematode found in the intestines of sheep and cattle. The adult worm ($\frac{1}{2}$ to $\frac{2}{3}$ in. long) lives in the first portion of the large intestine. But the larval stage is found beneath the mucus membrane of the intestines where it produces tumors varying in size from that of a pin-head to that of a hazel-nut. In the early stages these tumors may be more or less soft, but they become infiltrated with lime salts and sometimes the parasite is destroyed by this infiltration. Indeed it is very difficult to find the small parasite. The hard tubercular nodules may be scattered along the small and large intestines in variable numbers and sizes, and might be mistaken for tuberculous nodules.

If the animal is in good condition otherwise, condemn only the parts infected.

THE SPINE HEADED WORM—*Echinorhynchus Gigas.*

This is a very large round worm that infects the intestines of the pig. The male is about 4 in. and the female 12 in. long. This parasite penetrates the mucus membrane of the intestine with its head and this causes considerable irritation and inflammation. Sometimes they produce small abscesses around the head which project above the outer surface of the intestine. Again they may cause complete perforation of the intestine and thus produce peritonitis which results in the death of the pig.

The larvæ of this parasite live in the larvæ of the June-bugs or May-beetles (*Melolontha vulgaris.*)

Condemn the parts infected.

Ascaris lumbricoides (varieties-*vitula* in the ox and *suilla* in the pig).—The former variety is not very common; but the latter is very frequently found in the intestines, stomach and liver ducts of the pigs. According to most authorities this parasite requires no intermediate host; the eggs pass out and infect the pastures, pens, etc.; and other animals become infected by eating food upon or in which the eggs are found. It is said that an infected lot or pen may be disinfected by using kainit or lime. These nematodes are from 7 to 10 inches long. Condemn the parts infected.

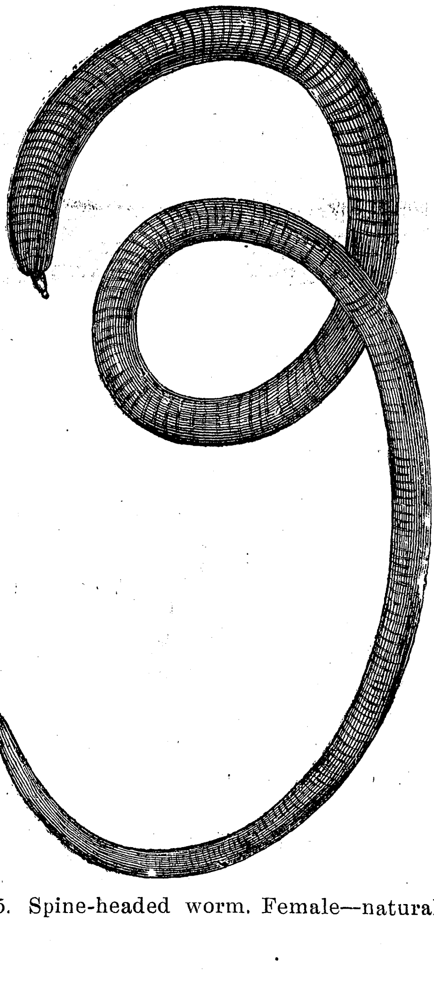

FIG 25. Spine-headed worm. Female—natural size.

Lingulata tænoides and *L. denticulatum*.—This parasite is usually found in the nasal passages of the dog, but has also been found in the nasal passages of the horse, mule, sheep, goat and man. It has been observed in this State most frequently in the liver of cattle, and, in two cases, in the liver of the rat. Its natural host is the dog. It is said to have been observed in the lungs and intestines of sheep and cattle. The parts infected should be condemned.

The following is the Meat Inspection law as it was passed by the City Council of Montgomery in September, 1896. Of course, it would not be applicable to many of our smaller towns and cities. However, if any of the towns or cities desire to inaugurate a system of meat or milk inspection, the Veterinarian of the College and Station will do all he can to aid them in formulating a meat inspection law and in establishing the work. Montgomery is proud of her efficient system of inspection. In some respects Montgomery has the most thorough and efficient meat inspection of any city in the United States:

AN ORDINANCE

To further regulate the slaughter of cattle for sale in the city of Montgomery.

Section 1. Be it further ordained by the City Council of of Montgomery, as follows: That an ante-mortem examination of all animals shall be made. Any animal found to be diseased or in a condition unfit for human food shall be marked by placing a metal tag in the ear bearing a serial number and "Condemned, Montgomery, Ala.;" the condemned animal shall also be marked with yellow paint in letters not less than four (4) inches long and wide, with the legible word "Condemned." Condemned animals shall be placed in pens set apart for this purpose, and removed only by a numbered permit signed by the inspector to that part of the abbatoir or to rendering works designated by the inspector, where they shall be killed under the supervision of the inspector and rendered in such a manner as to make their products unfit for human food.

Sec. 2. Be it further ordained. That all animals rejected on account of their pregnant or parturient condition shall be held in special pens during gestation and for ten days thereafter, unless removed by permit for stockers or for rendering in the same manner as specified in Section 1 for condemned animals.

Sec. 3. Be it further ordained. No animal shall be allowed to pass to the slaughter room until it has passed the ante-mortem inspection. All animals found on either ante-mortem or post-mortem examination to be affected with any of the following diseases or conditions are to be con-condemned and their carcasses treated as specified in Section 5:

1. Hog cholera.
2. Swine plague.
3. Anthrax, including Symptomatic Anthrax (black leg).
4. Rabies.
5. Malignant epizootic catrarrh.
6. Pyaemia and septicaemia.
7. Mange or scab in advance stages.
8. Actinomycosis (lump-jaw) in advanced stages.
9. Inflammation of the lungs, the intestines or the peritoneum.
10. Texas fever.
11. Tuberculosis, extensive or generalized.
12. All animals in an advanced stage of pregnancy or which have recently given birth to young.
13. Any disease or injury causing an elevation of temperature, or affecting the system of the animal to a degree which would make the flesh unfit for food.
14. Carcinomas (cancers) or malignant sarcomas, or any form or kind of tumors where extension (metastasis) has taken place to such a degree that the flesh is unfit for human food.

Sec. 4. Be it further ordained. That any organ or part of a carcass badly bruised or so diseased that the balance of the carcass is not affected, said organ or part shall be cut away and condemned.

Sec. 5. Be it further ordained, That all animals slaughtered shall be inspected at the time of slaughter by the inspector or his assistant. The head and internal organs of each animal shall be held until the inspection is completed, in order that they may be identified in case the carcass is condemned. If the carcass of any animal on ante-mortem or post-mortem examination be found diseased and unfit for human food, said carcass shall be marked with a yellow condemnation tag, and the sides, shoulders and quarters slashed and mutilated. The entire carcass, with the head, organs and the parts thereof, shall be removed under the supervision of the inspector, or his assistant, to tanks, deposited therein and rendered in such a manner that it cannot be withdrawn or used in any way as human food.

(a.) In cases where only a portion of the carcass is condemned, the condemned part may be cut away and sent to the rendering tank.

(b.) The inspector or his assistant shall remove the stub of the yellow condemnation tag at the time of placing the carcass or part of carcass into the rendering tank, and return said stub to the inspector's office, with a report of the number of carcasses and parts of carcasses destroyed, the reason for their destruction, and also state that they were tanked in his presence.

Sec. 6. Be it further ordained, That all hogs that are to be slaughtered shall be marked by placing a metal tag in the ear bearing a serial number and the words "Montgomery, Ala."

Sec. 7. Be it further ordained, That the microscopic inspection of pork shall be conducted as follows:

When the slaughtered hog is passed into the cooling room, or at the completion of the post-mortem examination, the inspector or his assistant shall take from each carcass three samples of muscles, one from the "pillar of the diaphragm," one from the psoas muscle, and the other from the inner aspect of the shoulder, and said samples shall be put into a self-locking tin box, and a duplicate number of the ear tag shall be put into the tin box with the samples. The tin boxes containing the samples are to be taken or sent to the microscopic room for microscopic examination, together with the numbers of all the carcasses from which samples were taken. The inspector or his assistant shall, as soon thereafter as possible, make a microscopic record of the results of all the microscopic examinations.

Sec. 8. Be it further ordained, That all carcasses found by microscopic examination to be affected with trichina, shall be disposed of as condemned carcasses, or they may be rendered into edible lard, at a temperature of not less than 150 degrees Fah., or made into cooked meat products if the temperature is raised to the boiling point a sufficient time to thoroughly cook the interior of the pieces. Any of these methods of disposing of the carcasses must be conducted under the supervision of the inspector or his assistant.

Sec. 9. Be it further ordained, That all meats delivered to the market or anywhere else in the city, shall be delivered in closed wagons, which wagons shall be thoroughly cleansed each day, under the supervision of the inspector.

Sec. 10. Be it further ordained, That the market clerk shall inspect all meat before it is delivered into the market for sale, and see that it is properly tagged and approved by the inspector.

Sec. 11. Be it further ordained, That all animals shall remain at the slaughter house stock yards not less than thirty-six hours prior to the time of slaughter.

Sec. 12. Be it further ordained, That any person, firm or corporation convicted for violating any of the provisions of this ordinance, shall be fined not less than one nor more than one hundred dollars.

The towns and smaller cities should not get the idea that it is necessary to have a large number of inspectors and apparatus in order to conduct a system of meat inspection. In Germany the inspector for the villages and towns is not, as a rule, a veterinarian or a medical man; but a man of average intelligence, who has been taught to recognize the well marked diseases and prominent diseased organs and tissues, and to examine pork for trichina. I would suggest that the examination of the pork for trichina be left to some local physician. It would rarely take more than one-half hour of his time per day. To secure a qualified man to inspect the animals "on foot" and at the slaughter, would be a little more difficult. However, this might be overcome by getting some moderately intelligent man to make some preparation for such work by coming to Auburn to study that special work and by visiting the Union Slaughter House in Montgomery, to see a somewhat extensive and very complete practical application of meat inspection.

The following works were consulted in the preparation of this Bulletin:

Friedberger and Fröhner's "Pathology and Therapeutics of Domestic Animals."

Diseases of Cattle, by the Bureau of Animal Industry.

Hog Cholera, by the Bureau of Animal Industry.

Swine Plague, by the Bureau of Animal Industry.

Bulletin No. 7, Bovine Tuberculosis, by the Bureau of Animal Industry.

Animal Parasites of Sheep, by the Bureau of Animal Industry.

Texas Fever, by the Bureau of Animal Industry.

Bulletin No. 4, Revision of Cestodes, by the Bureau of Animal Industry.

Nocard's "Animal Tuberculosis."

Neumann's "Parasites and Parasitic Diseases of Domestic Animals."

Walley's "Meat Inspection."

Ostertag's "Handbuch der Fleichbeschau."

Ostertag's "Zeitschrift fur Fleich-und Milch-hygiene."

McFadyean's "Journal of Comparative Pathology and Therapeutics."—Vol. IX, June, 1896.

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Annual Reports of Massachusetts Cattle Commissioners.

Annual Reports of Illinois Cattle Commissioners.

Annual Reports of Delaware Experiment Station.

Deutsche Zeitschrift für Thiermedicin.

Berliner Thierärtzliche Wochenschrift.

Bulletin	No.	127, North Carolina	Experiment	Station.
"	"	37, Missouri	"	"
"	"	63, Indiana	"	"
"	"	51, Minnesota	"	"
"	"	47, Nebraska	"	"
"	"	32, Delaware	"	"
"	"	67, Alabama	"	"
"	"	65, Cornell University	"	"
"	"	29, Iowa	"	"
"	"	41, Mass. Agr'l College	"	"

Abbot's "Principles of Bacteriology."

Sternberg's "Bacteriology."

Vaughn-Novy "Ptomaines and Leucomaines."

The veterinary department of the A. and M. College and experiment station manufactures *tuberculin* and *mallein* These diagnostic agents will be furnished free to graduate veterinarians and medical men who will send us detail reports of all tests made with them. In all cases send for tuberculin just before you are ready to use it and state the number of animals you wish to test, and who is to conduct the test. Full directions for using tuberculin may be found in Bulletin No. 67 of the Alabama Experiment Station.

Reports of, or correspondence on, any diseases that may occur among domestic animals in Alabama should always be directed to the Veterinarian of the A. and M. College and experiment station, Auburn, Ala.

BULLETIN No. 82. MAY, 1897.

ALABAMA

Agricultural Experiment Station

OF THE

AGRICULTURAL AND MECHANICAL COLLEGE,

AUBURN.

CORN, COW-PEAS AND WHEAT-BRAN FOR FATTENING PIGS.

J. F. DUGGAR, Agriculturist,

MONTGOMERY, ALA.:
THE BROWN PRINTING COMPANY, PRINTERS
1897.

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☞ The Bulletins of this Station will be sent free to any citizen of the State on application to the Agricultural Experiment Station, Auburn, Alabama.

CORN, COWPEAS, AND WHEAT BRAN FOR FATTENING PIGS.

By J. F. Duggar.

PORK PRODUCTION IN ALABAMA.

The low price of cotton in the last few years makes more imperative than ever before the necessity of producing on the farm the food required by laborers and teams engaged in the cultivation of our great staple crop. Home production of corn, hay and pork has increased in recent years. Yet there is still room for improvement, especially in the production of pork. With the hope of aiding in this important industry, the Agricultural Department of this station has begun a series of experiments in feeding pigs.

Why a state with such agricultural resources as Alabama should fail to produce all of the pork consumed within her borders has not been satisfactorily explained, although several causes have been mentioned in partial explanation. The risk of loss from hog cholera and the fact that corn is generally higher in price here than it is in the Northwest are usually mentioned as the chief hindrances to the upbuilding of the swine industry in the South.

As regards disease, the counties in which hogs are kept under fence are probably not more frequently and disastrously visited by cholera than are states where the hog is one of the main sources of farm revenue. While most veterinarians regard treatment as practically useless, all agree that precautions can be taken to check the rapid spread of the disease.

The higher price of corn here than in the Northwest by no means proves that the cost of raising hogs is so much greater here as to justify the neglect of the swine industry and the importation of a large proportion of the pork consumed in this State. There is no law, save that of custom, that the hog shall live on corn alone. There are partial substitutes abundantly and cheaply produced in the South. Among them are almost continuous pasturage, cowpeas grown as a renovating crop, peanuts, sweet potatoes and several other crops which may be harvested by hogs.

There is even reason to believe that in addition to the growing of meat for use on the farm and to supply local butchers, the production of pork for the packing companies can be made a profitable industry in some parts of the State. This, however, is possible only with an increased interest in methods of feeding, and with a wider appreciation of the value of the improved breeds.

The following extracts from a letter received in answer to inquiries by the writer bear on the possibilities of commercial pork production in Alabama:

Birmingham, Ala., Jan. 19, 1897.

J. F. Duggar,
Professor of Agriculture,
Agricultural and Mechanical College,
Auburn, Ala.

Dear Sir ;—

* * * "At the present time we are buying all of our packing hogs in Tennessee, shipping same to this point on the railroad, and have always done so on account of the inferior hogs raised in this State. The breeds of hogs we usually get from Tennessee are Berkshire and a cross between the Berkshire and Poland China. * * * The best hogs for packing purposes weigh from 175 to 250 lbs., and are barrows and the sows that have never been with pig. The above are live weights. * * * In regard to prices, they vary

at all times, and no rule can be set down as to when hogs will be cheap or high, but for the last year they have been cheaper than for the past twenty years. * * * * The price on good corn fed hogs, f. o. b., Birmingham, is 3 cents gross weight. * * *

"There is no reason why this industry should not grow to immense proportions in this section of the Union, and instead of buying pork from the West, we should be able to supply our own wants and ship to the Eastern markets. * * The past year has been a very bad year for those that have raised hogs; when hogs are bringing 5 cents gross, as they very often do, the profit must be very good."

Yours truly,
Birmingham Packing Company,
Per C. H. U.

OBJECTS OF THE EXPERIMENT

The experiment described in this bulletin, which was one of three tests conducted in the fall and winter of 1896-97, relates to only a small portion of the general subject of pork production. In this experiment our cheaper class of foodstuffs, viz., those harvested by the hogs themselves, are not considered. For this reason, and for other reasons mentioned later, the cost of growing a pound of pork, as recorded here, is not published as being the minimum, nor even as being as low as the average swine breeder, working under ordinary conditions, can show.

The object of the experiment was to learn the relative values of corn, cowpeas, and wheat bran as food for growing pigs. In the following pages comparisons will be made between these foodstuffs:

(1) As regards the amount of increase in weight made by pigs fed on the different rations.

(2) As regards the cost of the pork produced, and

(3) As regards the effects of the several materials on the quality of pork, on the size of the internal organs and general health of the pigs, and on the quality of manure produced.

THE PIGS USED IN THIS EXPERIMENT.

Twelve pigs, divided into four lots of three pigs each, were used in this experiment. They were all sired by the same Essex boar and were out of two Essex sows, reputed to be thoroughbred, and very closely related. With two exceptions the pigs were quite uniform in size, age and appearance.

The conditions of the experiment were in some respects unfavorable to the attainment of best results. The pens were so arranged that it was necessary to catch the pigs and carry them to the scales for their weekly weighings. Such disturbances always interfere with rapid fattening. The only shelter was a single layer of 12-inch boards without battens, affording but little protection from rain. The unvaried diet, necessary in such tests as these, tended to make the gain less than it would have been if the food had been occasionally changed as a means of improving the appetite.

When the first period of the experiment was begun, August 23, 1896, one litter of pigs was a little less, the other a little more, than five months old, and all were quite small for that age, the lot averaging only 46.8 pounds in weight. Prior to the experiment they had received very little grain, having lived chiefly on what was afforded by scant pastures and woodland, supplemented by green sorghum during the month just preceding the experiment.

Details of feeding and weighing were carried out under the immediate charge of Mr. T. U. Culver.

August, 26, 1896, the twelve pigs were divided into four lots, making the lots as nearly equal as possible in weight and appearance, and distributing the sexes as evenly as possible. That the lots were quite evenly matched, is shown by the fact that the heaviest and lightest lots differed by only 6.2 lbs.

To learn whether the several lots were evenly matched in feeding and fattening qualities as well as in weight, all lots were fed on the same kind and amount of food for twenty-one days. During this time, which we shall call Period I, each pen received daily 6 lbs. (2 lbs. per head) of shelled corn. The pigs, taken from pasture and put on an exclusive corn diet, fattened rapidly and made quite an economical gain. For every pound of gain in live weight Lot I required 3.57 lbs. of corn ;Lot II, 2.92 lbs ; Lot III, 3.32 lbs ;and Lot IV, (average for two pigs), 3.14 lbs. of corn.

Although the results are not strictly uniform for the several lots, they indicate that the different lots were fairly well matched.

THE RATIONS FED.

After three weeks of exclusive corn diet each lot of three pigs was given a different ration, beginning Sept. 16. The first week on the new rations was not regarded as a part of the experiment proper, but as a preparatory period during which the pigs might get accustomed to their new diet, and during which time the corn fed in the preceding period might be entirely eliminated from the body.

Hence Period II began Sept. 23, one week after the rations had been changed. During Period II, lot 1 was fed entirely on corn, lot II exclusively on cowpeas, lot III on equal weights of corn and cowpeas, and lot IV on equal weights of corn and wheat bran.

These rations were continued for seventeen weeks (from Sept. 16, 1896, to Jan. 13, 1897), before the experiment was closed. Indeed, the same feeding was continued after the close of the feeding experiment until every pig was slaughtered, the last one going to the butcher Feb. 23, 1897, after eating cowpeas alone for more than five months, without change.

Prior to Nov. 4 the corn, cowpeas and mixed rations were fed without grinding. After that date corn and peas for all pens were very coarsely ground. All rations were fed twice daily in the dry condition. This was done not because dry feed was regarded as best, but for convenience in weighing back any food left uneaten in the troughs. The plan was to give each pen all that could be eaten, but the pigs could doubtless have been induced to eat more, and hence to fatten more economically if the changes in amount of food offered had been more frequently made.

With the exception of a few weeks, all pens received daily with their food about half a teacup full of a mixture made up of sulphur, hardwood ashes, charcoal, and one part of sulphate of iron (copperas) to about thirty parts of the other constituents. The sulphate of iron was added to the usual ash mixture on the recommendation of Dr. C. A. Cary, Station Veterinarian, as a remedy for the large worms which abounded in the intestines of the pigs.

AMOUNT OF FOOD PER POUND OF INCREASE IN LIVE WEIGHT.

The following table shows the gains made during the sixteen weeks of Period II, the total amount of food eaten in the same time, and the number of pounds of food required to produce one pound of increase in live weight.

Summary for 16 weeks showing food eaten, gain, and pounds food per pound of increase in live weight.

	Food eaten	Total gain.	Food for each lb. of gain.
	Lbs.	*Lbs.*	*Lbs.*
Lot I. Corn................	844.2	173.3	4.87
Lot II. Cowpeas............	954.2	198.0	4.81
Lot III.. { ½ corn.......... ½ cowpeas......	908.7	209.5	4.33
Lot IV. { ½ corn .... ½ wheatbran.....	1044.4	203.0	5.21

The lot receiving equal parts of corn and cowpeas made slightly the largest gain, and required least food to produce a pound of increase in weight.

Judging by the quantity of food eaten, the ration consisting of corn and wheat bran was most palatable. This last ration, however, was least effective, pound for pound. The figures just given show that a mixture of equal parts of corn and cowpeas was more effective, pound for pound, than an equal weight of either corn or cowpeas.

This, at first, looks contradictory; yet it is not so when we recall that the animal needs rather a balanced ration than one excessively rich in nitrogenous material, like cowpeas, or than a ration especially rich in starchy or carbonaceous material, like corn. In the mixture each material has probably been made more effective by the presence of the other. In the superiority of a mixture of foods of such opposite qualities over either food alone there is some slight similarity to the well known fact that a mixture of three fertilizers, as acid phosphate, cotton seed meal and kainit, often prove superior to an equal weight of either one applied alone.

A striking example of the increased efficiency resulting from balancing a ration by mixing two unlike foodstuffs rather than feeding either alone is found in the results of certain American feedings experiments, which show that at usual prices in dairy districts there is greater economy and greater efficiency of food materials in feeding corn and skim milk than in feeding exclusively on either.

DIGESTIBLE MATTER IN THE SEVERAL RATIONS.

Not only was a pound of gain made with least weight of food when a mixture of cowpeas and corn was supplied, but also with the least weight of digestible matter.

The greater efficiency of a pound of digestible matter in the mixed or balanced rations is shown in the following table.

Digestible matter consumed in 16 weeks, pounds digestible matter per pound of gain, and nutritive ratio.

	Food eaten.	Digestible.	Digestible matter	Gain in live weight	Pounds digestible matter per lb. of gain.	Nutritive ratio.
	Lbs.	*Per cent.*	*Lbs.*	*Lbs.*	*Lbs.*	
I.	844.2 corn	79	667.	173.3	3.85	1 to 9.7
II.	954.2 cowpeas...	77*	735.	198.0	3.71	1 to 2.6
III.	454.3 corn..... 454.3 cowpeas ..	79 77*	708.	209.5	3.38	1 to 6.2
IV.	522.2 corn....... 522.2 wh. bran..	79 56	704.	203.0	3.46	1 to 6.8

* Calculated, using digestion percentages (coefficients) obtained when Canada peas, a closely related food stuff, was fed to swine Tenn. Bul. Vol. IX, No. 3, p. 130 and Expt. Sta. Record, Vol. VI, No. 1 p. 8.

The above table shows that a pound of digestible matter was most effective in the ration of mixed cowpeas and corn, nearly as valuable in a mixture of wheat bran and corn, decidedly less effective in an exclusive cowpea ration, and least valuable in a pound of corn.

As the result of numerous feeding experiments, made chiefly in Germany, a feeding standard has been formulated. According to Wolff's standard the proper nutritive ratio for fattening pigs—(and this is simply the ratio of digestible nitrogen in food to the sum of the digestible starch, sugar, fat, etc., the fat being first multiplied by 2.5 on account of its high fuel value)—is 1 to 5 or 6. In our experiments the digestible matter was most effective in those rations that approached nearest to the German standard: cowpeas, with the very narrow nutritive ratio of 1 to 2.6 and corn with the very wide nutritive ratio of 1 to 9.7, both proved less effective than balanced rations in which the nutritive ratio was 1 to 6.2 and 1 to 6.8.

PRICE OF PORK.

In order to get at the financial returns resulting from the use of different foods, it is necessary to state the price obtained or obtainable for the pork. All the pigs in this experiment were actually sold to a local meat dealer at 3 cents per pound gross. This was slightly less than would have been obtained by selling the carcasses at 5 cents net, a price which was then being paid for dressed pork and a price at which several other carcasses were sold last winter. Five cents per pound net is equal to 3 3-4 cents per pound gross, with pigs which dress 75 per cent of their live weight. In return for the reduced price, the Experiment Station reserved the right to cut from each carcass a section of meat to be photographed.

FINANCIAL RESULTS.

Assuming the prices prevailing in Auburn in the early part of the winter, we have 40 cents as the price of a bushel of corn and 50 cents as the cost of a bushel of cow peas. Wheat bran delivered at the Experiment Station barn cost $15 per ton.

At these prices the cost of one pound of gross increase was 3.35 cents when both corn and cowpeas were fed, 3.48 cents when only corn was given, 3.61 cents when cowpeas were fed alone and also 3.61 cents with a mixture of corn and wheat bran. At the above prices for food stuffs, a combination of corn and cowpeas, equal parts of each, afforded the cheapest gain, and this too in spite of the fact that cowpeas were priced higher, both per pound and per bushel than any other material.

During the three weeks of period II when all pigs, fresh from the pasture, received only corn, the gains were much more rapid than in the later stages of feeding. For the brief period, even with live pigs at only 3 cents per pound, the gain made was sufficient to pay the following prices per bushel of corn fed to the different lots: 46, 54, 50 1-2 and 53 1-2 cents. From this it follows that with corn at 40 cents, even with 3-cent pork, there was a profit during the first period of exclusive corn feeding, the margin of profit varying with the different lots from 6 to 14 cents on each bushel of corn consumed.

During this short period the average of all lots was 17.3 pounds of gain in live weight for every bushel of corn consumed. When exclusive corn feeding was continued, the rate of gain fell far below this figure, the average for the corn-fed pen during the sixteen weeks covered by period II being 11.5 pounds of increase in live weight per bushel of corn.

A better method of comparing the financial results from the several foods is obtained by calculating what prices animals pay for their food. On this basis, we find that with pork at 3 3-4 cents gross, the food consumed was worth for feeding purposes the prices given below:

Financial returns made for food consumed.

Corn, (lot 1.) per 100 lbs. of food, 77 cents; per bushel, (56 lbs.) 43 cents.

Cowpeas (lot II.) per 100 lbs. of food, 78 cents; per bushel, (60 pounds) 47 cents.

Mixture of one-half corn, one-half cowpeas (lot III.) per 100 pounds of food, 86.5 cents.

Mixture of one-half corn, one-half wheatbran (lot IV.) per 100 lbs. of food, 72 cents.

The mixture of equal parts of corn and cowpeas produced pork to the value of 86.5 cents per 100 lbs of food, or about 8 per cent advance over the value of the same foods fed separately. Assuming that this increased efficiency was shared in equally by both constiuents of the mixture, we have a return of 46.4 cents per bushel of corn and 51 cents per bushel of cowpeas when fed in combination.

If we assume a price of only 3 cents per pound gross for pigs, the quotation in Birmingham in January 1896, the prices obtained for the food consumed are correspondingly lowered. On this basis the returns per hundred pounds of food eaten are 62 cents for corn, 62 for cowpeas, 69 cents for a mixture of corn and cowpeas, and 58 cents for a mixture of corn and wheat bran. Only in a year of low prices for foodstuffs would such results be profitable, unless certain indirect benefits of feeding cowpeas, instead of selling them, be considered. An important indirect benefit of feeding, not taken account of in the above figures, is the value of the manure produced, a subject which will be discussed elsewhere in this bulletin.

In the case of cowpeas an important advantage of feeding instead of selling them is that thereby the heavy cost of picking may be saved, the pigs doing the harvesting. In this locality the custom is to pay half the cowpeas for the picking of the same, which is equivalent to saying that when cowpeas command 50 cents per bushel in the market, they are worth on the vines for purposes of sale only 25 cents per bushel.

On this basis of 25 cents per bushel for cowpeas, the lot fed on cowpeas alone makes a pound of pork at a cost of only 1.8 cents, and the lot fed on a mixture of corn and cowpeas makes its gain at a cost of 2.45 cents per pound.

Twenty-five cents per bushel of unpicked cowpeas will not pay for their culture, whether they are picked for half and sold, or pastured off with hogs. However, they are grown chiefly for the fertilizing value of their stems, leaves, and roots, and for this main purpose, with the production of seed as an incidental feature, the cultivation of cowpeas cannot be too strongly commended.

PROPORTION OF FAT AND LEAN MEAT AND SIZE OF INTERNAL ORGANS.

Experiments in several states have shown that it is possible to increase the proportion of lean meat, thereby improving the quality of the pork, by feeding materials rich in nitrogen. To effect this change it is necessary to begin the nitrogenous ration while the pigs are young and to continue it for a long time. In our experiments the ration of each lot was continued without change until each animal was butchered, which in some instances was several weeks after the end of period II. The minimum length of unchanged feeding was 120 days, the maximum (with one of the cornfed lot) 169 * days. On account of financial considerations, the pigs were not slaughtered all at the same time, but on such dates as the local market required them. Hence it was impossible to lay side by side portions of the different carcasses and thus judge directly of the proportions of fat and lean in each animal. Instead, photographs were made of sections of meat taken from representative animals in each lot, and by means of these, comparisons of the character of meat had to be made. This was not an entirely satisfactory method, because cloudy weather sometimes caused delay in taking photographs, and facilities for preserving the specimens in good order by means of refrigeration were wanting.

The cuts of meat selected for photographing were cross sections through the loins. The photographic work was kindly done by Prof. P. H. Mell.

The illustrations in the back of this bulletin speak for themselves. While individual variations somewhat obscure results, it appears that the largest proportion of fat accompanies the all-corn diet.

This evidence of an increased proportion of lean meat as the result of feeding nitrogenous or narrow rations is reinforced by the figures showing weights and percentages of fat found on the stomach and intestines of the pigs of the different lots. With exclusive corn feeding we find the largest percentage of intestinal fat, an average of 2.3 per cent. of the live weight. The lot fed on cowpeas alone showed only about half as much, 1.1 per cent., and intermediate percentages were afforded by the two lots fed on part corn along with some more nitrogenous food stuff. A small percentage of fat on

* Including period I, period II, one week between these periods and several weeks after the conclusion of period II.

the stomach and intestines argues a large proportion of lean meat in the carcass. These facts, as well as the weight and percentages of dressed carcass, liver, lungs, kidneys, spleen, and heart are set forth in detail in table VII in the appendix to this bulletin.

That table shows that the proportion of dressed to live weight was not appreciably influenced by the several food stuffs employed. It also indicates that with the nitrogenous rations there was an increase in the absolute weight of liver, kidneys, heart and spleen and that this increase was marked in the case of the spleen, not only in its absolute weight, but also in its percentage weight.

The general trend of the few experiments bearing on this matter is that by feeding to growing pigs a ration well supplied with protein, (the usual form of the nitrogenous matter of food stuffs,) there is an increase not only in the proportion of lean meat, but also an increase in the weight of many of the internal organs and in the strength of the bones. All these result of judicious feeding tend toward greater vigor, hardiness and increased power of resisting disease.

THE MANURE PRODUCED FROM DIFFERENT RATIONS.

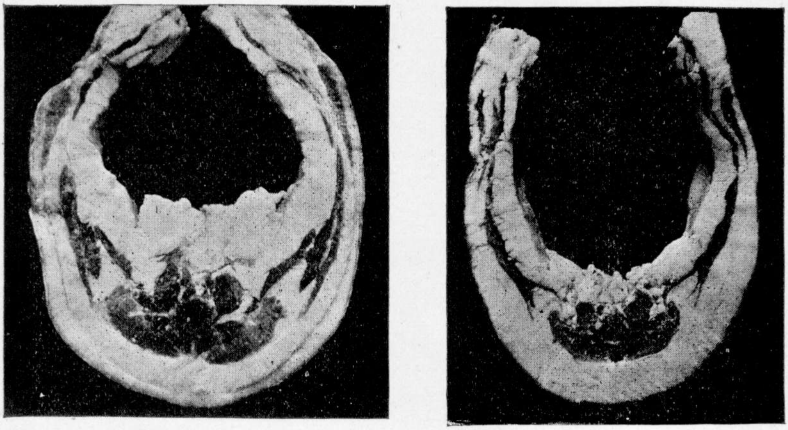
All our common foodstuffs have two values, first as food for the animal body and second as manure, or food for plants. The fertilizing value of the nitrogen, phosphoric acid, and potash that exist in foods is not destroyed by the process of digestion. On the contrary the manure even of milk cows and of growing animals contains considerable more than half of the fertilizing ingredients of the food; fattening animals frequently excrete in solid and liquid excrement fully 90 per cent. of the fertilizing materials originally contained in the food.

To compare the quality of manure produced by the different rations, both the solid and liquid excrements was collected from one pig fed on each ration. The pigs were placed in small stalls with tight floors and pine sawdust was used in sufficient quantity to absorb all droppings. The droppings of 48 hours were collected, the pigs used having first been brought to a constant daily ration of 3 pounds of grain per head.

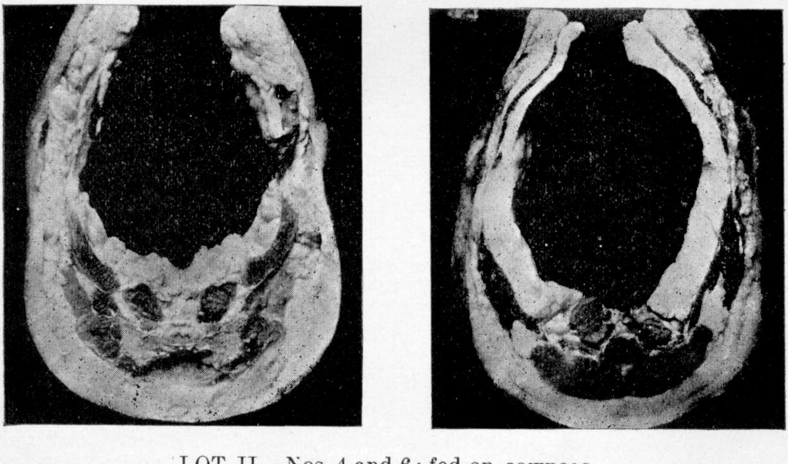
The samples of mixed dung, urine and sawdust and of the sawdust alone were analyzed in duplicate by Dr. J. T. Anderson, of the Chemical Department of the Station. The results detailed in Table I of the appendix to this bulletin are calculated from Dr. Anderson's analyses, first making allowance for the small amount of fertilizing, material contained in the sawdust.

From that table we may see that the pig fed on corn alone made the smallest quantity of manure, the amount of feed being the same as for the other pigs. This is probably due to the fact that animals on a carbonaceous diet consume less water than do those on a nitrogenous ration. The water allowed these pigs was not weighed, but governed wholly by the thirst of the pigs. This greater bulk of manure, due to greater delution with water, in two cases makes the manure from nitrogenous rations poorer pound per pound than that from a corn diet. Yet the total value of the manure produced is considerably greater when the ration consists of cowpeas or of part cowpeas or wheat bran than when only corn is fed.

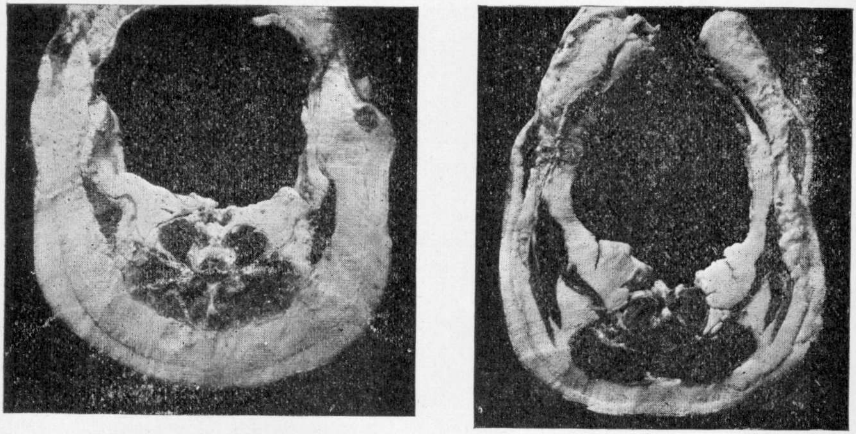
The weight of nitrogen excreted in 48 hours,- and it is nitrogen which is the ingredient that gives to animal manures their chief value,—is nearly 70 per cent. greater in the manure from cowpeas than in that from corn; it is fully 40 per cent. greater in manure from a ration of half cowpeas and half corn than in that from an exclusive corn ration.



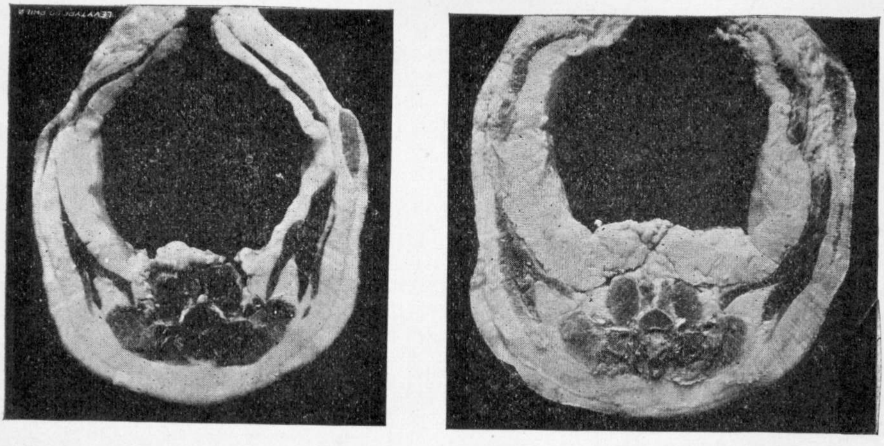
LOT I.—Nos. 1 and 2; fed on corn.



LOT II.—Nos. 4 and 6; fed on cowpeas,



LOT III.—Nos. 7 and 9; fed on a mixture of corn and cowpeas.



NOT IV.—Nos. 10 and 11; fed on a mixture of corn and wheat bran.

APPENDIX.

TABLE I.—*Composition and amount of solid and liquid manure amounts of nitrogen, phosphoric acid, and potash in excrement of 48 hours.*

Lot.	Food.	Nitrogen.	Phosphoric acid.	Potash.	Lbs. solid and liquid manure in 48 hours.	In excrement of 48 hours.		
						Nitrogen.	Lbs. Phosphoric acid.	Potash.
		Per cent.	*Per cent.*	*Per cent.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
I.	Corn	1.358	.966	.659	7.5	.102	.072	.050
II.	Cowpeas	1.467	.885	.642	11.4	.167	.101	.073
III.	Corn and cowpeas	1.141	.724	.296	12.6	.144	.091	.037
IV.*	Corn and wheat bran	1.023	1.219	.353	16.8†	.172	.205	.059

*The results with Lot IV are less reliable than with the other lots; it was necessary to use for analysis only the excrement of 24 hours, instead of 48; moreover, the duplicate nitrogen determinations in this case varied very widely.

†Calculated for 48 hours.

TABLE II.—*Results for Period I; sex and date of slaughtering of pigs used in Period II.*

Lot.	Pig. No.	Weight Aug. 26.	Gain Aug. 26—Sept. 16.	Corn eaten Aug. 26—Sept. 16.	Lbs. corn per pound gain.	Sex.	When slaughtered.
			Lbs.				
I	1	62.5	13			Sow............	Feb. 11, 1897.
	2	36.	13	126	3.57	Barrow.........	Jan'y 29, 1897.
	3	38.7	9.3			Sow............	Jan'y 18, 1897.
II	4	51.	15			Barrow.........	Feb. 4, 1897
	5	46.3	15.9	126	2.92	Barrow.........	Jan'y 13, 1897.
	6	41.5	12.3			Sow............	Feb 23, 1897.
III	7	53.	14.8			Barrow.........	Feb. 4, 1897.
	8	45.2	10.6	126	3.32	Sow............	Jan'y 23, 1897.
	9	45 2	12.6			Sow............	Feb. 12, 1897.
IV	10	52.	14.4			Barrow.........	Feb. 3, 1897.
	11	45.3	12.3	126	3.14*	Sow............	Feb. 10, 1897.
	13*	....	....			Barrow.........	Jan'y 22, 1897.

* No. 13 was not in the experiment until Sept. 16 when he was put in as a substitute for No. 12 which during Period I had proved unfit for the experiment. Results for Lot IV during Period I are calculated from results with Nos. 10 and 11.

LOT I.—CORN.

TABLE III.—*Statement of weekly weights of pigs, food eaten, gain made, and pounds of food per pound of increase in live weight.*

1896–'97. Week ending	Pig No. 1.		Pig No. 2.		Pig No 3.		Total, Lot I.		Food.			Total gain of lot 1 from Sept. 23.	Lbs. food eaten per lb. gain, from Sept. 23.
	Wgt.	Gain.	Wgt,	Gain.	Wgt.	Gain.	Wgt.	Gain.	Offer-ed.	Re-fused.	Eaten		
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Sept. 23	74.7		49.0		49.5		173.2						
Sept. 30	80.2	5 5	50.5	1.5	51.1	1.6	181.8	8.6	84	10	74	8.6	
Oct 7	80.3	.1	52.3	1.8	52.1	1.0	184.7	2.9				11.5	6.43
Oct. 14	83.0	2.7	52.5	.2	52.5	.4	188.0	3.3	36	1.8	34.2	14.8	7.35
" 21	84.3	1.3	53.9	1.4	54.6	2.1	192.8	4.8	38	1.1	36.9	19.6	7.40
" 28	88.6	4.3	54.1	.2	54.5	-.1	197.2	4.4	31	3.1	27.9	24.0	7.20
Nov. 4	94.8	6.2	56.0	1.9	57.5	3.0	208.3	11.1	44.5	......	44.5	35.1	6.19
" 11	101 5	6.7	59.0	3 0	63	5.5	223.5	15.2	46	......	46.	50.3	5.24
" 18	104.6	3.1	64 0	5.0	64.6	1.6	233.2	9.7	54	.....	54.	60.0	5.29
" 25	109.0	4.4	66.5	2.5	68.	3.4	243.5	10.3	56	......	56.	70.3	5.31
Dec. 2	113.0	4.0	69.5	3.0	69.2	1.2	251.7	8.2	56	.....	56.	78.5	5.47
" 9	118.6	4 6	74.8	5.3	74.2	5.0	267.6	15.9	67.5	1.5	66.	94.4	5.25
" 16	124.3	5.7	80.1	5.3	79.2	5.0	284.6	17.0	70	.9	69.1	111.4	5.07
" 23	131.1	6.8	86.5	6.4	83 5	4.3	301.1	16.5	70	......	70.	127.9	4.96
' 30	144.0	12 9	93.3	6.8	92.1	8.6	329.4	28.3	70	.....	70.	156.2	4.51
.n. 6	138.0	-6.	96.2	2.9	93.1	1.0	327.3	-2.1	70	......	70.	154 1	5.03
' 13	151.2	13.2	98.8	2.6	96.5	3.4	346.5	19.2	70	.4	69.6	173.3	4 87

LOT II—COWPEAS.

TABLE IV.—*Statement of weekly weights of pigs, food eaten, gain made, and pounds of food per pound of increase in live weight.*

1896-'97. Week ending.	Pig, No. 4.		Pig, No. 5.		Pig, No. 6		Total Lot II.		Food.			Total gain of lot 1 from Sept. 23.	Lbs. food eaten per lb. gain, from Sept. 23
	Wgt.	Gain.	Wgt.	Gain	Wgt.	Gain.	Wgt.	Gain.	Offer-ed.	Re-fused.	Eaten		
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Sept. 23	64.5	.....	63		52.5	......	180.0						
" 30	67.1	2.6	66.8	3.8	53.3	.8	187 2	7.2	84	....	84		
Oct. 7	72.0	4.9	70	3.2	56.7	3.4	198.7	11.5				18.7	4.49
" 14	76 8	4.8	73.1	3 1	58 7	2.0	208.6	9.9	46	1	45	28.6	4.51
" 21	75.6	—1.2	75	1.9	59.6	.9	210.2	1.6	44	.....	44	30.2	5.72
" 28	80 8	5.2	82.3	7.3	65.3	5.7	228.4	18 2	49	.....	49	48.4	4 58
Nov. 4	88.0	7.2	89 3	7 0	69.7	4.4	247.0	18.6	49	.....	49	67.0	5 59
" 11	92.0	4.0	94	4.7	74.2	4.5	260 2	13.2	53	.....	53	80.2	4.83
" 18	95.1	3.1	109	15.0	78.1	3 9	282.2	22.0	61	......	61	102.2	4 80
" 25	100.1	5.0	105	—4.0	84.4	6 3	285 5	3.3	63	.....	63	105.5	4.38
Dec. 2	101.8	1.7	109.5	4 5	85 0	.6	296 3	10.8	63	.....	63	116.3	4.84
" 9	107.0	5.2	114.5	5.0	88.5	3.5	310.0	13 7	71.5	......	71.5	130.0	5 00
" 16	112.3	5.3	119.5	5 0	92.1	3.6	323.9	13 9	84	....	84	143.9	5.12
" 23	115.5	3.2	117 5	—2.0	96.5	4.4	329.5	5.6	81	3.3	77.7	149.5	5.16
" 30	128.3	12.8	138 1	20.6	104.0	7.5	370.4	40.9	70	.....	70	190.4	4.27
Jan. 6	128.8	--.5	136.8	—1 3	102 1	-1.9	367.7	-2.7	70	.....	70	187 7	4.71
" 13	132.0	3.2	141	4.2	105.1	3.0	378 1	10.3	70	......	70	198.1	4 81

LOT III.—EQUAL WEIGHTS OF CORN AND COWPEAS.

TABLE V.—*Statement of weekly weights of pigs, food eaten, gain made and pounds of food per pound of increase in live weight.*

1896-7. Week ending—	Pig No. 7.		Pig No. 8.		Pig No. 9.		Total Lot III.		Food.			Total gain of Lot III from Sept. 23.	Lbs. food eaten per lb. gain from Sept. 23.
	Wgt.	Gain.	Wgt.	Gain.	Wgt.	Gain.	Wgt.	Gain	Offer-ed.	Re-fused.	Eaten		
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Sept. 23	70.0		56		60.2		186.2	9.4	84	6	78	9.4	
" 30	76.5	6.5	57.8	1.8	61 3	1.1	195.6						
Oct. 7	79.6	3.1	61.0	3.2	63.5	2.2	204.1	8.5				17.9	4.69
" 14	81.0	1.4	61.1	.1	65.6	2.1	207.7	3.6	34	.5	33 5	21.5	5.19
" 21	81.9	.9	59.5	1.6	65.0	-.6	206.4	-1.3	28	......	28	20.2	6.96
" 28	89.7	7.8	63.2	3.7	72.7	7.7	225.6	19.2	44	4.8	39.2	39.4	4.55
Nov. 4	98.0	8.3	64.7	1.5	77.5	4.8	240 2	14 6	46	4	42	54.0	4.09
" 11	107.0	9.0	68 3	3.6	82.5	5.0	257.8	17 6	50	......	50	71 6	3.78
" 18	112.4	5 4	71.5	3.2	88.1	5.6	272.0	14.2	66	10	56	85 8	3 81
" 25	119.1	6.7	71.5	0.0	93.6	5.5	284.2	12.2	70	......	70	98.0	4.04
Dec. 2	127.5	8.4	72 6	1.1	100.5	6.9	300.6	16.4	70	9.7	60	114.4	3.99
" 9	136.5	9.0	76.5	3.9	104.5	4.0	317.5	16.9	77	5	72	131.3	4.02
" 16	145.6	9.1	80.5	4.0	108.5	4 0	334 6	17.1	84	.....	84	148.4	4.13
" 23	151.0	5.4	82.5	2.0	111.7	3.2	345 2	10.6	84	3	81	159.0	4.05
" 30	165.5	14.5	88.7	6.2	122.7	11 0	376.9	31.7	76	1.3	74.7	190.7	4.03
Jan. 6	168.2	2.7	89 3	.6	123.8	1.1	381 3	4.4	70	.....	70	195.1	4 29
" 13	173.5	5.3	95.0	5 7	127.2	3.4	395.7	14.4	70	.....	70	209.5	4.33

LOT IV.—EQUAL WEIGHTS OF CORN AND WHEAT BRAN.

TABLE VI.—*Statement of weekly weights of pigs, food eaten, gain made and pounds of food per pound of increase in live weight.*

1896–7. Week ending—	Pig No. 10.		Pig No. 11.		Pig No. 13.		Total Lot IV.		Food.			Total gain of Lot IV from Sept. 23.	Lbs. food eaten per lb. gain from Sept. 23.
	Wgt.	Gain	Wgt.	Gain	Wgt.	Gain	Wgt.	Gain.	Offer-ed.	Re-fused.	Eaten		
	Lbs.	*Lbs*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs*	*Lbs.*
Sept. 23	68.0		59.5		51.0		178 5		84	......	84	8 0	
" 30	74.0	6.0	63.5	4.0	49.0	-2.0	186.5	8.0					
Oct. 7	76.0	2.0	65.6	2.1	54.3	5.3	195.9	9 4				17 4	4.83
" 14	80.4	4.4	67.3	1.7	57.2	2.9	204.9	9 0	50	.....	50	26.4	5.07
" 21	79.0	-1.4	66 0	-1.3	55.2	-2.0	200.2	-4.7	46	..	46	21.7	8.25
" 28	84.7	5 7	74 0	8.0	63 0	7.8	221.7	21.5	57	3.7	53.3	43.2	5.40
Nov. 4	92.0	7.3	79.3	5.3	65.0	2.0	236.3	14.6	56	.....	56	57 8	5.00
" 11	97.8	5.8	82.7	3.4	71.0	6.0	215 5	15.2	64	......	64	73.0	4.84
" 18	100.6	2.8	88.7	6.0	74.7	3.7	264	12.5	80	6.5	73.5	85 5	4.99
" 25	103.0	2.4	91.5	2.8	77.8	3.1	272.3	8.3	70	...	70	93.8	5 29
Dec. 2	110.7	7.7	96 6	5.1	80.5	2.7	287.8	15.5	70	...	70	109 3	5 18
" 9	116.9	6.2	99 8	3.2	83.0	2.5	309.7	21.9	78	5.6	72.4	131.2	4.87
" 16	123.1	6.2	103.0	3.2	85.5	2.5	313 6	3.9	84	6.6	77.4	135.1	5.30
" 23	132 6	9.5	110.7	7.7	89.3	3.8	332 6	19.0	84	.....	84	154.0	5 13
" 30	142.6	10.0	116 1	5.4	97.8	8.5	356.5	23.9	84	2.2	81.8	178.0	4.95
Jan. 6	145.5	2 9	118.3	2.2	99.5	1 7	363.3	6.8	84	.....	84	184.8	5.22
" 13	151.1	5 6	125 2	6 9	102.5	3.0	378 8	15 5	84	6	78	200.3	5.21

TABLE VII.—*Weight and percentage (live weight=100) of dressed carcass, liver, lungs, kidneys, spleen, heart, and fat on stomach and intestines.*

Lot.	Pig No.	Live. Wgt.	Dressed carcass.	Liver.	L'ngs.	Kid-neys.	Spleen.	Heart	Fat on stom'ch and in-testines	Dressed weight.	Liver.	L'ngs.	Kid-neys.	Spleen.	Heart	Fat on stom'ch and in-testines
		Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	%	%	%	%	%	%	%
I.	1	155.3	125.9	2.10	.70	.20	.10	.40	4.10	81	1 35	.45	.13	.06	.26	2.64
	2	104.0	77.1	1.98	.50	.25	.109	.21	2.30	74	1.90	.50	.25	.10	.20	2.20
	3	100.5	74.5	1.88	.45	.17	.078	.19	2.00	74	1.87	.45	.17	.08	.19	2.00
	Av.	**119.9**	**92.5**	**1.99**	**.55**	**.21**	**.096**	**.27**	**2.80**	**76**	**1.71**	**.47**	**.18**	**.08**	**.22**	**2.30**
II.	4	145.0	109.6	2.50	.50	.34	.171	.32	1.40	76	1 72	.34	.23	.11	.22	.90
	5	141.0	107.3	3.10	.50	.44	.200	.36	1.00	76	2 20	.35	.26	.14	.26	.70
	6	131.0	96.6	2.60	.62	.36	.156	.328	2.50	74	1.90	.40	20	.11	.20	1.80
	Av.	**139.0**	**104.5**	**2.73**	**.54**	**.38**	**.175**	**.336**	**1.63**	**75**	**1.94**	**.36**	**.20**	**.12**	**.23**	**1.10**
III.	7	179.5	135.0	2.50	.60	.38	.156	.39	2.60	76	1.39	.33	.21	.08	22	1.38
	8	96.6	72.7	1.55	.45	.20	.109	.25	2.10	73	1.60	.47	.21	.11	.26	2.17
	9	144.1	111.2	2.11	.61	.34	.140	.33	3.00	77	1.46	.42	.23	.10	.23	2.08
	Av.	**140.1**	**106.3**	**2.05**	**.55**	**.31**	**.135**	**.32**	**2.57**	**75**	**1.48**	**.41**	**.22**	**.10**	**.24**	**1.88**
IV.	10	165.0	126.7	2.70	.64	.34	.133	.34	3.30	77	1.64	.39	.21	.08	.21	2.00
	11	134.8	101.9	3.00	.67	.33	.150	.31	1.80	76	2.22	.49	.25	.11	.23	1 29
	13	110.9	80.4	2.56	.64	.28	.125	27	2.20	72	2.30	.57	.25	.11	.24	1.98
	Av.	**136.9**	**103.0**	**2.75**	**.65**	**.32**	**.136**	**.31**	**2.43**	**75**	**2.05**	**.48**	**.24**	**.10**	**.23**	**1.76**

BULLETIN No. 83. JUNE, 1897.

ALABAMA

Agricultural Experiment Station

OF THE

AGRICULTURAL AND MECHANICAL COLLEGE,

AUBURN.

HYBRIDS FROM AMERICAN AND FOREIGN COTTONS.

P. H. MELL.

MONTGOMERY, ALA.:
THE BROWN PRINTING COMPANY, PRINTERS.
1897.

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CONTENTS.

INTRODUCTION.

The investigations, the results of which are contained in this bulletin, were suggested by the reports made several years since that Egypt and India were fast becoming rivals of the United States in the cultivation and importation of cotton; that the cottons coming to this country from Egypt were in many respects the superior of the native staple, and that there was an increasing demand for the long staple cottons from the country of the Nile.

In the study of these foreign plants much time has been spent in the field watching carefully the growths of the forms during each season so that all of the peculiarities have been well noted and numerous records have been placed on file descriptive of the plants from the seed to the maturing of the boll. This preliminary work was deemed necessary before any crosses were made between them and the native American types. The same methods have been pursued with reference to the hybrids obtained from the blending of the species.

The author is under special obligations to the United States Department of Agriculture for many of the foreign seeds used in the experiments described in this bulletin. Acknowledgements are also made to Professor T. H. Middleton, former Professor of Agriculture of Baroda College, India, but now of University College, Wales, for valuable donations of Indian seeds, and for interesting data concerning the habitat of the plants in their native surroundings. To Mr. E. Madero thanks are due for cotton seeds sent from Mexico, and to Mr. John Musson, C. E. of Sydney, Australia for cotton seeds from that country and for several valuable books and pamphlets on the subject of the Botany of that remarkable section of the world.

HYBRIDS FROM AMERICAN AND FOREIGN COTTONS.

By reference to pages 299 and 300 of volume 4 (bulletin No. 71), it will be noticed that three steps were contemplated in the experiments on these foreign cottons, viz: 1st. To acclimate the plants; 2nd. To secure the best results possible in the health of the plants by careful selection of the seeds, and that the condition of soil and climate would permit; and 3rd. To so blend the best properties of the foreign cottons with those of superior grades of the American varieties as to produce, if possible, an exceptionably fine cotton plant. The contents of bulletin No. 71 are devoted to a consideration of the first two propositions, while this bulletin will discuss the results secured by the 3rd step.

At the close of the season of 1895 several hundred hybrids were obtained by uniting the varieties of American cottons mentioned on page 21 of bulletin No. 56 with the foreign plants discussed in No. 71. These hybrids were planted last season (1896) and 47 forms, more or less successful in results, have been selected for consideration in this bulletin. The others did not present features of sufficient importance to warrant favorable conclusions for the present, at least.

It is a fact well known to parties who have attempted experiments in crossing, that some species widely different in characteristics are difficult to blend, and, even where a hybrid is successfully secured, the resulting plant may not be as desirable as either one of the parents. In other words, the inferior properties of the stronger parent may be intensified in the offspring and the valuable features sought for may be greatly overshadowed by the objectionable characteristics. This work, therefore, requires the exercise of judgment supported by a large amount of experience and knowledge of the peculiarities of the plants to be blended. The experimenter who undertakes to make his hydrids from foreign plants which have not been carefully cultivated two or more seasons to acclimate the forms, and who does not become familiar with the habits of the plants as they grow under the new conditions of soil and environments, will meet with disappointments or at least, with unexpected and undesirable results. The failure to observe the rules largely explains the following undigested publication: "The hybrid difficulty obtained from *Gossypium hirsutum and G. barbadense* is worthless." This conclusion was drawn from experiments conducted for only one year.

Professor Middleton makes the following pertinent comments in a valuable pamphlet on "Indian Cultivated Cottons," page 4, on the effects produced in cotton plants by transferring them from one country to another where the conditions in climate and soil may be materially changed. The experiments conducted at the Auburn Station so fully corroborate there conclusions of Professor Middleton they are copied into this bulletin:

"*Habit.*—Soil affects the size and general appearance of the cotton plant to a very great extent. On sandy loams and well drained land most cottons are tall, lax in habit, with long, weak, spreading branches; on clay and badly drained soils they are small bushes with short branches.

"*Hairs.*—These are not perceptibly affected in the first season by a change of soil and climate.

"*Stems, Petioles and Peduncles* are affected in size by a change in habit, but are not otherwise altered by a change of soil.

"*Leaves, Stipules and Branches* are greatly affected in size, and the first and last to some extent in conformation, by change of climate. These leafy organs are very different in a moist atmosphere from what they are in a dry, and herbarium specimens may be misleading if e. g., some are made in the monsoon and others in the dry season. The sinuate character of the leaf of the *G. herbaceum* series of cottons is only marked in the monsoon, and the extra lobe of the *G. arboreum* series is more common and more marked during this season than it is afterwards. The bracteoles of the annual and shallow rooted cottons diminish markedly in size as the hot season advances.

"*Flowers.*—These do not alter perceptibly in form or color by transference to a new district. If the plant is healthy the flowers will be normal; but like the bracteoles they diminish in size late in the season.

"*Bolls.*—The bolls also become smaller, especially on light soils, as the hot season advances, but those that form early in the season should be true to kind whether grown on clay or sandy soil.

"*Seeds.*—In those bolls which mature well, the size or number of seeds is not affected during the first season by a change of soil and climate.

"*Lint.*—The fibre, more than anything else, is injuriously affected by change."

From the foregoing it will be readily understood, therefore, that no experiment in hydridization is satisfactory until the following steps have been taken:

1st. If foreign plants are blended with American species the foreign seeds must be first carefully planted in rich adaptable soil, cultivated by the most improved methods and the seeds selected from the most healthy plants and planted a second season at least, to adapt the plant to its new surroundings. Careful cultivation during three seasons would be better.

2nd. Frequent visits to the field should be made during all periods of the plant's growth, and all the stages of development thoroughly noted and studied. Full and detailed information of the plant's habits and peculiarities must be known, and this can only be secured by watching the growth throughout the entire season, from the germinating of the seeds to the opening of the bolls.

3rd. A judicious selection of the parents. Special attention being paid to the blending of forms which are prolific, hardy, early and healthy and which produce fibre of superior length, strength, maturity and fineness in texture. Of course it is useless to waste time in crossing inferior grades of cotton with those that already produce excellent fibre. The writer has, therefore, attempted to eliminate from his experiments all those foreign species which failed to show decided superior properties after two years cultivation.

4th. After the hybrids have been obtained the greatest care must be taken in the after cultivation and fertilization, to hold the blended properties together until permanency has been established. The inferior tendencies in the new plants must be watched and every effort available, in changing the character and condition of the soil, in the kind and the amount of fertilizers used and in the selection of the seeds, must be put forth to eradicate from the plant its infirmities. This requires the care, solicitous attention and tender nursing of the successful and faithful physician.

A few intelligent farmers here and there over the South have greatly improved the condition of the upland varieties of cotton within the past thirty years by judicious selection of the seeds from year to year, and as a result many so-called varieties are advertised for sale at fancy prices. As far as the writer has been informed, however, little if any effort has been put forth to unite into one or more healthy varieties the best properties of the American and foreign cottons by crossing experiments. This work is rendered all the more important now that the long staple cottons of Egypt are finding a ready market in our own ports. In 1896 nearly one million bales were exported from the Nile country, and of this amount 50,000 bales were sold in the United States, and buyers were ready and eager to secure this cotton even at eleven cents per pound. This price yielded the shippers fine profits since the fellah labor is so cheap. The Sea Island fibre sells for twelve cents per pound, but the demand is greater than the supply. Some of the cotton experts in New York predict that at the close of the season of 1897 the buyers in the United States will consume at least one hundred thousand bales of the Egyptian cotton. This, if true, is an alarming tendency, and the Southern planter must begin at once to checkmate this incroachment of the foreign staple. There is no reason, as far as the writer knows, why the South should not produce throughout the cotton belt the best grades of both short and long staple cotton.

LIST OF PARENTS.

The following American varieties improved under the methods discussed in bulletin 56 were selected for hybridizing with the foreign plants. (See page 21, bulletin 56).

No. 14. Cherry's cluster X W. A. Cook.
" 2. Allen's long staple X Peerless.
" 79. Wonderful X Peerless.
" 58. Rust proof X Peerless.
" 55. Petit Gulf X W. A. Cook.
" 56. Petit Gulf X Peerless.
" 71. Truitt X W. A. Cook.
" 11. Barnett X W. A. Cook.
" 70. Truitt X Peerless.
" 43. King X W. A. Cook.
Sea Island.

The foreign cottons used in the experiments were as follows.

Bajwara (Northwest Provinces of India).
Bamieh (Egyptian cotton).
Broach (Broach district of India).
Deshi (also a Broach cotton).
Goghari (Jambusar district of India).
Herbucco.
Indrepur.
Jakko (Egyptian cotton).
Mannoah (Egyptian cotton).
Mirzapore (Indian cotton).
Mit Afifi (Egyptian cotton).
Narma (Indian cotton).
Nadam (Madras cotton).
Nimari (Central Provinces of India cotton).
Surat kapas (Indian cotton).

For a detailed description of these foreign cottons the reader is referred to bulletin 71.

CHARACTER OF THE SEASON.

The season of 1896 was very unfavorable for the best growth of cotton, and the evil effects produced on the hybrids were manifest through most of the spring and summer. To bring out this fact the following climatic data are given. Dr. J. T. Anderson, of the Chemical Department, has kindly furnished the author with the readings of maximum and minimum thermometers and rain gauge recorded by him during the past season, from which the averages given in this connection were obtained.

Months.	Mean temp.	Mean max.	Mean min.	Rainfall.	Days of rain.
April	68.0	78.9	58.9	1.74	2
May	75.7	86.0	65.5	2.55	9
June	77.2	85.9	68.3	1.77	7
July (13 days)	82.4	90.9	79.5	9.29 (31 days)	12
August	81.2	90.2	72.5	2.26	4
September	76.0	85.9	66.5	5.78	3
October	63.4	72.0	54.8	1.54	6
November	57.6	65.2	50.0	7.37	8

As an item of comparison the following table of normals has been taken from the work: "Climatology of the Cotton Plant," written by the author and issued in 1893 by the United States Weather Bureau:

Months.	Mean temp.	Mean max.	Mean min.	Rainfall.	Days of rain.
April	63.4	72.7	54.0	3 82	
May	71.4	80.9	61.9	4.48	9
June	76.7	84.8	68.8	5.28	10
July	78.0	84.8	71.2	4.37	10
August	78.1	86.8	69.4	4.20	12
September	74.0	82.7	65.4	3.29	7.5
October	64.0	74.7	53.4	2.48	
November	53.8	63.8	43.7	4.49	

No. of Exp.	Name of Cotton.	Seed cotton per plot.	Seed per plot.	Lint per plot.	No. of plants per plot.	Per cent. of seed.	Per cent. of lint.	Length of fibre.	Diameter of fibre millimeters.	Max-breaking strain 1 strand grammes.	Min-breaking strain 1 strand, grammes.	Average breaking strain 1 strand, grammes.	Character of twist.	Character of maturity.
2	Allen x Peerless........	47.4	30.7	16.7	124	64.8	35.2	....	0.020	12.25	11.77	12.01	very good.	good.
11	Barnett x Cook.........	85.5	57.8	27.7	159	69.5	30 5	....	0 020	11.01	8.85	9.93	good.	good.
14	Cherry x Cook	71.4	50.4	21.0	130	70.6	29.4	....	0.020	14.20	12.31	13.26	excel.	very good.
43	King x Cook...........	69 0	44 3	4 7	112	64.0	36 0	..	0.018	14 47	10 81	12.64	excel.	good.
55	Petit Gulf x Cook	73.5	53 5	20.0	101	72.8	27.2	....	0.016	15.30	9 25	12.28	good.	good.
56	" " Peerless..	47.8	27.3	20.5	113	57.1	42.9	..	0.018	13.71	11.75	12.73	good.	good.
58	Rust proof x " ..	29.7	18.3	11 4	47	61.7	38 3	....	0.022	13.10	12.10	12 60	very good.	very good.
	Sea Island............	10.0	7.2	2.8	54	72.0	28.0	....	0.016	11.86	8.23	9 30	average.	average.
71	Truitt x Cook	60.7	40 7	20 0	113	67.1	32.9	..	0 014	12.35	9 68	11 02	excel.	excel
70	Truitt x Peerless.	17.9	31 4	16 5	135	65 6	34.4	...	0.021	15 38	12.79	14.09	excel.	very good.
79	Wonderful x Peerless ..	62 0	41.1	20.9	125	66.3	33.7	...	0 017	11.34	9 78	10 56	very good	very good.
104	Bajwara...............	17 0	11.8	4 2	60	75.3	24.7	32	0.032 0.024	10.46	5.14	7.16	fair.	medium.
191	Bamieh..............	12.4	7.0	5.4	112	56.5	43.5	42	0.024 0.040	22 73	16.70	18.72	excel.	excel.
187	Broach...........	7.6	5 4	2.2	39	71.0	29 0	30	0.028 0 032	15.60	5.81	9.41	fair.	fair.
196	Deshi	...	..	...	...	...	...	29	0.024	15.35	7 48	10.53	good.	irregular.
175	Goghara	13.3	9.2	4.1	44	69.2	30 8	30	0.024	15.02	10.07	11.74	excel.	excel.
184	Herbucco	9.0	6.2	2.8	53	68.9	31.1	32	0 016 0.024	8.86	8.27	8 61	poor.	fair.
180	Indrepur	8.1	5.6	2.5	59	69 1	30.9	32	0.016 0 024	11.88	8.10	10 54	good.	good.
186	Jakko	4.5	3.2	1.3	56	71.0	29.0	47	0 016	15 84	8.25	12 06	irreg.	irregular.
193	Mannoah	....	...	..	.	..	....	32	0 032	18.75	10.20	13 93	good.	good.
182	Mirzapore......	5 3	4.0	1.3	58	75.5	24 5	32	0.016	7.79	6.91	7.35	poor.	fair.
192	Mit Afifi	23.5	13.6	9.9	105	57.8	42.2	38	0 032 0.048	12.61	10.34	11.47	excel.	excel.
109	Narma..............	9.4	6 3	3.1	60	67.0	33 0	28	0 032 0.016	19.52	8.10	13.09	excel.	excel.
173	Nadam..............	13.5	9.1	4.4	96	67.4	32.6	33	0.032 0.048	9 78	7.12	8.45	good.	fair.
102	Nimari.............	5.5	4.0	1.5	50	72.7	27.3	25	0.016	9.64	8.87	9.25	poor.	fair.
190	Surat Kapas..........	2.8	2.3	0.5	55	82.0	18.0							

By a comparison of these tables it will be noted that there was a deficiency of rain during the spring and growing season (May-June) of 5.44 inches. During the summer period (July-August-Sept.), while the plant should be making bolls and developing fibre, and when an excess of rain was injurious, there were 5.47 inches of precipitation above the normal.

In the matter of temperature there was not much to complain about, the nights were not cold and the frosts in the early spring were not heavy enough to do material damage. The comparison made with the normals show that in the case of the mean temperature for the growing period (April 1st to June 30th) the season of 1896 was $3^\circ.5$ warmer, and the mean minimum temperature was $2^\circ.6$ higher than the normals. It is evident from the knowledge we have of the cotton plant that if the precipitation had retained the same relative ratio to the normals as is exhibited in the case of the temperature the results given in this bulletin would be materially changed for the better.

DISCUSSION OF THE PARENT TYPES.

In order that the reader may fully understand the relationship existing between the parents and the hybrids the following table has been condensed from bulletins numbers 56 and 71. It is clearly shown in this table which parent furnishes the strongest qualities, and by comparing with these results those given in the table of hybrids we will note how far these good properties have held sway in the development of the new form.

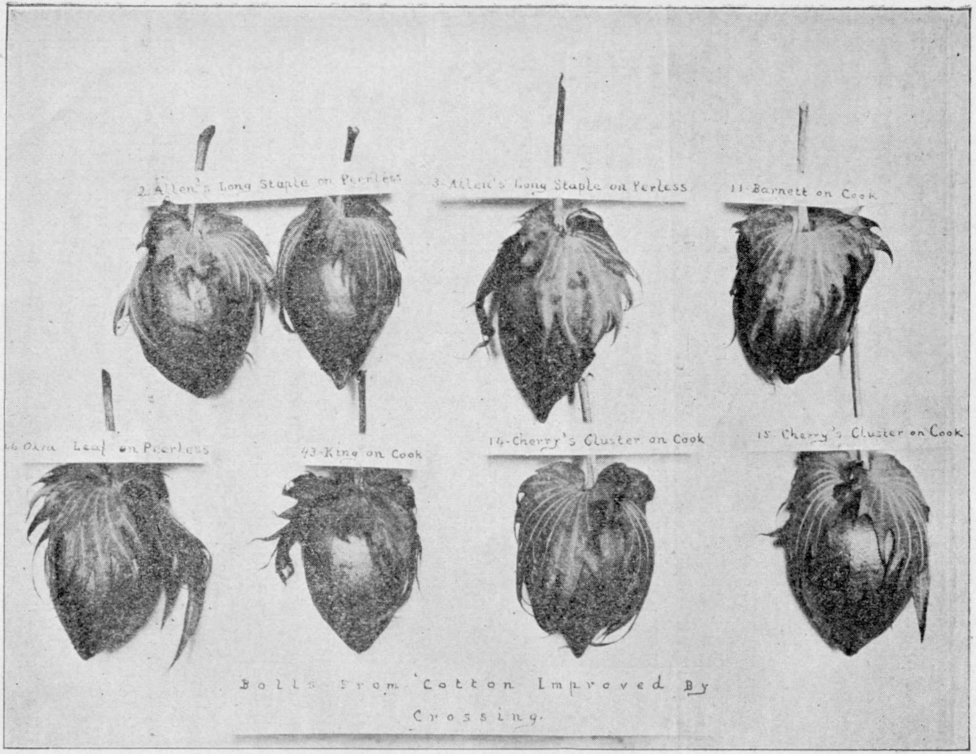

2 Allen's Long Staple on Peerless
3 Allen's Long Staple on Perless
11 Barnett on Cook
Okra Leaf on Peerless
43-King on Cook
14-Cherry's Cluster on Cook
15 Cherry's Cluster on Cook
Bolls From Cotton Improved By
Crossing.

PLATE 1.

Allen's long staple crossed on Peerless produces a boll of medium size gradually tapering to the end, and also one rather blunt pointed and cylindrical. (See plate I.) The involucre covers about one-half of the boll and is cut into lobes extending ¼ the depth of the involucre; the surface is covered with fine hairs; the bases are slightly united. The flower is pale yellow-white; the petiole is short and hairy. The plant grows to the height of 5 to 6 feet with long branches. Prolific. Leaves large and 3-lobed; covered with hairs. Seeds large, furry and light brown.

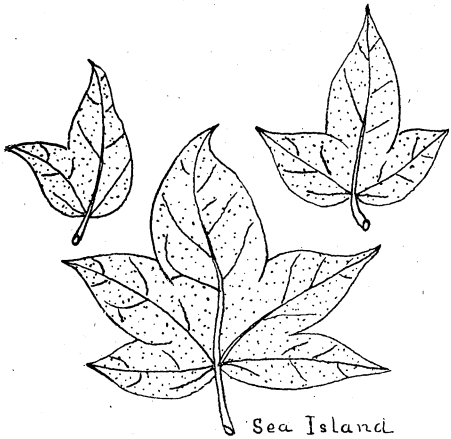
Barnett crossed on Cook produces a plant 4 to 5 feet high with branches of medium length and numerous, 5 to 8 bolls to each branch. Leaves 3-lobed and covered with hairs. Flowers light yellow with petiole about length of boll. (See plate I.) Boll nearly cylindrical and large with involucre length of boll and deeply lobed. Seeds furry, light brown and medium sized.

Cherry's cluster crossed on Cook.—Plant 6 to 7 feet high and prolific. Branches of average length and numerous, with 5 to 9 bolls to each. Leaves 3-lobed, covered with hairs. Flower pale yellow with petiole length of flower. Boll large and ends with an erupt point; involucre length of boll with deep lobes, and free at base. (See plate I.)

King crossed on Cook.—Plant 3 feet high and prolific. Branches long and few. Leaves 3–5 lobed and hairy. Boll large, oblong-pointed with involucre nearly length of boll and deeply incised. (See plate I.) Petiole length of boll. Seeds large, furry and brown.

The other American types mentioned on page 8 are in most respects like the varieties already described, and therefore it is deemed unnecessary to give detailed descriptions of them in this bulletin. The Sea Island species belongs to *Gossypium maritimum*, which is fully identified as follows:

G. maritimum.—Glabrous, stem erect, branched, tall; branches graceful, spreading, subpyramidal ascending, and later recurving; leaves rotundate-ovate, subcordate, 3-5 lobed, sometimes intermingled with other entire leaves, lobes ovate, ovate-lanceolate, or lanceolate-oblong, depressions between lobes subrotundate; single peduncle above the axis of leaf and stem, an inch long during flowering period, but afterwards elongating; bracts broadly ovate, cordate adhering at middle of base with calyx, but not coalescing among themselves, deeply cut into lobes, lobes near base slightly broader, lanceolate, terminating with an elongated point; corolla longer than bracts, petals yellow, or pale sulphur color, not entirely expanded during the flowering period; lower part of style free from stamens and equal in length to another bearing column; style somewhat three parted; boll ovate conical, acute, three to four celled, 6-9 seeded; seeds beaked at hilum, black, smooth and covered with long silky fibre.



P. H. Mell Del.

FIG. I.

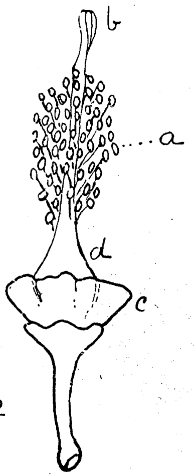


Fig 2

Sea Island Pistil.

P. H. Mell Del

BOTANICAL CHARACTERISTICS OF FOREIGN PLANTS.

Since writing the bulletin on Foreign cottons (No. 71) Professor T. H. Middleton's pamphlet on Indian cottons has been issued from the press, in which the common and scientific names are given; and, in as much as the seeds delivered at Auburn were so badly mixed, rendering it impossible to determine which plant represented the vernacular name, the classification given in bulletin 71 is repeated here with the correct common name indicated.

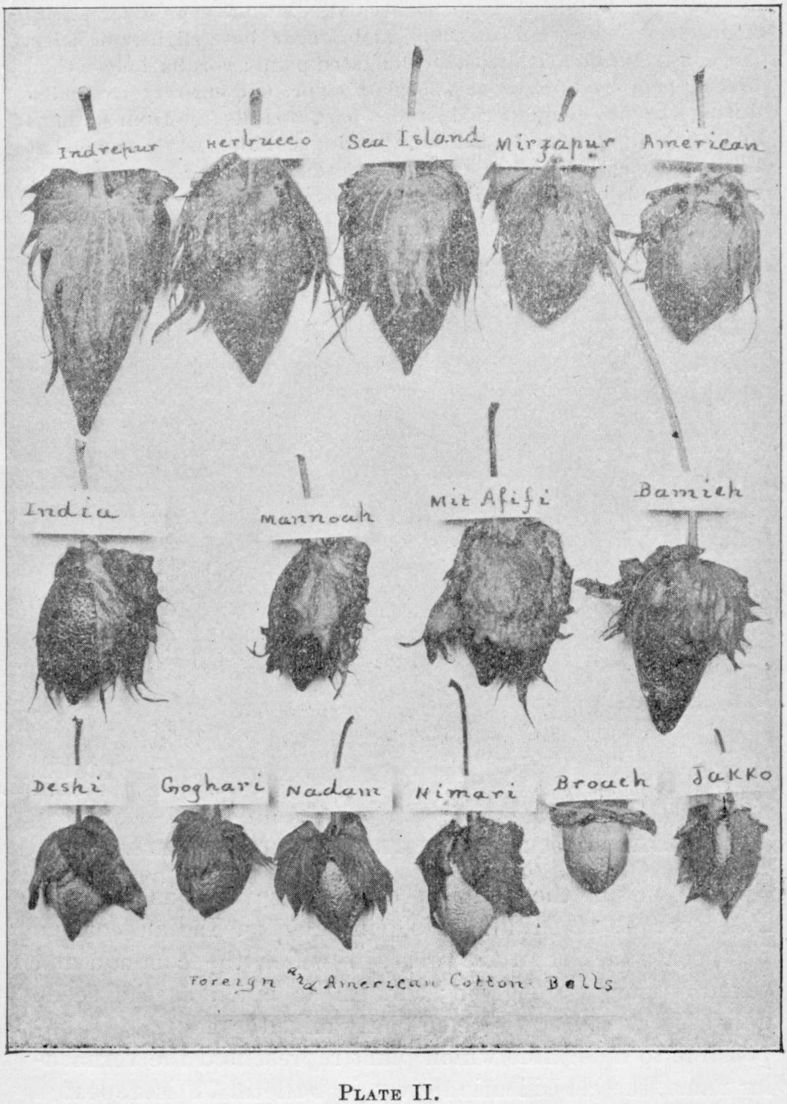

Indrepur
Herbucco
Sea Island
Mirzapur
American
India
Mannoah
Mit Afifi
Bamieh
Deshi
Goghari
Nadam
Himari
Brouch
Jakko
Foreign and American Cotton Balls

PLATE II.

Gossypium herbaceum, Tod. Stem erect, covered with long soft hair; branches spreading, slightly pyramidal; leaves 3-5 lobed, rarely 7 lobed, lobes rotundate obtuse, apex minutely mucronate; stipules linear lanceolate, acuminate very short; peduncle erect and nearly equal to half of peteole; bracts ovate cordate, with sharp cut teeth, general outline of bract leaf rotundate, bases united; coralla longer than the bracts, obovate, unequally wedge shaped, yellow, marked at base with purple spots, after flowering the outside surface turns reddish; bolls small ovate, hardly subrotundate, apex deeply hollowed out, 4-5 celled, cells 6-7 seeded; seeds ovate, short mucronate at hilum, covered with thick closely adhering fibre, in some cases white ash-gray, short, in other cases rather long and white. (See plate II.)

Broach, Goghari and Deshi are varieties of this species. Professor Middleton seems to think that Goghari is a cross between Wagria and Broach Deshi, and he states that a good crop of this cotton in India will produce from 400 to 500 lbs. of seed cotton per acre. It is considered to be a high grade staple in its native country.

Gossypium hirsutum.—Tod. Stem erect, branches spreading, slightly ascending, pyramidal, hairy; leaves ovate rotundate cordate, 3-5 lobed, those found at end of branches are at times acute and entire, lobes truncate-semiovate, subtriangular, acute or acuminate, the middle lobes larger and longer, at fold acute plicate; stipules ovate lanceolate (unequalateral, sharp rigid pointed, the other portion lanceolate), acuminate; bracts large ovate, acuminate, in the upper portion deeply cut into many narrow lobes, in the lower part simply dentate, the clefts are elongate linear produced at the apex into an attenuated point; corolla large, longer than bracts, during flowering period considerably expanded, petals pale sulphur color, afterwards rolling up and turning red; style long, exserted; boll large, walnut shaped, generally four celled, apex rotundate terminating abruptly into a sharp point; seeds ovate covered with short white fibre firmly adherent. (See Plate II.)

Bajwara, Herbucco, Indrepur, Mirzapore and Surat kapas are evidently varieties of this species. They resemble very closely Todaro's *G. hirsutum var. album*, the Indrepur, however, has a large boll rapidly tapering to a point, while the Mirzapore contains one more nearly the shape of a walnut and generally four celled. The shape of boll on the Indrepur type would indicate features of *G. glabratum, Tod.*

The three forms known by the vernacular names of "Jakko," "Mannoah," and "Mit Afifi," are varieties of *G. mari-*

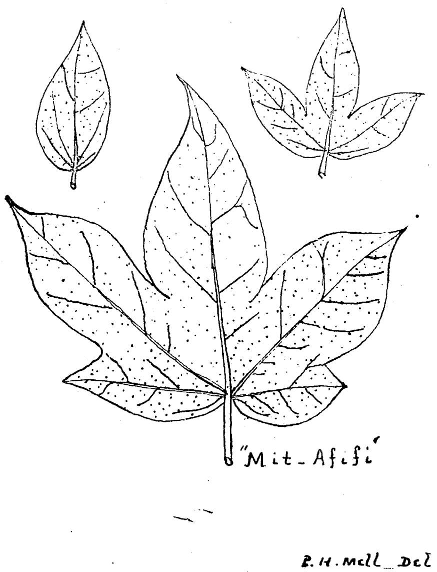


FIG. 3.

timum, Tod., the same species to which the sea island cotton is referred (see page 395). These cottons are grown in different parts of Egypt and produce very superior grades of fibre. The yield is large also, averaging in its native country 350 pounds of lint per acre. An illustration of the leaves of this species of cotton is given in figure 3.

Gossypium maritimum var *polycarpum*, Tod. Stem erect, simple; 1-3 peduncles in the axis of each leaf; few if any branches.

The plant grows to the height of 7-8 feet and is glabrous throughout. The few branches, if present at all, spring from near the roots. Generally branches are wanting. The leaves are large, deep green and free from hairs. The surfaces are dotted with darker green spots. The bolls grow in clusters from the axil of the leaf and main stem. The petals of the large conspicuous flowers are bright yellow with a deep or purple spot at the base on the inside. The involucre is nearly the size of the petal, bright green and smooth.

Figure 4 is a good representation of the leaf, petal involucrue and pistil of this plant.

FIG. 4—Bamieh.

Narma is probably a hybrid produced by blending the species *g. arborcum* Linn. and *g. Indicum*, Lam. The leaves are covered with short, soft hairs as well as all other Surfaces. Stem is somewhat shrubby and dotted with red spots; cordate leaves are 5-lobed, lobes broadly lanceolate and terminated with a bristle, sometimes a small rounded lobe is found between the other lobes; petiole dotted with red; petals bright yellow with red extending over fully one-third of the outside surface; a red spot is found also at the base of the petal inside, inner surface covered with minute hairs; bracts are small, very nearly entire, or at least apex slightly indented, hairy outside and adhering at base; peduncles are short and hairy; calyx entire and spotted green; stamens extend as far as the stigma; boll small ovate acuminate 3-4 carpels; seeds small, 8 in each cell; fibre short and brown.

Gossypium Wightianum Tod. Stem erect and covered with soft hairs; branches spreading, slightly ascending, leaves rather rotundate, obscurely obcordate, 3-5 lobed, lobes ovate, obtuse with bases drawn together or wrinkled, the depressions between the two lobes obtuse with small dentiformed lobes now and then interjected, stipules semiovate, somewhat sickle shaped, otherwise linear lanceolate, all acuminate; peduncles erect during the blooming period but recurved during fruiting; bracts ovate, very small, base united, cordate, acute, small serrated; corolla longer than bracts, obovate, unequally shaped, yellow, base spotted dark purple but after flower opens, petals turn red; bolls very small, ovate, 8-seeded; seeds small ovate-subrotundate, densely covered with fibre; fibre short and closely adhering and white.

Nadam. Nimari.

Professor Middleton classifies Nimari as a hybrid from *g. roseum* Tod. and *g. neglectum,* Tod. The plant cultivated at the Auburn Station, however, produced a yellow flower with a red spot at the base of the petal, while the plant described by Professor Middleton yields a white flower and resembles Todaro's *g. roseum var albiflorum.* Nadam cotton may be a variety of *g. Wightianum* Tod. with a strain of *g. indicum.* Lamk. Todaro's Wightianum closely resembles Linneus' *g. herbaceum* and there seems to be no good reason for introducing a new species with so little, if any difference from the the older form.

TABLE OF RESULTS OF HYBRIDIZATION.

The following table exhibits in a striking manner the results of hybridizing the foreign with the American cottons. The vernacular forms: *Bajwara, Goghari, Surat kapas Nadam, Indrepur* and *Narma* did not satisfactorily blend with the American varieties, or at least the issue from the experiments was not of such a decided nature as to warrant conclusions for the present. These varieties have, therefore, been excluded from the table in this bulletin, but further experiments with them will be continued the coming season to fully determine the fact whether or no they will blend with the American cottons so as to produce valuable hybrids. It may be of interest to state, however, that the indications seem to point to a refusal of *Bajwara, Nadam* and *Narma* to unite with the *gossypium hirsutum,* Miller. In regard to the other foreign cottons the table speaks in an intelligent manner and with satisfactory emphasis. It is gratifying to note the readiness with which the Egyptian forms *Mit. Afifi* and *Bamieh,* combine with the American types because of the marked superiority of these two cottons.

Number of Experiment.	Names of plants crossed.	Seed cotton per plot—lbs.	Seed per plot, lbs.	Lint per plot, lbs.	Number of plants to plot.	Per cent. of seed.	Per cent of lint.	Length of fiber in m. m*.	Diameter of fiber, m. m.*	Max. breaking strain, 1 strand, in grammes. ‡	Min breaking strain, 1 strand, in grammes. ‡	Average breaking strain, 1 strand, in grammes. ‡
122	Sea Island X Afifi	12.7	8.8	3.9	28	69.2	30.8	42	0 020	14.02	9.83	12.13
142	Afifi X Petit Gulf X Peerless	18.5	12.9	5.6	43	69.7	30.3	43	0.016	10.84	6.12	8.04
152	Cherry's Cluster X Cook X Afifi	41.2	29.2	12.0	93	70.8	29.2	36	0.016	13.51	6.76	9.08
157	Rust proof X Peerless X Afifi	10.4	8.3	3.1	43	72.1	27.9	38	0.032 0.048	9.83	6 26	7.72
171	Afifi X Cherry's Cluster X Cook	12.0	8.8	3.2	43	73.4	26.6	48	0.020	13.15	12.96	13.10
130	Wonderful X Peerless X Afifi	13.0	9.3	3.7	56	72 0	28.0	38	0.016	10 90	9.41	10.16
162	Afifi X Allen's Staple X Peerless	12.2	8.6	3 6	120	70.5	29.5	44	0.008	13.68	9.48	11.58
149	Truitt X Cook X Afifi	10.5	7 5	3.0	43	71.4	28.6	44	0.016	20.71	15.65	19 01
119	Allen's long Staple X Peerles X Afifi	5.7	4 0	1.7	51	70.2	29 8	40	0.016	13.50	11.16	12.33
148	Afifi X Rust proof X Peerless	20.5	15.4	5.1	99	75.0	25.0	33	0.008 0.024	21.40	19.17	20 29
163	Truitt X Peerless X Afifi	7.5	5.4	2.1	54	72.0	28.0	32	0.024	4.35	3.55	4.11
192	Afifi	12.9	8.8	4.1	105	67.4	32.6	38	0.032 0.048	12.61	10.34	11.47
129	Allen's Staple X Peerless X Broach	7.2	4 9	2.3	25	68.0	32.0	25	0.016	12.70	12.42	12 56
187	Broach	7.6	5.4	2.2	39	71.0	29.0	30	0.028 0.032	15.60	5.81	9.41
168	Jakko X Cherry's Cluster X Cook	14.2	10.0	4 2	48	70.4	29.6	38	0.024	8 86	7.69	8.28
186	Jakko	4.5	3.2	1.3	56	71.0	29.0	47	0.016	15.84	8.25	12.06
165	Barnett X Cook X Herbucco	17.2	11.9	5.3	61	69.2	30.8	36	0.016 0.024	11.45	8.05	10.10
137	Herbucco X Allen's Staple X Peerless	12.0	7.9	4.1	51	65.8	34.2	25 33	0.016 0.224	9.57	3.97	7.12
184	Herbucco	9.0	6.2	2.8	53	63.9	31.1	32	0.016 0.024	8.86	8.27	8.61
155	Petit Gulf X Peerless X Bamieh	17.7	12.0	5.7	64	68.0	32.0	29 31	0.016	white. 12.44	Yel. 9.30	11.12

Number of Experiment	Names of plants crossed.	Character of twist of fiber.	Character of maturity of fiber.	Character of foreign seed.	Character of American seed.	Character of hybrid seed.
122	Sea Island X Afifi	excel	excel	Smooth black	Smooth black	Smooth and green.
142	Afifi X Petit Gulf X Peerless	irreg	irreg.	Smooth black	Dark brown	Green furry.
152	Cherry's Cluster X Cook X Afifi	irreg	irreg.	Smooth black	Light brown	Green furry.
157	Rust proof X Peerless X Afifi	irreg	irreg.	Smooth black	Dark brown	Smooth and green.
171	Afifi X Cherry's Cluster X Cook	excel	excel	Smooth black	Light brown	Smooth and green.
130	Wonderful X Peerless X Afifi	good	good.	Smooth black	Light brown	Smooth, brown & green.
162	Afifi X Allen's Staple X Peerless	good	good.	Smooth black	Light brown	Brown furry.
149	Truitt X Cook X Afifi	excel	excel	Smooth black	Brown	Smooth and furry.
119	Allen's Long Staple X Peerless X Afifi	good	fair	Smooth black	Light brown	Brown furry.
148	Afifi X Rust proof X Peerless	excel	fair	Smooth black	Dark brown	Green furry.
163	Truitt X Peerless X Afifi	poor.	poor	Smooth black	Brown	Smooth and green.
192	Afifi	excel	excel	Smooth black	....	
129	Allen's Staple X Peerless X Broach	good	good	Yellow brown	Light brown	Brown furry.
187	Broach	fair	fair	Yellow brown	....	
168	Jakko X Cherry's Cluster X Cook	fair	aver	Smooth black	Light brown	Smooth and furry.
186	Jakko	irreg	irreg	Smooth black	....	
165	Barnett X Cook X Herbucco	fair	fair	Light furry	Light brown	Light brown.
137	Herbucco X Allen's Staple X Peerless	irreg	irreg	Light furry	Light brown	Brown furry.
184	Herbucco	poor.	fair	Light furry	....	
155	Petit Gulf X Peerless X Bamieh	fair	fair	Smooth black	Dark brown	Brown and green.

Number of Experiment.	Names of plants crossed.	Seed cotton per per plot—lbs.	Seed per plot, lbs.	Lint per plot, lbs.	Number of plants to plot.	Per cent of seed.	Per cent of lint.	Length of fiber in m. m.*	Diameter of fiber. m. m.	Max. breaking strain, 1 strand, in gramures.	Min. breaking strain, 1 strand, in gramures. ‡	Average breaking strain, 1 strand, in gramures. ‡
153	Petit Gulf X Cook X Bamieh...........	12.3	8.8	3.5	49	71.6	28.4	38	0.016	13.63	8.20	10.88
121	Cherry's Cluster X Cook X Bamieh	22.0	15 6	6.4	93	70 9	29.1	41	0.012	13.01	11.57	12.29
154	Barnett X Cook X Bamieh.............	11.2	8.0	3.2	50	71 4	28.6	32	0.024	11.51	9.31	10.32
160	Bamieh X Cherry Cluster X Cook......	21.3	14.8	6.5	120	69.5	30.5	44	0.008	13.68	9.48	11.58
170	Bamieh X Rust proof X Peerless.......	16.5	11.6	4 9	90	70.3	29.7	38	0.016 0.032	12.75	8.01	9.93
133	Wonderful X Peerless X Bamieh	16.2	11.6	4.6	58	71.6	28.4	33	0.016	4.58	3.53	4.05
134	Allen's Staple X Peerless X Bamieh....	10.6	8.2	2.4	54	77.4	22.6	38	0.024	12.24	10.64	11.44
191	Bamieh..................................	11.9	7.9	5.4	112	66.2	33.8	42	0.024 0.040	22.73	16.70	18.72
					42	69.0	31.0	42	0.008	13.89	10.07	11.98
141	Mannoah X Petit Gulf X Peerless......	10.6	7.2	3.4					0.016			
118	Cherry's Cluster X Cook X Mannoah...	25.0	17.6	7 4	105	70.4	29.6	40	0.016	10.30	9.73	10.01
								36	0.016	Yel.	White	
147	Mannoah X Sea Island................	9.0	6.4	2.6	42	71.1	28.9	42	0.020	11.96	7.01	9.42
146	Mannoah X Rust proof X Peerless......	5.5	4.0	1.5	59	72 7	27.3	34	0.020	15.74	14.44	15.09
159	Petit Gulf X Cook X Mannoah.........	7.2	5.1	2.1	68	70.8	29.2	32	0.016	10.22	6.96	8.84
169	King X Cook X Mannoah..........	4.0	3.0	1.0	42	75.0	25.0	31	0.024	9.25	8.70	7.98
193	Mannoah................................	....	....	....	....	....	... ..	32	0.032	18.75	10.20	13.93
131	Petit Gulf X Cook X Mirzapur	7.7	5.6	2.1	38	72.7	27.3	33	0.016 0.028	8.56	4.63	7.91
117	Cherry's Cluster X Cook X Mirzapur...	7.3	5.1	2.2	64	69.9	30.1	34	0.016	18.11	4.86	7.62
182	Mirzapur................................	5.3	4.0	1.3	58	75.5	24.5	32	0.016	7.79	6.91	7.35
132	Allen's Staple X Peerless X Nimari	6.0	4.3	1.7	27	71.7	28.3	25	0.016 0.024	8.77	7.55	8.16
102	Nimari.................	5.5	4.0	1.5	50	72.8	27.2	25	0.016	9.64	8.87	9.25

Number of Experiment.	Names of plants crossed.	Character of twist of fiber.	Character of maturity of fiber.	Character of foreign seed	Character of American seed.	Character of hybrid‡seed.
153	Petit Gulf X Cook X Bamieh............	excel ..	excel...	Smooth black..	Dark brown....	Green furry.
121	Cherry's Cluster X Cook X Bamieh......	excel ..	excel ..	Smooth black..	Light brown...	Green furry.
154	Barnett X Cook X Bamieh	aver...	aver. ..	Smooth black..	Light brown. ..	Brown furry.
160	Bamieh X Cherry's Cluster X Cook......	good. ..	good. ..	Smooth black..	Light brown. ..	Smooth, brown & green.
170	Bamieh X Rust proof X Peerless........	good ...	fair	Smooth black..	Dark brown ...	Smooth and green.
133	Wonderful X Peerless X Bamieh........	poor ...	poor. ..	Smooth black..	Light brown. ..	Smooth, brown & green.
134	Allen's Staple X Peerless X Bamieh.....	excel ..	excel ..	Smooth black..	Light brown. ..	Smooth and brown.
191	Bamieh..........	excel...	excel ..	Smooth black..		
141	Mannoah X Petit Gulf X Peerless.......	good. ..	good. ..	Smooth black..	Dark brown....	Green furry.
118	Cherry's Cluster X Cook X Mannoah....	fair	fair	Smooth black..	Light brown. ..	Green furry.
147	Mannoah X Sea Island.................	fair	fair ...	Smooth black..	Smooth black..	Smooth black.
146	Mannoah X Rust proof X Peerless	excel ..	excel...	Smooth black..	Dark brown....	Green furry.
159	Petit Gulf X Cook X Mannoah..........	excel ..	excel ..	Smooth black..	Dark brown....	Smooth and green.
169	King X Cook X Mannoah...............	fair	aver ...	Smooth black..	Brown	Smooth and green.
193	Mannoah	good. ..	good. ..	Smooth black..	....	
131	Petit Gulf X Cook X Mirzapur.........	irreg...	irreg...	Light furry	Dark brown....	Light green.
117	Cherry's Cluster X Cook X Mirzapur....	irreg...	irreg...	Light furry	Light brown ...	Brown furry.
182	Mirzapur............................	poor ..	fair	Light furry	....	
132	Allen's Staple X Peerless X Nimari	fair	aver....	Greenish.......	Light brown. ...	Brown furry.
102	Nimari	poor ...	fair	Greenish.		

* A millimeter is equivalent to 0.03937 of an inch.
‡ A gramme is equivalent to 15.4 grains.

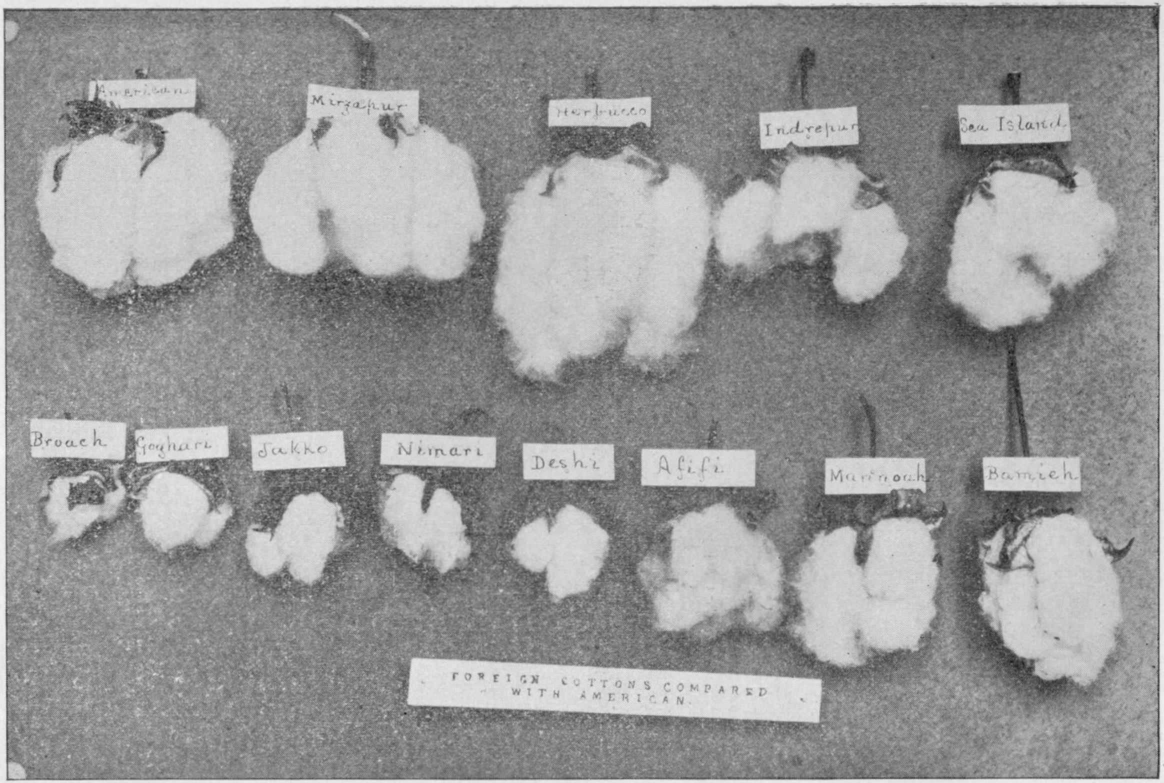


PLATE III.—Open bolls of American and Foreign Cottons. Reduced 1-6.

Cherry's Cluster x Cook x Afifi (152).—Leaves of two kinds, one dark green with upper surface smooth and lower with few scattered hairs, other free from hairs, except along the veins on under surface; petiole in some cases partly red with deeper red spots, others with slight tinge of red and also spotted; petals in some flowers bright yellow, in others almost white; involucre slightly adhering base smooth and tinged with red; bolls in shapes resembling both parents.

Rust proof x Peerless x Afifi (157).—Leaves smooth on the upper surface, short hairs on the lower, petiole tinged red with dark dots over surface, also over the midrib, leaf very decidedly wrinkled; petals in some flowers bright yellow with red spot at the base, in others lighter yellow free of red spot, but in a reversed position on the torus; involucre on the bright yellow flower, large bright green tinged with red on the outer surface, spotted with darker green, only slightly joined at base, fringed with hairs, those on the lighter colored flowers about two-thirds the size and in other respects like the larger involucre; pistil in the bright yellow flowers with a long style and recurved stigma, the peduncle is as long as the involucre, the pistil in other flowers is shorter with a broader calyx cup, peduncle only one-third as long as in the other flower.

Afifi x Cherry's cluster x Cook (171).—Some of the leaves have smooth surfaces above and hairy below while others are covered with hairs, petiole and veins are dotted with black spots; petals bright yellow, in one flower red spot at base wanting in another, spotted with red on the upper margins, those petals with red spot at base grow on the torus in a reversed position to others without the red spot, the latter are larger; involucre in one case slightly adheres at base free in other flowers, the first are hairy on the outer surfaces and the latter are hairy only on the margins, the former is also larger than the latter; peduncle tinged red with three deep red spots just below the calvx cup.

Truitt x Cook x Afifi (149).—One leaf is decided Afifi type while others are decidedly Cook in shape (or *g. hirsutum*) and hairy surfaces some of the flowers are more like the Afifi parentage while others resemble the *hirsutum* with the exception of a small red spot at the base of the petals.

Barnett x Cook x Herbucco (165).—The entire surface is hairy because both parents are so conditioned; two kinds of leaves, the same in shape, but one with very few minute hairs almost smooth and a darker green; flowers in some instances with deep yellow petals and red spot at base, while in others the petals are lighter in color, red spot absent, involucre with few hairs on outside and adhering at base, peduncle tinged red, but devoid of hairs; very few black smooth seeds in bolls, but mostly white furry with a few green seeds present.

Petit Gulf x Cook x Bamieh (153.)—The following illustrations give very clear ideas of this hybrid:

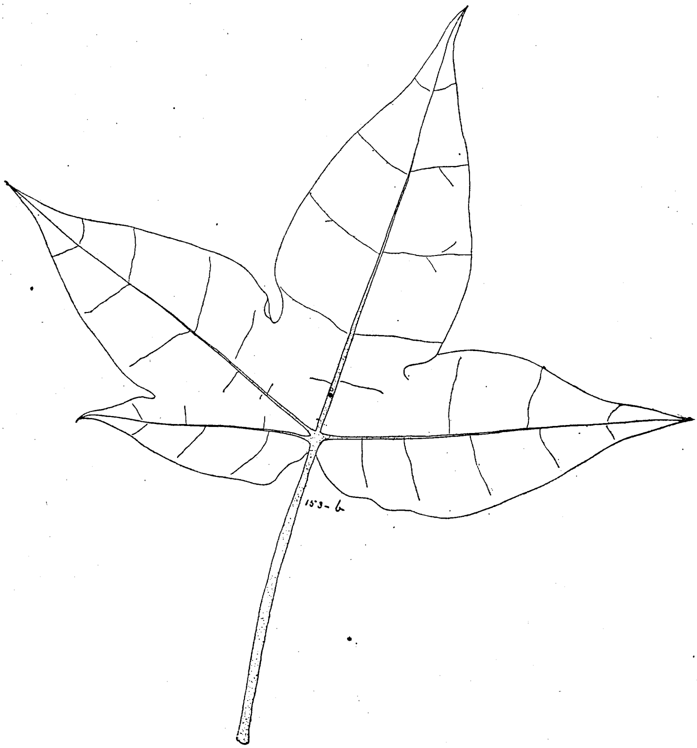


FIG. 5.—Leaf from Hybrid Petit Gulf X Cook X Bamieh.

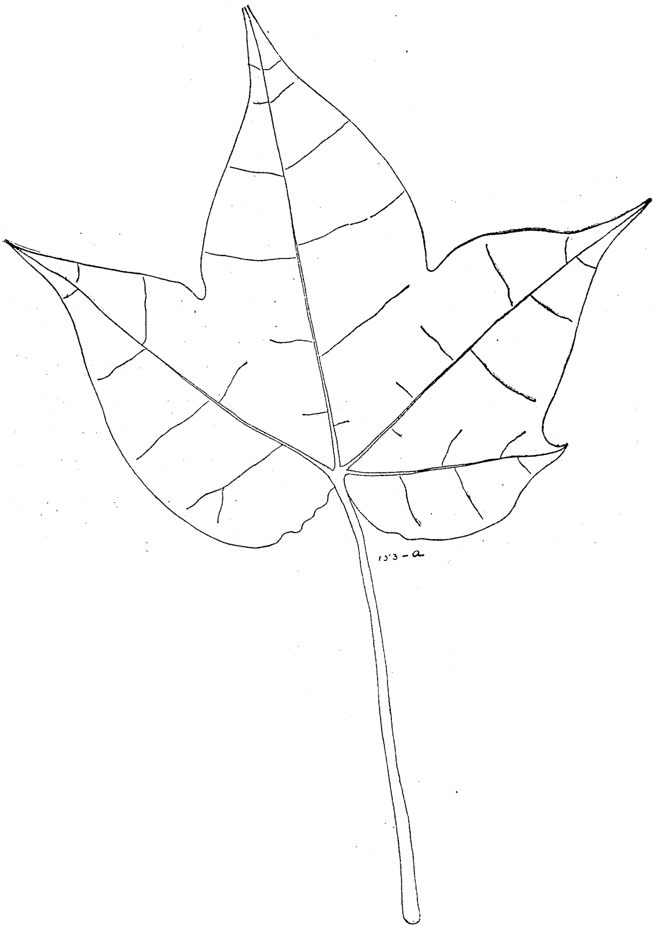


FIG. 6.—Leaf from Hybrid Petit Gulf X Cook X Bamieh.

Leaf (a) has fine hairs on the under surface and very few on the petiole and along the veins on the upper surface, spotted red, black dots on petiole, (b) no hairs, petiole red-green, dotted black, (b) contains a gland on the midrib, but this is wanting in (a); petals (a) bright yellow (b) lighter, in (a) red spot is retained at the base while in (b) it is absent; the upper half of the involucre is tinged red with a few hairs on the margins; the pistil in (a) is more slender

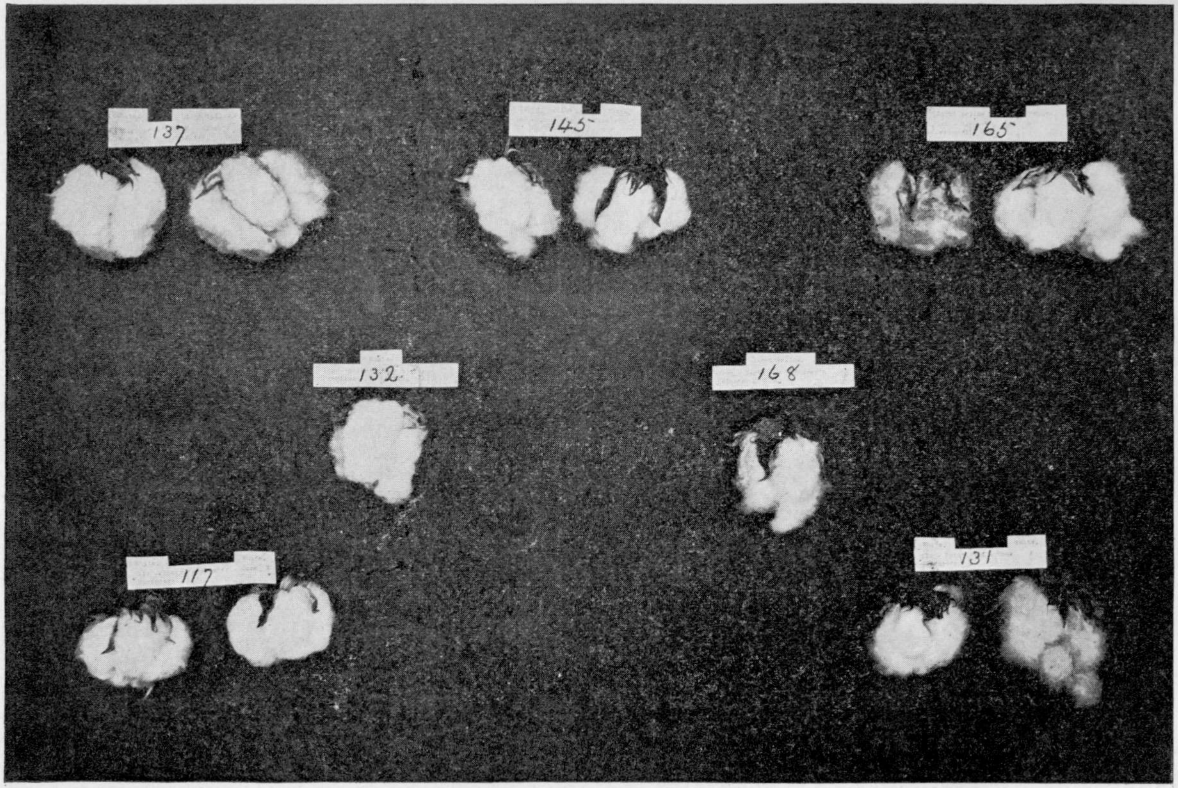


PLATE IV.—Open bolls of hybrids. The numbers containing two bolls, exhibit yellow and white fibre, features of each parent. Reduced 1-6.

than in (b); some of the seeds are black with the staple slightly adhering, some deep green with fibre strongly adhering, some yellowish white with thickly adhering fibre.

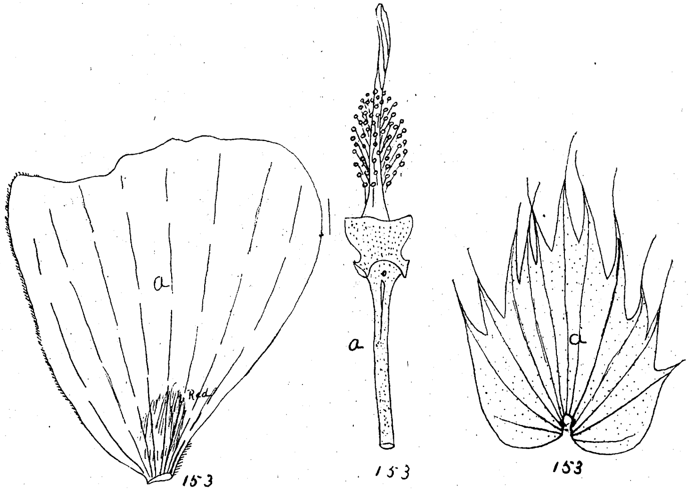


FIG. 7.—Parts of flower; Hybrid Petit Gulf X Cook X Bamieh. (The number, 153. refers to experiment. See table, page 405.)

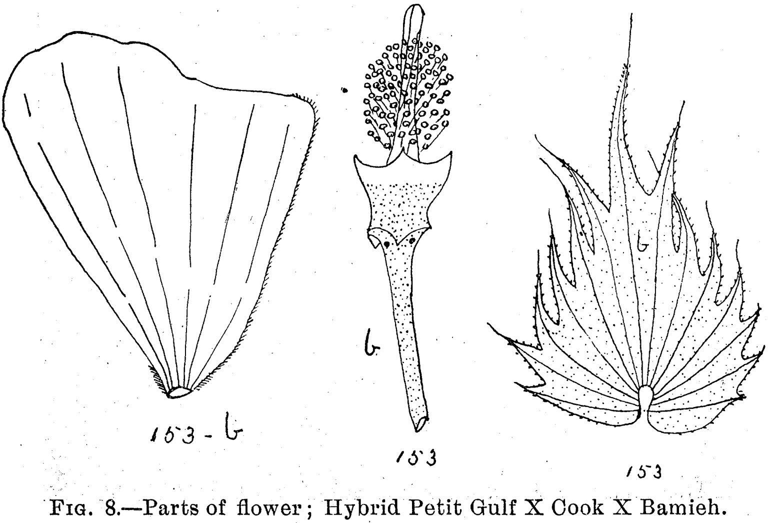


FIG. 8.—Parts of flower; Hybrid Petit Gulf X Cook X Bamieh.

Mannoah x Petit Gulf x Peerless (*141*).—Leaf with minute hairs over the under surface, all other surfaces smooth, petiole and veins dotted, only one kind of leaf on the plants; petals in some flowers deeper yellow and larger than in others, red spot at base of all petals; involucre in some cases covered with short hairs in others smooth, except on margins; calyx cup in those flowers with larger petals is more cleft than in the smaller flowers.

Cherry's cluster x Cook x Bamieh (121).—Leaves three and five lobed, almost entirely smooth over all surfaces, petioles and veins spotted; flowers of two kinds, some tending more to the Cherry and Cook types while others are as decided in their features towards the Bamieh form, although

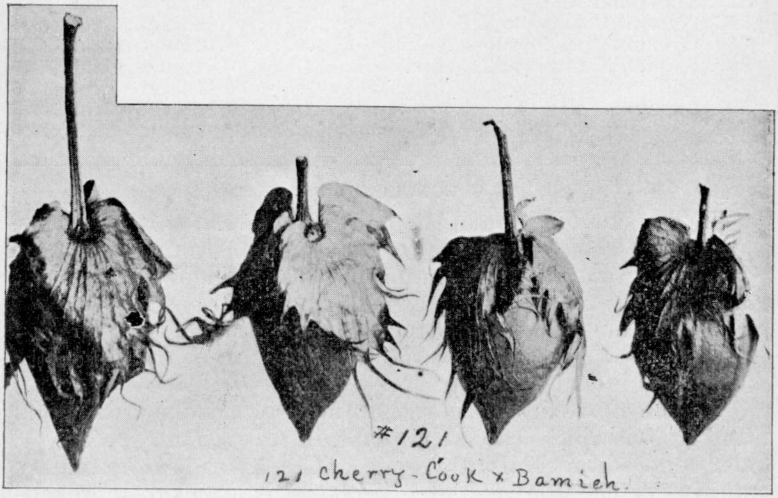


Fig. 9.—Bolls of Hybrid Cherry's Cluster X Cook X Bamieh 121.

both parents are evident in each kind; the bolls are also compound in shape and size, as is shown in the illustration, fig. 9. The long peduncle and sharp point to the boll are Bamieh characteristics, and the short peduncles and more rounded points are features belonging to the other parent, the blending of two parents is also shown in the form and condition of the involucre, the boll with the long peduncle exhibits the Bamieh involucre while the second one to the right is more like the Cherry's cluster involucre; the seeds are black smooth (few), white and green furry in about equal quantities, most of the seeds are large.

Ten best cottons as to strength, maturity, twist and amount of lint.

No. of Experiment.	Name of hybrid	Strength grammes	Twist.	Maturity.	Per cent. Lint.
149	Truitt X Cook X Afifi	19.0	Exel.	Exel	28.6
171	Afifi X Cherry X Cook	13.15	Exel.	Exel.	26.6
121	Cherry X Cook X Bamieh	12.29	Exel.	Exel.	29.1
122	Sea Island X Afifi	12.13	Exel.	Exel.	30.8
153	Petit Gulf X Cook X Bamieh	10.88	Exel.	Exel.	28.4
130	Wonderful X Peerless X Afifi	10.16	good..	good..	29.5
160	Bamieh X Cherry X Cook	11.58	good..	good..	30.5
192	Afifi	11.47	Exel.	Exel.	32.6
191	Bamieh	18.72	Exel.	Exel.	33.8
141	Mannoah X Petit Gulf X Peerless	11.98	good..	good..	31.0

CONCLUSIONS:

1. The combination of the *gossypium hirsutum* and *gossypium maritimum* yield a cotton plant which produces fibre of the best grade in strength, maturity, twist, length, fineness and yield per acre.

2. The blending of small and large boll species is not desirable, as a rule, because the resulting forms are generally weak and inferior.

3. The *g. maritimum* is rather slow in maturing its bolls and frost is apt to catch the plant, in this climate, before 60 per cent. of the bolls are open. The hybrid procured by uniting *g. maritimum* and *g. hirsutum* is quicker in reaching maturity, and is more prolific.

4. The black, smooth seeds are generally transferred into furry seeds of a dark brown color.

5. The Egyptian species are finer grades of cotton than those received from India, in length of strands, strength and texture. They unite, also more readily with the American species and the hybrids are generally equal to the parents in qualities.

6. The Sea Island cotton combines with the Afifi and Mannoah to produce superior grade of staple and the plant is rather prolific. There is a prospect in the present stage of the experiments of securing a variety which will be a healthy, long staple upland cotton.

BULLETIN No. 84. AUGUST, 1897.

ALABAMA

Agricultural Experiment Station

OF THE

AGRICULTURAL AND MECHANICAL COLLEGE,

AUBURN.

TURNIPS.

F. S. EARLE, Horticulturist.

MONTGOMERY, ALA.:
THE BROWN PRINTING COMPANY, PRINTERS
1897.

☞The Bulletins of this Station will be sent free to any citizen of the State on application to the Agricultural Experiment Station, Auburn, Alabama.

TURNIPS.

Perhaps no garden crop is more widely planted for fall and winter use in this state than turnips, certainly none is grown with more ease or with more uniform success. The requirements for this crop are very simple. The soil must be either naturally rich or it must be made so by abundant applications of stable manure, or of some complete fertilizer; and it must be made fine and mellow for the seed. It is not necessary for the manure to be well rotted for turnips. That fresh from the lot or the stable will do as well, provided only that it is well wet down by rain before planting. When planted broadcast no cultivation will be required, but it is usually best, especially early in the season, to sow in drills in order to admit of cultivation either by wheel hoe or narrow horse cultivator. If there is sufficient moisture in the soil to ensure the prompt germination of the seed, and to allow the young plant to get well established, turnips will grow and thrive with comparatively little rain fall. They occupy the ground only during the late summer and fall when gardens are too often given up to weeds. Although of such easy cultivation it is evident that the crop is not as widely planted as it should be, since it is a common thing to see ruta bagas imported from Tennessee exposed for sale in the towns of middle Alabama. There is certainly no reason why every part of this state should not raise a full home supply of this vegetable for the table; and it seems probable that when our agricultural methods become better systematized that they will be grown far in excess of this need, and be utilized as an adjunct stock food. It is hardly probable that turnips will ever come to take the prominent place in the regular farm rotation here that they do in England and some other countries, but there can be little doubt that they could be profitably grown for stock feed as a catch crop on early cow pea stubble, and to utilize various odd corners about a farm that would otherwise be allowed to grow up in grass and weeds.

Feeding experiments at the north where turnips or other root crops have been used in comparison with corn ensilage have uniformly turned out in favor of the ensilage as being the cheaper. Our conditions are, however, different. After harvesting a crop of ensilage corn we can still plant a crop of turnips, thus getting both ensilage and turnips from the same land, a case where their comparative values need not be studied quite so closely. Again at the North it is necessary to gather and store the turnip crop, which, with so bulky a product, adds materially to its cost. Here they may be allowed to stand in the field and be harvested as needed, which saves expense, besides utilizing the feeding value of the tops. As a feed for sheep even the labor of gathering may be avoided, for by a system of moveable hurdles or fences the crop may be pastured down to the great benefit of both land and sheep. Land so pastured would be found to be so effectively "cow penned" as to need little or no fertilizer for a full crop of corn the following spring. This suggestion is recommended to the earnest consideration of the sheep men of our coast counties, where it is now recognized that some provision for winter feed would add largely to the productiveness of the flocks.

Turnips are among our hardiest vegetables in their ability to withstand cold. They are seldom injured by the winters of middle and south Alabama. During severe seasons it has been noticed that some kinds resist the cold better than others. Over forty varieties of turnips, many of them imported from France, were planted at this Station last year, one of the principal objects of the experiment being to test their comparative hardiness. The winter proved to be an average one, the lowest point indicated by a self-registered thermometer being only 11 degrees on January 28. This temperature was not a severe test and none of the kinds were injured enough to entirely destroy their feeding value, but it was noticed that those kinds in which the habit of growth was shallow, thus exposing considerable portions of the root, soon became flabby or corky and unfit for table use. This corroborates previous observations and shows that the root is the tenderest part of the plant, and that varieties are hardy or not according as the habit of growth leaves the root exposed or protected by the soil. Varieties of turnips may be classified according to their shape into flats, globes and longs. The flat turnips all seem to have a shallow habit and to grow much exposed. They are valuable for their earliness but should not be planted for a winter crop. The longs, though rooting deeply enough, usually expose fully a third of their length so that they are quite as tender as the flats. They seem to have nothing to particularly recommend them and their general planting is not advised. The hardiest varieties, as well as the heaviest yielders, will be found among the globes; and varieties should be selected from this class for the general crop. The flesh of turnips is either white or yellow. So far the deepest rooting, best protected, and therefore the hardiest kinds have been found among the yellow fleshed varieties. It may safely be asserted that the hardiest varieties of turnips to resist cold will be found among the yellow globes.

Turnip seed may be planted at any time during the period of summer rains, say from the first of July on, but the earlier plantings will be more troubled with grass and weeds, and will not make such good roots as those which come on later after the nights are cooler. The best time for planting the main crop for late fall and winter use will depend somewhat on the season, so it is usually best to make a number of successive plantings. In the latitude of Auburn the best results will usually follow planting during the last half of August or early in September. Later plantings are frequently so retarded by the long drouths of October and November that they do not develop good roots before growth is stopped by cold. With the first warm days of early spring such plants will run up to seed without ever making good roots. For a spring crop plant in February, or not later than the first week in March. Quite young seedlings are rather tender so that winter plantings are sometimes lost from sudden freezes. In the coast counties there are usually enough warm days during the winter so that growth in hardy plants is not entirely suspended; and plantings of turnips may be made at any time during the fall and winter with a reasonable prospect of success.

It is customary to delay planting till just after a good rain when the seed will come up quickly in the still moist soil. When the soil is very dry seed may also be planted safely for it will lie unharmed in the soil till rain comes to give sufficient moisture for germination; but very heavy rains falling after the seed is planted will in most soils form a hard crust that prevents many of the little plants from coming through, thus giving a poor, uneven stand. When seed is planted in soil that is only slightly moist there is danger that it will sprout, and that the little plants may dry out and die before reaching the surface. If it is desired to plant when the ground is dry the safest plan is to open rather deep drills, and at night half fill them with water. Early in the morning before the sun dries up this moisture sow the seed and cover lightly by brushing in a little dry dirt with an old stubby broom. Turnip seed is small and should not be covered deeply. This mulch of dry dirt prevents the loss of the water by evaporation and also the baking of the soil so that seed planted in this way comes up very promptly. As the plants grow the drill can be filled in during cultivation. This method of planting will be found successful on well prepared land even in quite dry weather. If the seed is planted and then watered on the surface, the water will quickly evaporate leaving a hard crust that prevents the coming up of the seed.

VARIETIES.

It is not intended to weary the reader with a detailed account of all the kinds grown on the Station grounds during the last year. It will be sufficient to say that none of the foreign kinds tested seemed to excell the varieties commonly grown in this country. The general conclusion as to varieties may be summed up as follows. For the early crop, and to plant in succession for marketing when young, plant the flat kinds. For the main crop for late fall and early winter use, and especially for stock feed, plant the globes. For late winter use plant the yellow globes. For spring planting, especially if a little late, plant the flats.

Ruta Bagas.—The ruta bagas are usually classed with turnips though they should really be considered as a distinct vegetable. Cultural requirements and uses are the same as with the true turnips. They require a somewhat longer growing season and should be planted the last of July or the first half of August in this latitude. The yield on good soil is even heavier than with turnips, and they are eaten by cattle with greater relish. They are quite hardy, but will not stand as much cold as the yellow globe turnips. Each seedsman has some special strain of purple top ruta baga but for practical purposes all are much alike.

Extra Early Purple Top Milan.—This has proved to be one of the earliest and most desirable of the flat kinds. Planted August 26, it was ready for use by October 1. The foliage is rather scanty, but the roots are good sized, sweet and tender. It stands closer planting than the larger topped kinds, the roots fairly piling up on each other in the row.

Purple Top Strap Leaf.—This is one of the standard flat kinds that has much merit for general planting. It will probably make useable roots on poorer land and with less manure than any other kind. It is a heavy cropper but is from one to two weeks later than the Milan, and is not quite so delicate in flavor.

Early White Flat Dutch.—This is a good reliable flat kind but it has no advantage over the other two mentioned except that its pure white color makes it rather more attractive for market purposes. In season it matures with the last or possibly a little later.

Scarlet Kasmyr.—This is a very early flat turnip of recent introduction that is being extensively advertised. In color it resembles a scarlet radish which makes it a very striking novelty. It is almost as early as the Milan and fairly productive, but as grown here it develops a strong bitter taste making it almost uneatable when cooked. It cannot be recommended.

Purple Top White Globe.—This well known kind may be considered the standard of excellence among the white fleshed globes, and it is strongly recommended for general planting. It is a rank grower and a great yielder. The roots are large and shapely and of good quality. Among other desirable white fleshed globes may be mentioned the following: Early Auvergne Red Top, White Broad Leaf Globe, Red Top Norfolk, White Norfolk and Green Top Norfolk. These were all grown from French seed.

Golden Ball.—This is, on the whole, the most satisfactory of the yellow globes. It is of good medium size, good flavor, matures early, but keeps in the ground as well or better than any of the other kinds.

Yellow Aberdeen Purple Top.—This is a very rank growing late maturing kind. The tops are exceedingly heavy and vigorous but are quite liable to mildew. The root is larger and coarser than in the Golden Ball. It is a valuable kind for stock, and especially for sheep, as the heavy tops would furnish a great amount of pasturage for these animals.

Two varieties of so-called winter turnips of southern origin were planted, but the seed came late, and was not sown till the last of September. The tops remained green all winter, but neither kind produced roots of edible size, and both ran to seed very early in the spring. The test was not satisfactory.

Among the imported novelties Black Alsatian deserves a word of notice on account of its superior flavor. As grown here it was a very small, long or carrot shaped turnip, covered throughout by a dull black, cracked, exceedingly unattractive looking skin. The flesh, however, was white and fine grained with a peculiarly sweet nutty flavor unlike any of the kinds usually grown. The yield was very small and it can only be recommended to those who prefer quality to quantity and good looks.

BULLETIN No. 85. AUGUST, 1897.

ALABAMA

Agricultural Experiment Station

OF THE

AGRICULTURAL AND MECHANICAL COLLEGE,

AUBURN.

JAPANESE PLUMS.

F. S. EARLE, Horticulturist.

MONTGOMERY, ALA.:
THE BROWN PRINTING COMPANY, PRINTERS
1897.

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JAPANESE PLUMS.

No fruits of recent introduction have attracted wider attention and none promise to be more generally useful than the different varieties of Japanese plums. Like most fruits and ornamental plants that come to us from Japan they thrive in all parts of this state, and seem destined here to supersede the plums of native origin. The European varieties of plums do not as a rule do well in the South. The trees are not adapted to the climate and the fruit is so susceptible to the attacks of the curculio and of the brown rot that it seldom reaches maturity.

The Japanese plums are referred botanically to *Prunus triflora*, a species that is not now known in the wild state, but is supposed to have come originally from China.* As a class the trees are strong upright growers when young, but they bear so heavily that growth is usually very moderate in older trees. They come into bearing very early, often showing some fruit at one year from planting, and setting full crops at two and three years. A decided tendency to over bear may be considered one of their greatest faults. Some varieties bloom very early in the spring and are consequently liable to danger from frost; but others bloom with peaches or later and full crops may be expected as often as from the later fruit. In fact this season's experience shows that they are less affected by unfavorable weather at blooming time, since all the Japanese plums in this region were loaded, while the peach crop was very light, owing to the blasting of the flowers caused by warm foggy weather in the spring.

The fruit keeps and ships remarkably well. It will average nearly as large as that of the European varieties, the colors are if anything even brighter and more attractive,

*For the history of the introduction of these plums and for the best general account of them see Bulletins 62 and 106 of the Cornell University Agr. Exp. Station, by L. H. Bailey.

and the quality is good enough to satisfy the most fastidious. While they are subject to the attacks of the curculio and the rot they probably suffer no more from these causes than the inferior native kinds.

With so many points in their favor it is no wonder that the Japanese plums are attracting wide attention and are being largely planted both for market and for home use.

PROPAGATION.

These plums are now usually budded on stocks of the Marianna plum grown from cuttings. Formerly they were often budded on peach stocks but the Marianna root proves to resist borers, and unfavorable soil conditions, better than the peach, and it promotes a stronger growth. Budding on the native Chickasaw stock is not to be recommended as the roots sucker so badly as to be a perpetual nuisance in the orchard.

While the Marianna seems admirably adapted as a stock for these plums, it has proved a disastrous failure as a stock for the peach. This was tried extensively in a neighboring state a few years ago. A number of large orchards were planted with peach trees on Marianna roots. They grew well for the first year or two but the union was not perfect and they uniformly became dwarfed, short lived and unproductive. In no case have profitable crops been harvested from these orchards.

Well grown stocks may be budded in June, in which case the bud will start into growth the same season, and the trees may be planted the following winter. Such trees are known to the trade as "June buds." Though of small size they grow rapidly and usually make fine trees. It is more usual to defer budding till August. Buds set at this season do not as a rule begin to grow till the following spring, and hence are referred to as "dormant buds." Good orchards can be grown by planting these "dormant buds" but it requires more care and attention than planters are usually willing to give. The ordinary custom is to allow them to grow in the nursery row for another year. They are now known as "one year olds" and it is such trees that are recommended for general planting. A "two year old" Japan plum if well grown is too large to be conveniently or cheaply handled, and if not well grown they should certainly be rejected.

SELECTION AND PREPARATION OF SOILS.

These plums will grow fairly well on almost any well drained soil. Wet, seepy, or sour lands should always be avoided. The trees will, as a rule, be longer lived and healthier on clay than on sandy soils, though a sandy top soil underlaid by a good red clay subsoil is usually a favorable location. Hill tops are to be preferred to low lands on account of greater freedom from spring frosts, and from diseases. Except where soils are naturally very poor, old somewhat worn land is preferable to new land. Rich new soils will produce too rank a wood growth, and induce rotting of the fruit.

The land should be cleared of all stumps or other obstructions, and during the fall should be deeply plowed and well harrowed. When ready to plant lay off the rows with a turning plow, running several times in the same place so as to throw out as deep a furrow as possible. This will save most of the labor of digging holes.

If the land is level enough* to admit of making the trees row both ways, mark the cross rows by dragging a heavy log chain, while walking to guide stakes set at the ends and middle of the field. If the ground is in good fine order the chain will leave a mark that can be plainly seen, and with a little practice a careful man can lay off rows in this way rapidly and accurately.

PLANTING.

The trees should now be brought to the field and be heeled in at convenient intervals so as to be quickly acces-

*It is not advised to plant commercial orchards on lands so rolling as to require terracing. For further discussion of orchard soils see Bulletin 79, pp. 89-90.

sible to the planters. The planting crew will consist of two to three men according to the condition of the soil. If soft and in good condition one man can handle the dirt fast enough for the planter. In hard rough soils he will need two shovelers. The planter should be a careful man with some experience and plenty of good sense; and he should be made responsible for the work of the shovelers. The planter takes a small bundle of trees with him (not over a dozen should be exposed to the air at one time) and with a sharp pruning knife clips off the ends of the larger roots leaving stubs four to eight inches long. This is partly for convenience in planting, and partly because these old roots will be of but little use to the tree except as an anchor to hold it fast in the ground. These old roots have lost their power of rapidly absorbing water and dissolved plant food from the soil. This is only done by the new growth of soft white rootlets, that will push out all the more rapidly and abundantly for having part of the old ones cut away. As the planter cuts back the roots of the tree the shoveler throws out the dirt from the bottom of the furrow at the point where it is crossed by the chain mark. The planter now sets the tree in place, noticing first if the hole is the right depth to leave the tree standing a half inch or so lower than it did in the nursery row. He then sights both ways quickly to see that the tree is in the proper position, and, at the word, the shoveler fills in small shovels full of fine dirt, which the planter packs closely about the roots by tramping it with his feet. This is one of the most important parts of the operation, and the future growth of the tree will depend largely on having the dirt brought in close contact with all parts of the roots, and so packed down that it will not settle away and leave air spaces about them. No clods, rocks or sods should be allowed to go in the hole near the roots, as they prevent the proper packing of the soil. When the soil is mounded about the tree a little above the surrounding level, the planter, placing a foot on either side of the tree to prevent loosening the roots, clips off the top with his knife at a point just above the knee, or say two feet from the ground. Side limbs, if there are any, which is not usual with one-year-old trees, are cut away and the tree is planted.

Digging great holes and carefully straightening out the long roots and getting them into just such or such position, as has been so often recommended for planting trees, is simply a waste of labor. The only essentials for successful tree planting are first, to prevent the roots from drying out through exposure; second, that they are put in mellow soil that is well compacted about them; and third, that the top is heavily cut back to prevent a too great demand for moisture when the leaves open, and before the new root growth has had time to develop sufficiently to absorb the large amount of water required by the leaves. Two active men can, in properly prepared soil, plant from 400 to 800 trees per day and do the work well. After the trees are planted the furrows should be thrown back with the plow and the ground cross harrowed to prevent washing.

Trees may be planted successfully in this climate at any time from November to March that the soil can be put in good condition. Planting may even be delayed as late as April or May when the trees are kept dormant in cold storage. Late planting is, however, not recommended. Fall or early winter planting will usually give the best results, Root growth normally begins much earlier than leaf growth, and the early planted tree has time to get well established in the soil with its new roots ready to supply the moisture demanded by the unfolding leaves. In the late planted tree the root and leaf growth must begin together, and in dry spring weather this is a severe tax on the vitality of the tree.

The proper distance apart to plant the trees will depend to some extent on the richness of the soil and on other considerations. In most cases sixteen by twenty feet will be found a suitable distance.

CULTIVATION.

Frequent shallow cultivation from early spring till after the middle of summer is necessary for the best success with plums. If the land chosen can be worked both ways, and if it has been cleared of stumps so as to admit of the use of wide cultivators and harrows, this will be simple and inexpensive. Most people will wish to grow some crop between the trees for the first two years. For this purpose nothing is better than cotton. It should be planted a little late so that cultivation may continue as late in the season as possible, and the rows next the tree row should be given a little more space than the others to avoid rubbing the trees in cultivation. Other hoed crops like Irish potatoes may be substituted for cotton, but no crop should be planted that will prevent the frequent stirring of the soil up to midsummer or later. Oats or other small grain crops should be particularly avoided. Nothing is harder on young trees than small grain crops. After the second summer the trees will occupy the land so fully as to make a crop of any kind between them unprofitable. If weeds and grass spring up after the last working they should be allowed to fall down and lie on the ground as a mulch during the winter, and should be plowed under in early spring; or better still, they may be plowed under in the fall and the land at once be seeded to rye or winter oats. Such a winter crop prevents washing and it also takes up the soluble fertilizing elements from the soil and prevents their leaching away during heavy winter rains. This winter crop should be plowed under in February or early March thus returning this fertility to the soil. It should on no account be allowed to mature.

FERTILIZING.

On land that is rich enough to make say half a bale of cotton to the acre without fertilizers no fertilizer will be needed for plum trees; or at least not until after they have borne several heavy crops. On soils so poor as to require fertilizers to produce profitable crops of corn or cotton the trees will be benefitted by light applications also. For the first two years one or two pounds per tree of some good complete fertilizer may be used. A mixture of 3 parts of cotton seed meal, 3 parts acid phosphate and 1 part kainit is recommended for this purpose. The first application may be conveniently applied just after the trees are planted and before the furrows are filled in. It should be scattered in the furrow on either side of the tree so as to be covered by the plow in filling the furrow. The fertilizer should not be placed in immediate contact with the roots. In subsequent years the fertilizer can be broadcasted about the trees where it will be worked in by the first spring plowing. As the trees reach bearing age increasing quantities of acid phosphate and kainit should be used with a less proportion of cotton seed meal. It is not advisable to use stable manure in the plum orchard. On thin soils it will be a good practice to sow cow peas broadcast at the time of the last cultivation, say about August first. They may be plowed under and the ground seeded to rye or oats in October; or they may be allowed to lie on the ground as a winter mulch. A good growth of peas will add nitrogen enough to the soil so that the cotton seed meal may be largely omitted from the fertilizer.*

PRUNING.

The method of pruning at the time of planting has been already described. It is more essential then than at any subsequent time. Soon after the new growth starts in the spring all superfluous shoots should be rubbed away, leaving three or four of the strongest near the top of the stem to form the head of the future tree. It is usually necessary to go over an orchard two or three times in order to catch all the trees in the right condition for this operation. The shoots that are allowed to remain should preferably be

*For a further discussion of fertilizers for orchards see Bull. 79 pp. 97-99.

scattered a little along the stem. If too near together they will form sharp crotches as they grow older, that split down more easily when the trees are loaded with fruit. They will grow rapidly when the others are removed. When they reach a length of twelve to eighteen inches the tips should be pinched off to make them more stocky, and to induce branching, otherwise these limbs will grow too long and straggling, and too much of the seasons growth must be sacrified at the winter pruning to bring the heads back to proper shape. The one summer pinching will usually be all that is really necessary, though the careful grower will continue to go over his trees at intervals cutting off a surplus limb here, and pinching back a shoot there, to keep the trees growing into a desirable form. During the first winter, or preferably just before the buds start in the spring, the trees should be again carefully pruned, removing all surplus branches and shortening in the past seasons growth so as to give the tree a symmetrically rounded head. This is an important operation as it is practically the last chance to shape the top of the future tree. The second spring the trees will send out numerous shoots that will make a very rapid growth. At eighteen to twenty-four inches these shoots should be pinched back. This will tend to make them branch and become more stocky, and it will also hasten the development of fruit buds for the next seasons crop. Subsequent pruning must depend on the condition of the tree. If growth is very strong during the summer it should be checked by pinching. Usually after the trees begin to bear this will not be necessary. Every winter the trees should be gone over to remove dead or broken branches, shorten in or remove water sprouts, cut back new growth when it is too long and limber, and, where the tree is evidently over bearing, to head back the old wood. No rules can be given for such work but it must be left to the judgment and skill of the operator. One rule should, however, always be enforced and that is to never cut off a limb unless some good reason can be given for it. A little wholesome neglect in the matter of pruning will do less harm than indiscriminate cutting.

THINNING.

Nearly all tree fruits are benefited by judicious thinning when the trees are carrying a full crop. In no case is this more important than with most varieties of Japanese plums. Fruit buds are produced in the greatest abundance and when the season is favorable the fruits set so thickly as to fairly hide the limb from view. Such crowded fruit must necessarily be small and inferior. Besides, the maturing of so many seeds is a great drain on the vitality of the tree. Another argument in favor of thinning is the lessened danger of loss from rot. Where the fruits are packed closely on the limb a single rotten one will quickly con-

Burbank plum, showing effect of thinning on size of fruit.

taminate all its neighbors; but if part have been removed so that they hang singly, the disease will progress much less rapidly. The effect of thinning on the size of the fruit is well illustrated by the accompanying cut which is a photographic reproduction of two twigs of Burbank plum, one of which has been thinned and the other not. The increased size of the fruit when thinned nearly or quite makes up in bulk for that taken off, and its superior quality largely increases its market value. Do not thrash the surplus fruit from the tree with poles as is sometimes recommended. That is simple barbarism. It should be removed by hand, taking care to pick off all imperfect or inferior specimens, leaving only perfect fruits hanging far enough apart so that no two touch each other. This should be done when the fruit is about half grown and before the stone hardens. It is usually best to go over the trees a second time just before the fruit swells for ripening. Many growers object to hand thinning fruit on account of the expense; but if all the fruits are allowed to remain on the tree they will have to be picked when ripe, so that if it pays better to pick part of them while still green the expense argument fails.

MARKETING.*

Most varieties begin to color some days before they are fully mature. Growers frequently make the mistake of picking and shipping them in this unripe condition. No greater mistake could be made. Such fruit will color after picking, it is true, but it will always be tough and leathery, and will never develop the sweet rich flavor of tree ripened fruit. The only way to retain and build up a market for fruit is to furnish goods that not only look well but taste well. There is less excuse for this green picking with Japanese plums than with most fruits for they are remarkably good keepers, even when fully ripened on the tree.

*For a general discussion of the marketing of fruits and vegetables see Bulletin 79, pp. 103, 110.

Fruit of all kinds should always be carefully hand picked—never shaken from the trees, and should be handled with such care as to preserve the natural bloom and prevent all bruising. If baskets are used for picking they should be lined throughout with cloth to protect the fruit from the sharp edges of the splints. Buckets are usually to be preferred to baskets for picking as they are smoother; and the "emptys" can be conveniently nested for sending back to the field. At the present time the Georgia six-basket crate, holding about three pecks, is probably the best package for southern grown plums. Perhaps the greatest objection to it is its expense. Plums are also shipped in one-third bushel boxes but this package has been used to ship so much poor fruit, that it is no longer considered a high priced package. Refrigerator transportation should be employed where possible, but plums will stand shipment by express or by freight in ventilated cars with greater safety than peaches.

INSECT ENEMIES AND DISEASES.

If it were not for injurious insects and plant diseases, the growing of fruit of any kind would be comparatively easy. These insidious foes meet the grower at every turn and tax his ingenuity and skill to the utmost to overcome them. Successful fruit growing is getting to mean more and more a constant battle with insects and fungi. At first view this seems discouraging, but after all it is the one factor that assures the wide awake industrious fruit grower a fair price for his goods, for the sloven can not control these pests, and must ultimately be forced out of the business. Only the more important of the numerous enemies of the plum and those that are known to be destructive in this state will be considered here.

CURCULIO.

This is the insect (*Conotrachelus nenuphar*) that causes worms in peaches, plums and cherries. It is a curiously shaped grayish brown beetle about the size of a grain of rice. It passes the winter in the adult or beetle stage, coming out from its hiding places about the time the trees begin to bloom. It feeds sparingly on the young peach and plum leaves as they expand, but does little damage in this way. When the young fruits are formed they are visited by the female, who cuts a crescent shaped flap in the skin and deposits an egg under the flap. This egg soon hatches into a tiny white worm (the larva) which gradually works its way toward the pit of the fruit. When the wormy fruit finally falls to the ground the full grown larva comes out and burrows into the soil where it undergoes its transformations and at length emerges as the fully developed beetle. The damage done by this insect is well known, and it often reaches enormous proportions. Where trees continue to bear crops year after year, the curculio increases so rapidly that the entire crop often proves worthless. A season when all the fruit is destroyed by frost will so diminish their numbers from lack of suitable breeding places, that the following crop will be comparatively free from them. No one should plant an orchard of either plums or peaches who does not resolve to fight this insect by every possible means. The beetle has the habit of folding up its legs and wings and dropping to the ground when it is suddenly disturbed. The usual method of destroying it depends on this

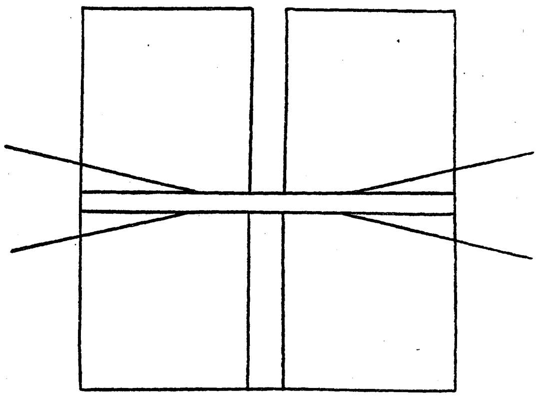

Diagram of frame for a curculio catcher.

seemingly unimportant habit—a fact that well illustrates the necessity for the most careful and painstaking study of the habits and life history of all injurious insects. A frame covered with white cloth, but having an opening in one side to admit the trunk, is placed under the tree, which is then suddenly jarred. The curculio at once "play possum" and drop on to the sheet where they can be gathered up and destroyed. If the land is level and the trees have been specially trained with high heads, the frame can be made in the shape of an inverted umbrella, and be mounted on a wheel, with handles like a wheelbarrow; and one man can roll it about the orchard. Such machines are usually provided with a pan under the center which is filled with kerosene and the insects roll down into it and are killed without delaying the operator. In most orchards a frame like that shown in the cut to be carried by two men will be found more convenient. This is made by taking a piece of 2 by 4 in. scantling 8, 10 or 12 ft. long, according to the size of the trees, and nailing on light cross-bars of the same length, and handles. The cloth is tacked over the whole frame and the side opening cut out. If the trees are small the scantling may be heavily padded at the center, and the trees be sufficiently jarred by swinging the frame against the trunk sharply once or twice. With large trees it is better to strike the separate limbs with a padded mallet. The blow does not need to be heavy but it must be a sharp, sudden jar, not a gentle shake, or the beetles will not fall. After jarring each tree the beetles should be picked up and killed, or they may be dropped in a bottle with a little kerosene in order to keep track of the amount of the catch. The beetles will lie still a longer or shorter time, according to the temperature, but in warm weather they soon jump up and fly away, so that it is necessary to gather them up at once. A modification of this catcher is used by some consisting of two light half circular frames each carried, supported from a strap around the shoulders, by one man. The two men meet under each tree and jar it with mallets, the two half circles thus completing the catcher. This is probably a little more expeditious as the time lost in approaching and backing away from the tree with the other catcher is saved.

This catching of "bugs" will be looked upon as small business by some, and as tedious and expensive business by others, but it is the price we must pay for sound fruit, except in years when the previous crop has been entirely destroyed by frost. When gone about in a businesslike, systematic manner the trouble and expense is less than would be supposed. Two good men will easily care for 500 trees, and the amount of fruit saved will many times repay the cost. Jarring should begin as soon as the flowers fall. If no curculio are found wait a few days and try again. As soon as they are found in any number each tree should be jarred once or twice daily, until the diminished catch indicates that it is no longer necessary. Usually two or three weeks will serve to catch most of the beetles, but sometimes it will be found necessary to continue the work until the fruit is ripe. The few bearing plum trees on the Station grounds were jarred this year as follows:

April 5	(a part of trees only)........	57 beetles.
April 6	(too windy for good work)...	116 "
April 7	(bright still morning).......	304 "
April 8	....	145 "
April 12	....	38 "
April 13	....	31 "
April 16	....	11 "

The work should have been begun at least a week earlier, as many of the plums were already stung; but the record shows how quickly the beetles can be disposed of in a comparatively isolated orchard. When a man has to catch his neighbors bugs as well as his own the case becomes more difficult.

Jarring is the most reliable remedy for this troublesome insect, and it should not be omitted under any circumstances; but there are other means for helping to keep it in check that should also be employed. One of the most important of these is the destroying of all fallen wormy fruit. This is often done by pasturing the orchard heavily with hogs or sheep. These animals will pick up the wormy fruit as fast as it falls. Where this is not practicable all fallen fruit should be picked up by hand two or three times a week, and either be fed to stock or boiled to destroy the worms.

In the early spring the beetles often take shelter under trash of various kinds in the orchard. If the ground is plowed, harrowed, and then dragged smooth with a plank, such shelter will be hard to find; and a few cobs or pieces of bark laid about the trunk will prove attractive to the insects. By turning over these traps every morning considerable numbers can often be killed, and this, too, early in the season before they have deposited their eggs.

The feeding habit of the beetle makes it possible to kill some of them by spraying the trees with Paris green. Plum foliage is not so easily injured by the arsenites as peach foliage, so there is no objection to employing this means of fighting the curculio. It has been found that mixing the Paris green with lime water, or better still with Bordeaux mixture, lessens its injurious effect on the foliage. As the Bordeaux mixture is useful for other purposes also it should be used as the vehicle for applying Paris green to plum trees. Some experimenters* have held that spraying with Paris green would, in itself, give sufficient protection from the curculio. It is not advised to rely on this alone, however, but to use it in connection with the other remedies suggested.

This line of treatment is equally applicable to peaches and the subject is of such importance to the southern fruit grower as to warrant the restating of the proposed treatment in the form of a condensed summary:

*Notably C. M. Weed, see Bulletin 8, 2nd. series, of the Ohio Experiment Station, issued September, 1890.

SUMMARY OF TREATMENT FOR PEACH AND PLUM CURCULIO.

1. When trees are in bloom, trap them under bark or cobs placed at base of tree, the ground in the orchard being first made smooth as possible.

2. Spray three times with 4 oz. of Paris green mixed with a barrel of Bordeaux mixture. Spray first just before flowers open, second just after they fall, and third in ten days or two weeks.

3. Jar the trees, and catch the beetles on sheets, going over the trees every day from the time the blooms fall until the beetles are all caught.

4. Destroy all fallen wormy fruit either by pasturing to hogs or sheep, or by hand picking.

PLUM BORER.

The plum is often attacked by the peach tree borer (*Sannina exitiosa*). A small moth, much resembling a wasp in general appearance, lays eggs on the bark at the base of the tree. When the egg hatches the young larva burrows into the bark and makes long winding tunnels between the bark and the wood. The presence of the borer is usually indicated by masses of gum and sawdust that exude from the wounds. If several borers attack the same tree, they may girdle it, and thus cause its death. It is a serious pest throughout the south, especially on sandy lands. When borers have gained entrance to the tree, the dirt should be pulled away and the borer be cut out with the point of a knife, taking care to injure the live bark as little as possible. If the base of the trunk is kept covered with a wash containing Paris green, the moth will either be deterred from laying the eggs, or the young, when hatched, will be destroyed before gaining the shelter of the bark. The dirt should be hoed away from the trunks in the orchard in early spring and the tree be carefully examined and all borers killed. Before hoeing back the dirt paint the trunks for a foot or more with Bordeaux mixture and Paris green, using about four times the strength that is applied to the foliage. In four to eight weeks the wash should be applied again. Bordeaux mixture is recommended instead of white-wash since it sticks to the bark so much longer.

PLUM APHIS, LOUSE, OR GREEN FLY.

The plum aphis (*Aphis pruni*) is a large dark colored plant louse, that is sometimes very abundant and destructive in this state. It often occurs in great numbers on the leaves and young shoots. It can be destroyed by spraying with kerosene emulsion, but it is more resistant than most of the plant lice, and a strong emulsion is required. Luckily plum foliage is not easily injured by this spray. The mechanical mixture of kerosene and water, made with the Weed attachment to a knapsack pump, has been used on the Station grounds as strong as one part of kerosene to five of water without injuring plum foliage in the least. A single application of this strength completely destroyed the aphis, though it resisted repeated applications of the ordinary strength, one of kerosene to ten of water.

SAN JOSE SCALE.

This dreaded insect attacks plums as well as most other fruit trees. In fact it was probably first introduced in the east on nursery stock of Japanese plums brought from California. It is unfortunately established in this state at several places and should be carefully looked out for. Methods of treatment, &c., are given fully in Bulletin 77.

PLUM ROT.

The brown rot (*Monilia fructigena Pers.*) is easily our most troublesome and destructive fungus disease of the peach and plum. Its effect on the fruit is too well known to need description. Unseasonably warm, damp, foggy weather at blooming time sometimes induces an early development of this rot fungus that attacks the flowers, causing them to blast. This cause destroyed the peach crop this spring in many parts of the south. Plum flowers seemed more resistant or perhaps opened at a time when weather conditions were less unfavorable, as the plum crop was not injured. The rot fungus also attacks young rapidly growing shoots causing them to blight and die in a manner somewhat resembling pear blight. When bearing trees are making too great a wood growth this twig blight is often a serious trouble, and injuriously effects the future health of the tree. Bordeaux mixture is now the standard remedy for all diseases of the class to which the plum rot belongs, and it has been used with considerable success for the treatment of this pest by various experimenters.* Its use, however, has not always proved successful, and the brown rot must still be classed among the diseases that are very difficult to successfully control. Among preventive measures may be mentioned the planting of resistant varieties, it is a well known fact that some varieties rot much quicker than others; the selection of high, well drained soil of moderate fertility, and the use of such fertilizers only as will not induce too rapid and succulent growth; checking a tendency to too much wood growth by stopping cultivation, or even seeding an orchard to oats, if on very rich land; training a tree with a somewhat open head to allow free circulation of the air and consequent rapid drying of the fruit, for the disease does not spread while the fruit is dry; careful thinning of the fruit so that no two fruits touch each other; the systematic picking off and destroying of all diseased fruits as soon as possible after the disease makes its appearance; the careful pruning out and burning of all dead twigs and of all mummied fruits during the winter, as these serve to carry over the contagion for another year. The last two are very important. In addition to the above suggestions spray the trees three times with Bordeaux mixture and Paris green as advised in treatment of curculio. For later sprayings Prof. Chester advises using acetate of copper, 6

*F. D. Chester of the Delaware Experiment Station has been particularly successful in the application of fungicides for this disease. See Bulls. 19, 29 and 34 of that Station.

to 8 oz. to the barrel of water rather than the Bordeaux mixture, as the latter will stain the fruit unpleasantly. Farther work is greatly needed in spraying peach and plum orchards under southern conditions, and on a commercial scale, for the prevention of brown rot.

ROSETTE.

This is a disease of the peach and plum that is distinct from, but quite closely resembles, the notorious peach yellows. It takes its name from the tuffted growth of the small, curled and yellowed leaves on diseased trees. This peculiarity is so marked that such trees attract attention at a considerable distance. The disease was first observed in Georgia, where it was extensively studied by Dr. Erwin F. Smith of the Department of Agriculture.* He found it to be contageous, and that it could be communicated from tree to tree by innoculation. He was not able to determine the exact cause. No remedy is known except to cut down and burn all diseased trees as soon as detected. While the disease has not spread and become as troublesome as was at one time feared, it should not be neglected, as a more virulent outbreak may occur at any time.

I have observed isolated cases of Rosette at different points in Lee and Chambers counties during the present Summer (1897) so it must be included among Alabama diseases.

BLACK KNOT.

Blackened swellings of the twigs and smaller branches of plum trees caused by a fungus (*Plowrightia morbosa*) often do considerable damage, in some cases even causing the death of the tree. This fungus is quite common on the wild cherry (*Prunus serotina*) and on some of the wild plums in central Alabama. Specimens have been taken on the Japanese plums in Mobile county.

*See Bull. No. 1, of the Division of Vegetable Pathology U. S. Department of Agriculture (1891).

The careful cutting out and burning of all diseased twigs during fall and early winter and spraying the trees in the spring with Bordeaux mixture, as advised for the rot, will serve to keep this disease in check.

OTHER DISEASES.

Various leaf eating insects and leaf inhabiting fungi sometimes attack the plum. No better treatment for them can be given than the sprayings with combined Paris green and Bordeaux mixture that have already been advised.

Large excrescences known as "crown galls" are sometimes noticed on the trunk or main roots of the plum and other fruit trees. They often seriously interfere with the health of the tree. Recent experiments by Dr. B. D. Halsted* indicate that they are communicable. No remedy is known, but nursery stock showing these excrescences should be carefully rejected.

The smaller root knots caused by nematode worms that occur so abundantly on peach roots in infested lands are seldom seen on the plum.

Blisters or pockets filled with gum are sometimes found under the bark on the trunk and limbs. This condition is known as gummosis. It indicates a seriously diseased state of the tree, but cause and remedy are both unknown. In the south many peach and plum trees die from gummosis.

VARIETIES.

For a detailed description of the varieties of Japanese plums the reader is referred to Bulletins 62 and 106 of the Cornell University Experiment Station by Prof. L. H. Baily who is the acknowledged authority on this subject, and to the catalogues of the leading southern nurseries.

Only such varieties will be mentioned here as have been

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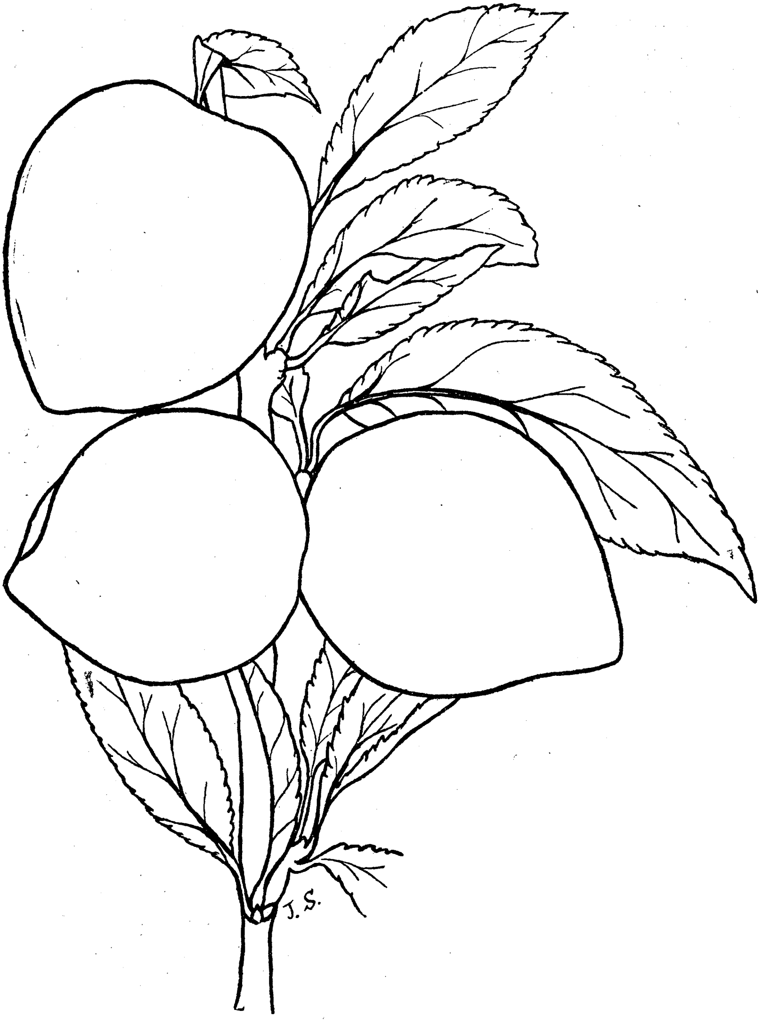
*Annual Report of the New Jersey Experiment Station for 1896, p. 413.

fruited on the Station grounds and give promise of being generally useful for home use or market. They will be mentioned in the order of ripening.

KERR.

This fine yellow plum formerly called Hottankio, which is represented exact size in the accompanying figure, has been



Outline of fruit and foliage of Kerr plum, natural size.

the earliest of the Japanese plums to ripen on the Station grounds both in 1896 and 1897. Its good size, fine flavor, and attractive appearance together with its early ripening make it a promising variety both for market and the home garden. It is free from rot and is a rather late bloomer, thus being less liable to injury from frost. It was one of the few kinds that gave a partial crop in the unfavavorable season of 1896. The season of 1897 has been rather late, but the Kerr was beginning to ripen by May 26, and was at its best during the first week in June. It does not seem to be as heavy a bearer as some others, but that is not always a disadvantage as it saves the laborious work of thinning.

RED JUNE.

This season's experience serves to emphasize the value of this fine early red plum. It stands on our list as "Red Nagate" but Bailey (Cornell Bulletin 106, p. 24) gives preference, for good reasons, to the name proposed by Stark Bros. It closely follows Kerr in ripening, being ready to pick this season the second week in June. Its fine color, good flavor, firm flesh and fine keeping qualities, together with its freedom from rot, very late blooming habit, and abundant fruitfulness make it one of the most desirable kinds for general planting.

BERKMANS.

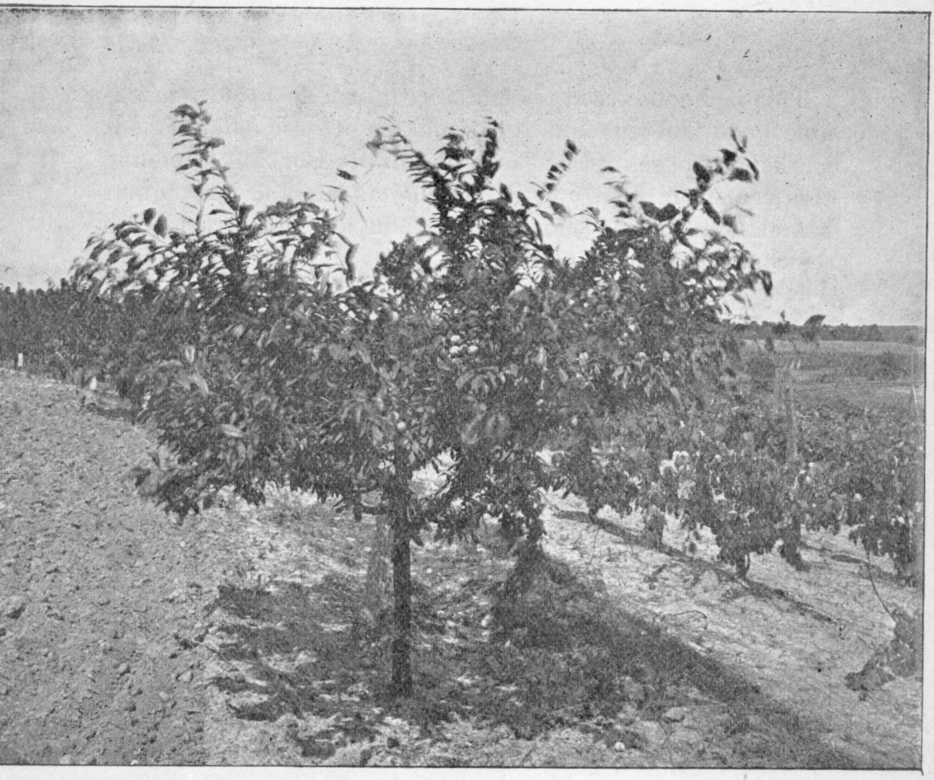
This is one of the varieties that has been confused under the name of Botan. It has been called Sweet Botan or White Fleshed Botan. To my taste it is the finest flavored of the Japanese varieties. Its flesh is juicy and melting so that it probably will not ship as well as the firmer fleshed kinds, and it develops an unfortunate tendency to rot under unfavorable conditions. It should certainly be included in every home orchard, and should not be neglected for market purposes, though it would be unwise to plant too largely of it. In season it comes between Red June and Abundance.

ABUNDANCE.

This is probably the best known and most widely planted of the Japanese varieties. It was formerly known as Botan and as Yellow Fleshed Botan. Perhaps its greatest fault is a tendency to overbear which makes the fruit small and inferior, unless heavily thinned. It is recognized as a standard market plum. It ripened this season the third week in June·

BURBANK.

This fine kind is a marked favorite in most plum growing regions. Unfortunately here it developes an alarming ten-



Tree of Burbank plum showing spreading habit of growth.

dency to rot on the tree. The partial crop set in 1896 was all lost by rot, and in 1897 a larger proportion of the fruit rotted than any other kind except Kelsey. Even on trees that were carefully thinned, and were sprayed two or three times early in the season with Bordeaux mixture, the loss was considerable. Like Abundance it is inclined to overbear and is much benefitted by thinning as is shown in the photograph on page 431. The spreading habit of growth of the tree is well shown in the accompanying photograph. This is strikingly different from the trees of the other varieties mentioned in this bulletin which are all upright growers. The Burbank has a long ripening season, furnishing pickings this year from June 20 to July 4.

CHABOT.

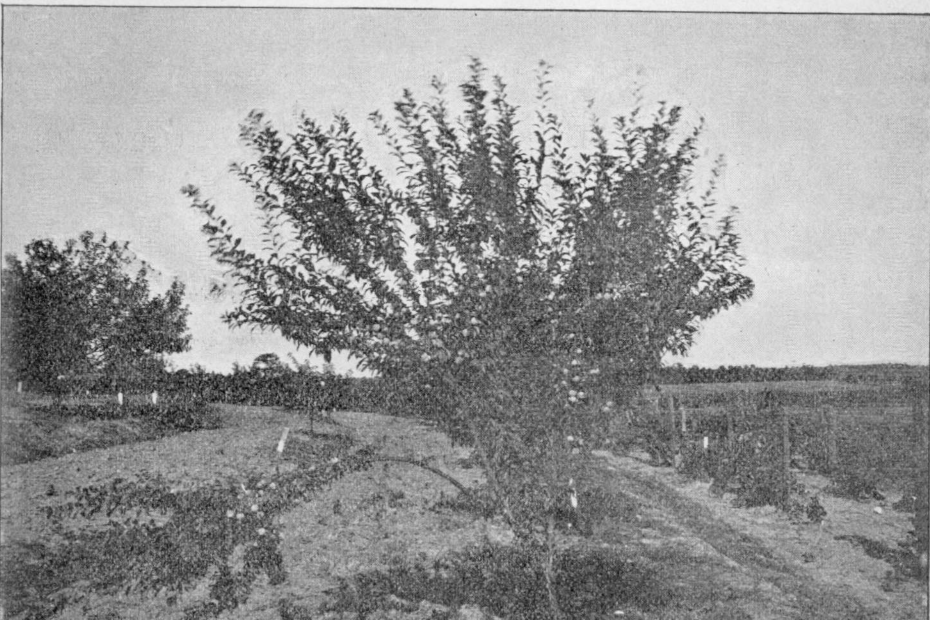
This is a good sized red plum with firm flesh and remarkable good keeping qualities, making it well adapted for market purposes. In season it follows Burbank, ripening this year from July 5 to 10. It blooms late and is a regular bearer. It ripened more fruits than any other variety on the Station grounds in 1896.

SATSUMA.

This fine kind is often called blood plum from the dark red color of the flesh which resembles that of the old Indian cling peach. The flavor is exceedingly rich and fine. It is very desirable for the home garden as the fruit is especially suited to canning, jellies and preserves. When cooked it retains its fine color and flavor to a remarkable degree. As a market fruit it has two serious drawbacks. It blooms very early in the spring and is thus liable to loss of crops from frost; and, though the flesh is so brilliantly colored, the skin is dull and unattractive. It has been accused of rotting badly, but this year it was noticeably free from that trouble. It ripens with the Chabot, and like that variety it is a very long keeper.

KELSEY.

This was the first of these plums to be introduced from Japan. It is also the largest and the latest to ripen. Where it can be safely grown it is a magnificent fruit, but it can hardly be recommended for this state on account of two very serious faults. It blooms even earlier than the Satsuma, in southern Alabama sometimes beginning to open in January, so that full crops are infrequent; and it is more subject to rot than any of the other kinds. The accompa-



Tree of Kelsey plum.

nying illustration shows a Kelsey tree on the Station grounds bending with its load of half grown fruits. This tree was thinned twice and sprayed three times, and the rotting fruits were repeatedly picked from it, but at this writing (July 22nd.) it has lost fully three-fourths of its crop from rot, and it is still an open question whether any perfect fruit will mature. The season of ripening is somewhat uncertain, varying from the middle of July to October according to the condition of the tree and the season.

BULLETIN No. 86. AUGUST, 1897.

ALABAMA

Agricultural Experiment Station

OF THE

AGRICULTURAL AND MECHANICAL COLLEGE,

AUBURN.

I. More About the San Josė Scale.

II. A Sweet Potato Pest.

III. Regaraing Carbon Bisulfid.

IV. Insecticides and Pumps in General.

C. F. BAKER.

MONTGOMERY, ALA.:
THE BROWN PRINTING COMPANY, PRINTERS
1897.

☞The Bulletins of this Station will be sent free to any citizen of the State on application to the Agricultural Experiment Station, Auburn, Alabama.

I. MORE ABOUT THE SAN JOSE SCALE.

In the inspection of various nurseries made in Alabama this spring, several facts of interest regarding this pest were noted. In nurseries where all stock was kept moving every three years, there were no cases of evident infestation among the nursery trees. Although on some of these places apple trees in old orchards and the old wood of pear grafting stock over five years of age, bore the San Jose scale. I was told by experienced nurserymen that it would be entirely practicable to move also all blocks of grafting stock every three years. On the places above mentioned this plan will be followed, and the orchards removed entire. All of which will practically preclude the possibility of the San Jose or any other scale gaining a foothold in these nurseries. Acting on my advice, all the nurserymen visited (and most of the larger nurseries in the state were inspected) have undertaken thorough methods of fumigation. Thus, while the first move will protect the nurserymen the fumigating will still further protect purchasers of stock.

Food Plants Other Than Fruit Trees.

The question is often asked as to what trees other than the fruit trees, the San Jose scale will attack, Webster, in Ohio, has found it on Basswood or Linden, Sumac, Elm, Walnut, Willow, several Poplars, Catalpa, Chestnut, Osage Orange, and Snowball. A specimen of Cotoneaster, coming from a Long Island nursery and sent to Webster for examination, was found to be very badly infested.

Varieties of Fruits Possessing Immunity.

Inquiries have frequently come to me as to whether there were any varieties of the various fruits possessing immunity from the attacks of this pest. I have heard of but one, and that was reported by Webster. He says: "The Early Richmond Cherry I believe to be exempt from attack, as I have found trees whose branches interlocked with those of a pear that had been killed by the scale, yet the cherry was uninfested; and in two cases that came under my observation, where this variety of cherry had been grafted upon mahaleb stock, and shoots had sprung up from below the graft, the shoots were badly infested with scale, while none at all could be found on the trees themselves.

What Does This Scale Look Like?

This question has come up for reply more often than any other in connection with the San Jose scale. And right here I would say that the "San Jose Scale" is a *bug* pure and simple, and not a "fungus" or a "blight." It is a very small bug and forms minute, grayish, circular scales, having a small dark dot at center. These scales are closely attached to the bark, and when numerous and covering more or less completely the entire surface they give the bark the grayish, scurfy appearance mentioned in Bull. 77. The infested twig shown in fiig. 1, a, will give some idea of the gross appear-

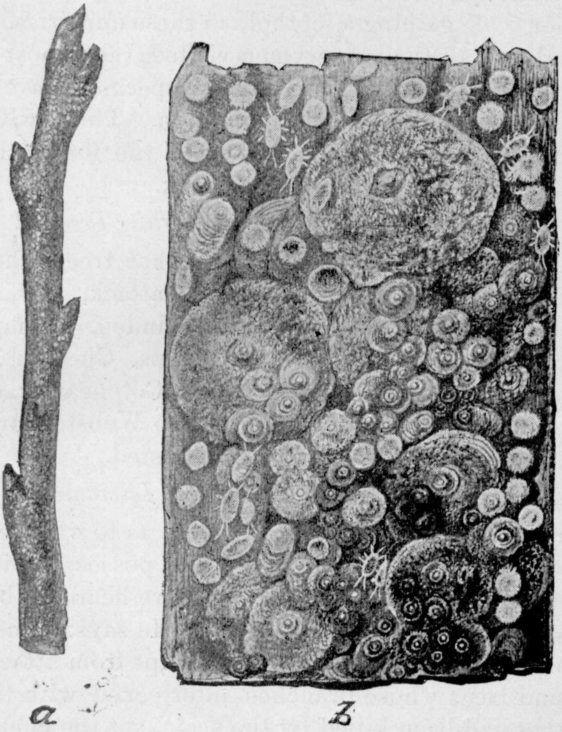


FIG. 1. Appearance of scale on bark; a, infested twig, natural size; b, bark as it appears under hand lens, showing scales in various stages of development and young larvæ. From Bull. No. 3 N. S. U. S. Dept. Agrcl. Div. of Entomology.

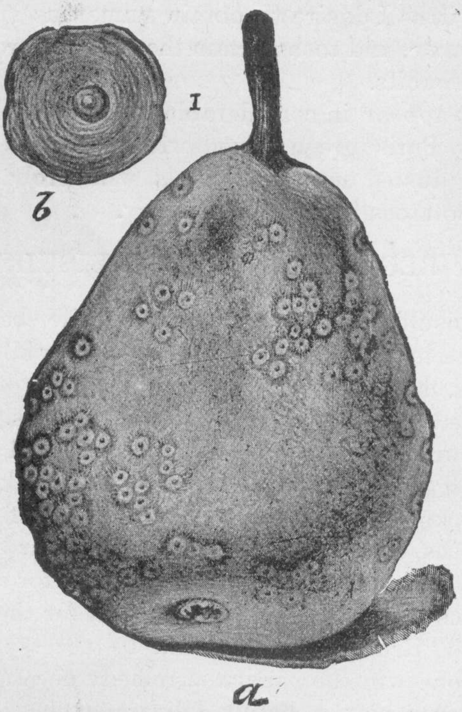


Fig. 2. Appearance of scale on fruit; a, infested fruit, natural size; b, a single scale enlarged. From a Div. of Ent. Bull. U. S. Dept. Agrcl.

ance, while placed under a good magnifying glass this same twig may show the appearance at fig. 1, b, in which can be seen numerous scales and several of the minute active young. The scale also occurs sometimes on the fruit and then may present the appearance shown in fig. 2, a, one of the scales enlarged being shown at fig. 2, b.

II. A SWEET POTATO PEST.

Several years ago specimens of a larva injuring sweet potatoes were sent from Ocean Springs, Miss., to the U. S. Entomologist. Now, what is apparently the same thing has turned up in Alabama. But little is known of it, so that further facts would be very desirable. It is mentioned here to draw the especial attention of growers of sweet potatoes to it, as I desire to obtain numerous specimens of the living larvæ, and to ascertain the facts regarding its life history and habits.

Should it appear in considerable numbers an application of one part Paris green mixed with ten parts of flour or plaster and dusted onto the plants, will probably protect the sweet potatoes from further injury.

III. REGARDING CARBON BISULFID.

Carbon bisulfid is a clear, very volatile bad smelling liquid, which has become extremely useful for killing insects in granaries, mills, and in stored food products of all kinds it is also used for gophers, rats and ants in hills.

Here in our Southern homes we are bothered by a great' many very aggravating little household pests, like bedbugs crickets, cockroaches, ants, the little silvery "fish moths,' clothes moths, book lice, carpet beetles, flour beetles, etc· Numerous remedies have been suggested for combatting these various pests, so many in fact that for their accurate use a special "Receipt Book" would be necessary to point out to the housewife the particular remedy necessary in each case. However, now, a happy deliverance has come to us in the form of the beneficent Carbon Bisulfid. By its use a house can be completely ridden in one night of not only all these, but all rats and mice with them. It will necessitate leaving the house for one night, but the end will, in most cases, justify almost any means.

Carbon Bisulfid is an extremely explosive substance, and it will not do to inhale it, but it can be used readily if ordinary care be exercised. Its odor, while very rank, will yet disappear very rapidly and completely in fresh air. Moreover, when used to kill insects infesting various food products, like the weevils in grain or peas, or beetles in flour, it leaves no discernible taste behind it. If the proper care be taken to see that not a spark of fire exists anywhere about the house or is carried near the house while it is being treated, no ill effects will follow the use of Carbon Bisulfid.

In making preparations to treat the house, first see that all windows, doors, ventilators, chimney openings and fire-places are securely closed, and all fires *entirely* extinguished. Now go through the house and rapidly pour the liquid into large pans, previously conveniently placed, at least a pound to the medium sized room. It would be better if these pans were set up on tables or shelves. Place some also in closets and cupboards. Start with the attic, if there be one, and proceed rapidly down and out, closing all the doors. If the outside doors have broad open spaces beneath, close these with rugs or something of the sort, and look for any other openings that might be stopped up. Next morning the doors may be opened and the house aired out. It is used on these same principles in stores, warehouses, granaries and mills.

The Carbon Bisulfid costs ten cents per pound in fifty pound lots, and twelve cents in ten pound lots, and can be ordered direct from Mr. Weed in New Orleans (see below). Several clubbing together could thus obtain it at very small cost. When not in use store the tightly closed can in a cool place.

IV. INSECTICIDES AND PUMPS IN GENERAL.

Fortunately we now have a dealer in these special wares here in the South, who will supply anything in this line at the lowest possible prices. This is Mr. H. E. Weed, 1809 Marengo St., New Orleans. He supplies all the best grades of standard insecticides, and the most improved forms of dusting bellows and spray pumps. Every farmer and gardener should certainly own a good spray outfit, and a small stock of the standard insecticides and fungicides like Paris Green, Copper Sulphate (for making Bordeaux mixture), Whale-oil Soap and Carbon Bisulfid. It *pays*, most emphatically, as has been proven by repeated trial and long actual use. To the most successful operators they have become essential.

A great many patent insecticides are now on the market under various trade names, though most of them are mixtures, with some one or more of the old staple insecticides as a base. These are often not to be compared in effects and generally not in price with the best brands of the pure articles, and I would recommend that the latter always be purchased. Prepared Bordeaux mixture and kerosene emulsion are sold in small packages, but I should always advise the use of a fresh preparation,—home made.

NOTE ON PYRETHRUM.

Through a typographical error in Bull. 77 I find myself advising the "melting" of Pyrethrum, which would be rather a difficult thing to do. For "melted" read "moistened." Perhaps better still than the method there mentioned for its use against flies, would be the scattering of some of the powder onto a hot stove or into a pan of coals, or by means of a dusting bellows throwing the dust into the air among the swarm of flies.

Whenever You Are Troubled by Insects

of any kind whatever, in the house or barn, on the farm or garden, in the orchard, in the store, warehouse or mill, or anywhere else, send specimens at once, safely packed in a small wooden box with the facts concerning them, to the Entomologist, Agricultural College, Auburn, Ala. He is stationed here at your service, and will give prompt attention to all communications, furnishing you with information regarding the insects and remedies for them, free of all charge.

BULLETIN No. 87. AUGUST, 1897.

ALABAMA

Agricultural Experiment Station

OF THE

AGRICULTURAL AND MECHANICAL COLLEGE,

AUBURN.

SOIL INOCULATION FOR LEGUMINOUS PLANTS.

J. F. DUGGAR, Agriculturist.

MONTGOMERY, ALA.:
THE BROWN PRINTING COMPANY, PRINTERS.
1897.

The Bulletins of this Station will be sent free to any citizen of the State on application to the Agricultural Experiment Station, Auburn, Alabama.

SOIL INOCULATION FOR LEGUMINOUS PLANTS.

BY J. F. DUGGAR.

GENERAL OBJECT OF THESE EXPERIMENTS.

A summary of this bulletin is given on page 483.

The subject of maintaining the fertility of the land very closely concerns every tiller of the soil, whether cotton planter, tobacco grower, grain farmer, livestock breeder, or horticulturist. This bulletin bears on the question of soil improvement. It approaches that subject by explaining how, in experiments recently conducted at this station, we were able to largely increase the yields of certain soil-improving plants, which plants are also valuable for forage.

NITROGEN COLLECTING PLANTS.

Nearly every intelligent Southern farmer recognizes the fact that a crop of cowpea vines turned under at the proper time adds greatly to the fertility of the soil. The superiority in this respect of cowpeas over crabgrass, ragweed, etc., is generally recognized. Both cowpeas and weeds are helpful in so far as they add vegetable matter, which, when rotted, improves the mechanical condition of the soil and enables it to retain increased quantities of water in a season of drought.

If both are beneficial, then why the superiority of cowpeas? The answer is found in the fact, not known until comparatively recent years, that cowpeas and related plants have the power, not possessed by the majority of plants, to draw a large part of their nitrogen from the air instead of being entirely limited in growth by the amount of nitrogen in the soil or fertilizer.

Among all flowering plants this power of utilizing the free nitrogen of the air is found only in those which the botanist classifies as belonging to the natural order *Leguminosœ.* Hence the term leguminous plants or legumes so generally used in the sense of nitrogen-collecting plants.

In the plowing under of non-leguminous plants no fertilizing element is added to the soil, these in decaying restoring no more nitrogen, phosphoric acid and potash than they abstracted from the soil in growing. This is also true in regard to the phosphoric acid and potash in leguminous plants. But legumes in decaying afford more nitrogen than they took from the soil, that portion of their nitrogen supply which they obtained from the air being a distinct gain to the soil in which the leguminous plant is buried.

In the class of leguminous plants are embraced all clovers, peas, vetches, beans, lespedeza, melilotus, alfalfa, and a multitude of others, both wild and cultivated.

The plowing under of the entire plants of this class, and in some cases the turning under of the roots and stubble alone, enriches the soil by increasing the nitrogen supply. This nitrogen, if purchased in the form of cotton seed meal or commercial fertilizers, would cost 12 to 18 cents per pound.

While the leguminous plants do not need to be fertilized with nitrogenous manures, they do require a liberal supply of phosphoric acid and potash, either in the soil or fertilizer. The growth of leguminous crops will not make decidedly richer soils that are deficient in mineral elements, unless the good effects of leguminous plants are supplemented by applications of phosphates and potash compounds. These mineral fertilizers are needed by leguminous plants and by the non-leguminous staple crops that follow them in the rotation. The market price of the mineral constituents of fertilizers is considerably less than half that of nitrogen, hence the economy of liberally supplying legumes with mineral fertilizers in order that they may the more heavily draw on the air for nitrogen.

For forage, as well as for green manuring, leguminous plants rank above grasses and other forage plants, being richer in nitrogenous material and producing a richer manure.

ROOT TUBERCLES.

By examining the roots of thrifty leguminous plants one will find numerous enlargements or swellings, varying in size from that of a mustard seed to that of a pea, or sometimes grouped together in a rough mass more than half an inch in diameter. (An illustration of young enlargements or tubercles on the roots of hairy vetch plants is given in figure 4.) The larger and more abundant these tubercles or root nodules are, the greater the activity of the plant in appropriating the nitrogen of the air.

Without these tubercles a leguminous plant cannot profit by atmospheric nitrogen, and has no advantage over non-leguminous plants, as the gasses, cotton, etc. If it has tubercles on its roots a leguminous plant is able to use the free nitrogen of the air. The air comes in contact with the tubercles under the surface, for air circulates in all cultivated soils. The exact means by which these tubercles place a supply of nitrogen at the disposal of leguminous plants is not thoroughly understood and a discussion of the theories bearing on that phase of the subject is uncalled for here. It is enough to say that these tubercles may be regarded as houses in which dwell multitudes of germs, or more specifically bacteria or bacteria like bodies, separately invisible except under a microscope of high power; and that these are the agencies by which atmospheric nitrogen reaches the higher plant. On the decay of the tubercle great numbers of these micro-organisms are left in the soil ready to cause tubercles on the next crop of the same legume.

Nearly every genus of leguminous plants has its own specific or "adapted" germ, which, if present in the soil or on the seed sown, is able to cause the development of these tubercles and to secure to the plant the consequent advantages. As a general rule, to which there are exceptions, the germ which induces the growth of tubercles on one legume is unable, at least temporarily, to produce tubercles on plants belonging to other genera; for example, the germ which causes tubercles on clover is impotent on vetch. Hence for the thrifty growth of a given legume, say clover, the soil must contain the corresponding form of germ life; if this "clover germ" is absent, the only way to successfully grow clover on poor and medium soils is to use liberal quantities of nitrogenous fertilizers, an expensive practice. If the proper germs are present and if all other conditions are favorable, as drainage, proper mechanical condition, and a sufficiency of phosphoric acid, potash and lime, clover plants will thrive and be largely independent of soil nitrogen, drawing a large part of their supply from the atmosphere.

Are most soils naturally stocked with the micro-organisms necessary to the thrifty growth of every kind of cultivated leguminous plant? Our experiments, of which a part are recorded in this bulletin, show that in some southern soils the germs essential to the thrifty growth of certain legumes are wanting or else present in insufficient number. Their absence from many southern soils explains why the opinion is so prevalent in some localities that the clovers are not suited to the extreme South.

SOIL INOCULATION.

Inoculating the soil, as the term is used here, consists in supplying some material containing the germs necessary to cause the growth of root tubercles.

We do not hesitate to compensate for a deficiency of phosphoric acid or potash or even of nitrogen by applying fertilizers. It is just as logical to apply the requisite germs as to provide the essential fertilizing elements, for really in supplying the germs we are in effect feeding the plant on nitrogen.

Soil inoculation may be effected either by applying the material containing the germs directly to the soil or by placing the seed before planting in contact with the inoculating material. Both methods were used in these experiments.

WINTER GROWING LEGUMES.

Only a few cultivated legumes are extensively grown in the South and indeed the majority of farmers of this State who grow leguminous crops of any kind confine themselves to the cowpea. The value of this plant in southern agriculture cannot easily be over estimated and the acreage in cowpeas should be extended far beyond present limits. As a summer crop no substitute for the cowpea could be named which would give such general satisfaction as a renovating plant.

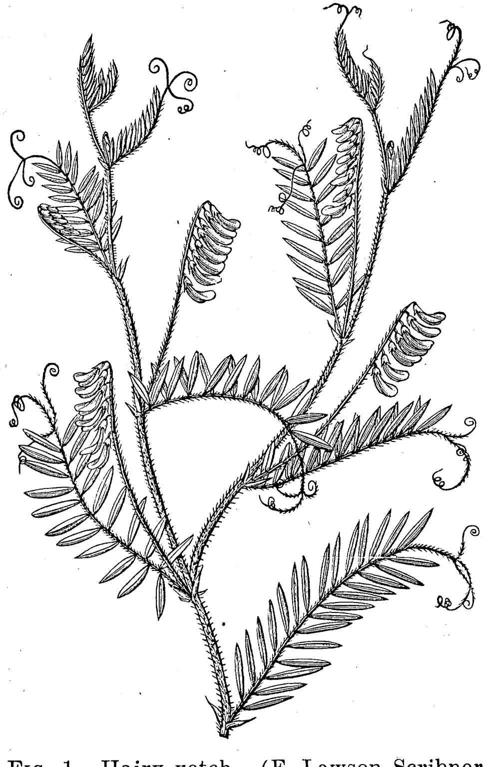


FIG. 1. Hairy vetch. (F. Lawson-Scribner, U. S. Dept. of Agriculture, Divison of Agrostology, Circular No 2.)

But winter leguminous plants are also needed. They not only add vegetable matter and nitrogen when plowed under in the spring, but they also, while growing, prevent the winter rains from washing the soil and from leaching out the most valuable fertilizing material. With the aim of securing these advantages numerous renovating plants have been tested here and especial attention has been given to hairy vetch and crimson clover which are regarded as the most promising of the winter growing legumes.

HAIRY VETCH (*Vicia villosa*).

Hairy vetch is a vinelike annual plant, the slender branches sometimes growing eight feet long. Sown in September or October, it is ready for cutting the following April or May. If not supported, the vines form a dense mat of fine stems and leaves 18 to 30 inches thick. If rye is sown thinly with the seed of hairy vetch the vetch plants climb to considerable height on the rye straw and are more easily harvested.

Hairy vetch is valuable for turning under as a green manure, for green forage, for hay and for pasturage. Both here and at the Mississippi Experiment Station it was found a most excellent plant to furnish winter grazing on Bermuda grass sod. The main objection heretofore mentioned to the general culture of hairy vetch is the cost of the seed. Our seed purchased this season from Peter Henderson, New York city, cost $4.50 per bushel. At least one bushel of seed per acre is desirable when sown broadcast for hay or pasturage, to which for hay might be added one or two pecks of rye or one bushel of winter oats. Doubtless much thinner seeding in drills would suffice when only seed is wanted. The high price of seed need not prohibit the culture of hairy vetch, for the seed can be grown on the farm after a start is made with purchased seed.

According to our experiments, another obstacle to vetch culture will be found in the absence from many soils of the germ that produces tubercles on vetch plants. For this condition the experiments indicate a remedy.

FIELD EXPERIMENTS WITH HAIRY VETCH.

October 17, 1896, four plots, each one-fortieth acre, lying side by side, were sown with seed of hairy vetch. The soil was very poor. Preceding crops were Kafir corn for forage in 1896, and oats in 1895. So far as could be learned this field had never borne any other leguminous crop than cowpeas and no cowpeas since 1894.

The plowing and harrowing necessary in preparing a seed bed was the same for all plots. The fertilizer contained no nitrogen; on each plot were applied 400 pounds per acre of acid phosphate and 120 punds per acre of sulphate of potash. Every plot was seeded at the rate of 30 quarts per acre, sown broadcast and covered with a smoothing harrow and roller. On plots 1 & 3 the seed received no treatment. The seed for plots 1 & 4 was treated as follows before sowing: The seed was dipped in water into which there had been stirred and allowed to settle earth from a lawn, once a garden spot, where common vetch (*Vicia sativa*) had for several years in succession made a thrifty growth. At the time of taking the earth for this purpose the young plants of common vetch were about two inches high and already they showed the tubercles on the roots which are characteristic of vigorous leguminous plants. The seed for plots 2 & 4, after being moistened in this material, was sown and immediately covered, the harrow and roller running across all plots in covering the seed.

Early in December the more vigorous growth on the inoculated plots was noticeable. By January 1, the difference was striking even at a distance of a hundred yards. The treated plants were of a luxuriant green, the untreated plants decidedly brownish and smaller than the others. At that date, two and one half months after planting, average plants were dug from both series of plots and photographed. (See figures 3 & 4.) On the inoculated plots practically all the plants had clusters of tubercles on the roots. On plot 1, untreated, no tubercles had formed on the roots. The difference grew greater and greater, the plants without tubercles making scarcely any growth after February, while the inoculated plants grew without interruption.

May 20, 1897, all plots were cut. A scythe was used on the inoculated plots, but on plot 1, untreated, the plants were so small that they had to be cut with a sickle and picked up one by one. The inoculated plants were then in the height of bloom, had formed some immature pods, and constituted a mass of green about 15 inches thick, most of the branches being about 3 feet long. On plot 1 there were few branches over 8 inches long and there were fewer branches per plant than on the other plots.

The green weights were taken immediately after cutting, May 20, and the dry weights June 21, after thorough curing and one month's storage of the hay.

The results calculated per acre were as follows:

Yield per acre of hairy vetch without and with inoculation.

HAIRY VETCH.	Green forage.	Cured hay.
	Lbs.	*Lbs.*
Not inoculated (Plot 1)................	900	232
Inoculated (Plot 2)...................	9136	2540

Comparing the yields on plots 1 & 2 we find that with inoculation the yield was over ten times as great as without inoculation, the increase in hay being 995 per cent.

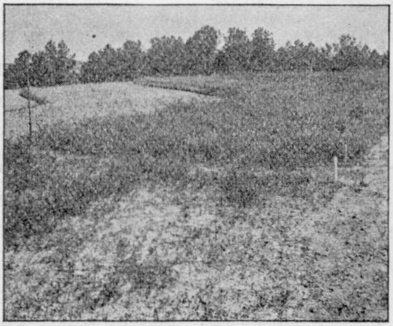


FIG. 2. The foreground shows the plot not inoculated (P 1); the background, the inoculated plot (P 2).

Figure 2 shows the appearance of plots 1 & 2, a short time before cutting; the light colored and nearly bare fore-ground is the uninoculated plot, while the more luxuriant growth toward the background and beyond the stakes represents the inoculated plot.

The yields of only plots 1 & 2 are given in above table, for only this pair of plots represents fairly the gain in favor of inoculation. Lot 3 was so situated that a thin sheet of surface water from plot 4 flowed over it. The effect was to bring sufficient germs from the treated plot to inoculate about half the plants on plot 3. That about half of these plants had been thus accidentally inoculated was suspected during the spring from the irregular growth on plot 3. When cut most of the unthrifty plants on plot 3 had attained a length of only about 8 inches and were devoid of turbercles. The other plants, accidentally inoculated, had branches 3 feet long and an abundance of tubercles.

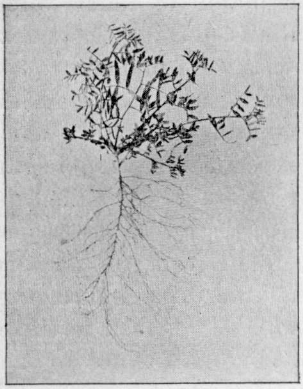


FIG. 3. Hairy vetch plant, Jan. 1, from plot not inoculated.

FIG. 4. Hairy vetch plant, Jan. 1, from inoculated plot.

The actual yield of thoroughly cured hay were 1,036 pounds per acre with partial inoculation (plot 3) and 2,184 with careful inoculation of the seed before planting (plot 4).

It should be added that after cutting the vines the soil under the thicker stuble on plot 2 was in better mechanical condition, more friable and less hard, than under the comparatively bare surface of plot 1, where there had been no inoculation. This same favorable effect of a fair growth of hairy vetch on the mechanical condition of the soil was noted in another field. The yield on this latter field where the plant had been grown for several years in succession and where there was an abundant supply of tubercles was 17,765 pounds per acre of green forage, which when cured, afforded 4,174 pounds of hay.

That the soil of plot 2 was improved by the stubble of hairy vetch is apparent now (August 20) when the German millet sown after vetch on all plots is notably greener and larger on the inoculated than on the untreated vetch plots.

POT EXPERIMENTS IN THE GREENHOUSE.

The object of these experiments was to ascertain whether five different soils from neighboring farms would be helped by inoculation to produce vigorous plants of hairy vetch, Canada field pea, crimson clover, alfalfa, lupins, lespedeza and cowpeas. These pot experiments were planned to run parallel with similar experiments on a large scale in the field. However the artificial inoculating material, which had to be opened when the pot experiments were begun, had fermented and lost its vitality before outdoor planting could be commenced.

Ordinary unglazed flower pots, fresh from the factory, were used, the large, small and medium sizes holding respectively 14, 8, and 3 pounds of soil. The only fertilizer used was high grade acid phosphate, one-half ounce for each large and medium pot and one-fourth ounce for each small pot. In the bottom of the large and medium pots was spread one and one-half ounces of cotton seed hulls and one-half ounce in each small pot. After planting, each pot was covered with a layer of cotton seed hulls, half an inch thick, to prevent compacting the soil in watering the plants.

Five different upland soils were used in the pots. The soils, all taken from the surface, were as follows:

Soil A.—From an upland rocky field, with reddish loam soil, about 3 miles southwest of Auburn. This field had been cleared about twenty years and had been in cotton most of that time. It had certainly not borne a crop of legumes in 5 years, and was believed to have never had any cultivated leguminous plant on it. It was of more than average fertility, last year's cotton crop being estimated at one-half bale per acre on this field, with the usual light fertilization.

Soil B.—Surface soil from a sandy cotton field, cleared about 5 years before, and which had never borne a crop of cultivated leguminous plants. This field is about 2 miles southeast of Auburn, and apparently less fertile than the preceding.

Soil C.—Sandy soil from woodland of mixed pine and hardwood, adjoining the field from which Soil B. was taken. The coarse litter on the surface was raked away before taking the sample, which, however, contained much organic matter in a fine state of division.

Soil D.—Loamy soil, of poor quality, from a pasture on the Station Farm where for two years Japan clover (*Lespedeza striata*), also called lespedeza and old field clover, had grown thickly for two years. The old lespedeza plants and about an inch of the surface soil were removed before taking the sample.

Soil E.—From the immediate vicinity of decayed cowpea roots in a poor sandy soil on the Station Farm, where this plant was grown in 1896 and at intervals in previous years.

The pots were arranged in pairs, every condition being alike in the two pots, except that the seed or soil of one pot was inoculated and given an odd number. The even numbered pots were not inoculated.

Inoculation was effected as follows:

One-half bottle of imported nitragin or germ fertilizer (a gelatinous material containing immense numbers of specific living germs) was diluted with well water and sprinkled on about 25 pounds of earth, and one gill of this earth was then mixed with the upper soil of the odd numbered pots. A bottle of "clover nitragin" was used for the pots intended to be inoculated for clover, and a bottle of "vetch nitragin" for the inoculated vetch pots. The earth used in preparing the earthy inoculating material was in all cases taken from the same field as Soil B.

The inoculating material for cowpeas was "homemade," consisting of 6 ounces of Soil E., from around old cowpea roots, applied to each large odd numbered pot that was intended for cowpeas. Likewise the inoculating material for lespedeza consisted of 2 ounces of Soil D., from a lespedeza pasture.

Crimson clover and lespedeza had to be replanted March 13; the other seeds were planted February 24–28, equal quantities of seed being used in the inoculated and not inoculated series. The pots were placed in a greenhouse and watered with boiled or rain water. Equal quantities of water were supplied to inoculated and not inoculated plants, although this was a hardship on the larger inoculated plants. All plants suffered from insufficient or infrequent watering and from the attacks of the red spider.

Except alfalfa and lespedeza, all plants on April 17 were reduced to a uniform stand in the treated and untreated series. The vetch, Canada field pea, lupin, and crimson clover plants were harvested May 24, the remainder June 11, except the alfalfa. The dirt was washed from the roots with a jet of water. Weighings of thoroughly dried tops and roots were made June 24–26, on chemical balances.

POT EXPERIMENTS WITH HAIRY VETCH.

Hairy vetch seed was sown February 24 in eight medium sized flower pots, containing four different soils. One pot containing each soil was left without inoculation and given an even number. The other pot of each pair, designated by an odd number, was inoculated as before described with a small amount of earth previously treated with clover (Trifolium) nitragin. In addition the seed were also dipped in a solution of this nitragin.

The superior growth on most soils of the plants which were inoculated may be seen by reference to figures 5 & 6.

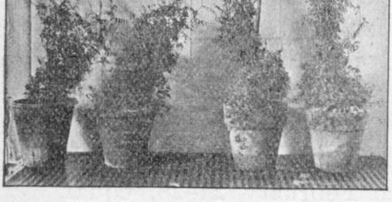


FIG. 5. Haiy vetch.
A 10, not inoculated.
A 9, inoculated.
C 8, not inoculated.
C 7, inoculated.

FIG. 6 Hairy vetch.
D 8, not inoculated.
D 7, inoculated.
E 10, not inoculated.
E 9, inoculated.

The tops of the vetch plants were cut and the dirt carefully washed from the roots May 24. After thorough drying, both tops and roots were weighed, with the results shown in the appendix to this bulletin.

For the sake of clearness only the increase in the yields of tops, roots, and entire plant are given here, the results being expressed in percentages :

Gain in percentages from inoculating hairy vetch grown on different soils.

Soil.	Soil from	Increase attributable to inoculation.		
		Tops.	Roots.	Entire plant.
		Per cent.	*Per cent.*	*Per cent.*
A	Cotton field, 20 years cleared.	21	65	38
C	Woodland....................	25	69	38
D	Lespedeza pasture...........	577	69	186
E	Cowpea field................	928	252	466

The above table shows that on all soils there was a large gain in both tops and roots as the result of inoculation. For these four soils the average increase from inoculation was 86 per cent. in tops, 92 per cent. in roots and 89 per cent. in total product, using the weights given in the appendix as a basis of comparison.

Examination of the roots from all pots showed that in every inoculated pot there was an abundance of tubercles. In the pots not inoculated the case was quite different; the untreated plants growing in Soils D. and E. had not a single tubercle, which deprivation of atmospheric nitrogen is sufficient to account for the extremely slight growth on those two poor soils. The untreated plants on the richer woodland soil fared better, as did also those in soil A., for in this latter case a number of tubercles developed on the untreated as well as on the treated plants. Even under these circumstances inoculation was beneficial.

POT EXPERIMENTS WITH CANADA FIELD PEA (*Pisum arvense*).

This plant is scarcely distinguishable in appearance from the English or garden pea. In Canada, and in the northern part of the United States, it is grown for grain and forage, both being very nutritious. Our tests in the field indicate that is not so valuable here as is hairy vetch. The results of inoculation with this plant are regarded as equally applicable to the English pea. Only new garden spots seem to need inoculation for English peas.

Canada field peas were grown in four soils, there being four pairs of medium-sized pots. One pot of each pair was treated with inoculation earth prepared with vetch (Vicia) nitragin, pea nitragin not being at hand. The seed were not dipped in a solution of nitragin, as the vetch seed had been.

From a very early period of growth the inoculated plants took the lead, growing taller and having larger leaflets of a darker green color than the corresponding untreated plants. Their superiority in size May 19, a few days before harvesting, may be seen by reference to figures 7, 8, 9 and 10.

The weights of thoroughly dried tops and roots gave the following percentage gains for inoculation :

Gain in percentages from inoculating Canada field peas grown on different soils.

Soil.	SOIL FROM—	Increase attributable to inoculation.		
		Tops.	Roots.	Entire plant.
		Per cent.	*Per cent.*	*Per cent.*
A	Cotton field, 20 years cleared.	165	—15*	58
B	Cotton field, 5 years cleared..	268	139	199
C	Woodland	151	495	275
D	Lespedeza pasture..........	234	94	156

* Loss.

From the above table it is apparent that the increase in tops, attributable to inoculation, was in no case less than 151 per cent.

Averaging the actual yields on all soils, the average increase for Canada field peas with inoculation was 197 per cent. in tops, 87 per cent. in roots and 138 per cent. in total product.

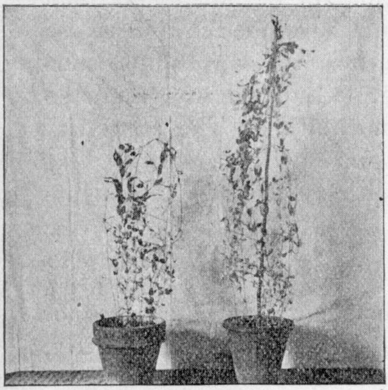


FIG 7. Canada field peas,
A 8, not inoculated.
A 7, inoculated.

FIG. 8. Canada field peas.
B 8, not inoculated.
B 7, inoculated.

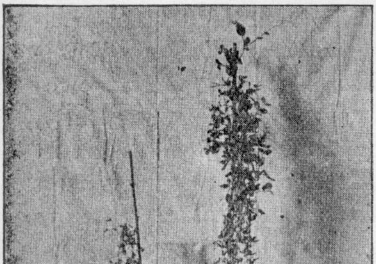


FIG. 9. Canada field peas.
C 6, not inoculated.
C 5, inoculated.

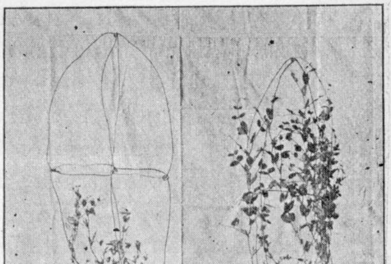


FIG. 10. Canada field peas.
D 6, not inoculatbd.
D 5, inoculated.

Plants growing in the inoculated pots produced an abundance of tubercles. The plants without inoculation developed no tubercles in Soils B. and D., and only one small group of tubercles in Soil C., and this, occurring near the surface, was doubtless caused by accidental inoculation from without.

In Soil A., which for many years had been free from leguminous plants, an abundant supply of tubercles developed without treatment. It should be noted here that without inoculation tubercles were developed in Soil A. on hairy vetch, Canada field peas, crimson clover, lupins, cowpeas and lespedeza. In no other soil tested was there so general an infection without inoculation. The regularity with which tubercles developed unaided in a soil so long free from legumes is in accord with results of experiments in Germany.

CRIMSON CLOVER (*Trifolium incarnatum*).

This is an annual plant, which, sown in September or October, matures early in the following May, and, if thrifty, may be used as pasturage, forage or green manure early in April in time to cause no interference with late planted crops.

Since sufficient seed for one acre (1 peck) can be bought for about 80 cents, cost of seed does not constitute an objection to crimson clover as in the case of hairy vetch. There is reason to believe that crimson clover will prove the most useful of all soil-improving plants for the cotton planter owning suitable soil. Yet this plant has heretofore failed in a very large percentage of the communities of Alabama in which it has been tried. During the past season crimson clover was tested under the writer's supervision on more than thirty farms in different parts of the State. In the great majority of instances it failed. Typical crimson clover roots from nearly all of these localities were examined by the writer and the dwarfed plants in almost every case showed either the entire absence of tubercles or more frequently the presence of an inadequate number of quite small tubercles.

The failure of crimson clover on the Station Farm the past season was complete. This was true whether the land was well or ill prepared, whether the stand of plants was thick or thin. Few plants grew over 3 inches high, or had flower stems longer than 6 inches. If thrifty, the growth should have been considerably above one foot.

On examining the roots this failure could be easily accounted for. No nitrogenous fertilizer or manure was applied to crimson clover and no tubercles developed on the roots except along certain roadsides where small tubercles appeared late in the season. The failure was apparently due to nitrogen-hunger, which can be overcome, as shown below.

POT EXPERIMENTS WITH CRIMSON CLOVER.

Our pot experiments were intended to ascertain whether this cause of failure could be overcome by inoculation. The results justified the expectation. However, the yields were extremely small in pots for the following reasons: (1) The small size of most of the pots used for crimson clover; (2) planting in March instead of in September; (3) the attacks of red spiders in the greenhouse, and (4) insufficient and infrequent watering, causing the death of some of the plants and necessitating the close of the experiment while the plants were very young. These causes, singly or together, also reduced the yields of other plants growing in pots.

The plants when cut had been growing only about 10 weeks, or about one-third the usual time required for growth.

As inoculating material clover (Trifolium) nitragin was used, mixed with Soil B., as previously explained.

May 24, about 10 weeks after planting the seed, the little plants were harvested, many of them, especially among the larger uninoculated plants, being already nearly or quite dead, as the result of insect injury and of deficiency in the water supply.

FIG. 11. Crimson clover.
B 2, not inoculated.
B 1, inoculated.
E 2, not inoculated.
E 1, inoculated.

The weights taken after thorough drying, showed the following gains from inoculation :

Gain in percentages from inoculating crimson clover grown on different soils.

Soil.	SOIL FROM—	Increase attributable to inoculation.		
		Tops.	Roots.	Entire plant.
		Per cent.	*Per cent.*	*Per cent.*
A	Cotton field, 20 years cleared.	72	70	71
B	Cotton field, 5 years cleared..	130	7	74
C	Woodland....................	150	506	326
E	Cowpea field (av. 4 pots).....	609	198	379

Here the increase in tops attributable to inoculation was in no case less than 72 per cent. Averaging the actual yields on all soils, the average increase from inoculating crimson clover was 158 per cent. in tops, 128 per cent. in roots and 146 per cent. in total product.

That the inoculated plants were more vigorous than those not inoculated may be seen by reference to figure 11, which shows typical differences between the two classes of plants. This superiority of the inoculated plants was not due to the entire absence of tubercles on the plants that were not artificially inoculated. Plants in these pots were found to have tubercles, and this was true in all soils; these tubercles, however, were evidently not so active and efficient in promoting growth as were those on the plants which had been artificially inoculated. Apparently the germs causing the tubercles in the even-numbered pots were accidentally introduced in watering the plants, (see Note 1 in the Appendix). If so, then we should expect tubercles to develop later in the pots not intentionally inoculated, and this later development may be the explanation of the lesser efficiency of these tubercles.

The results of inoculating crimson clover, although obtained with plants that had made only a fraction of their normal growth, give encouragement to the hope that this plant may be made to thrive in many soils where it has failed heretofore, in default of inoculation. No other winter growing renovating plant seems so well fitted to the needs of the cotton farmer as crimson clover. Its successful growth as a catch-crop in winter would greatly improve the soil, and thereby materially increase the profits of the cotton planter.

Probably in those localities in which red or other clover is generally and successfully grown the soil is already inoculated with the necessary organisms and artificial inoculation is superfluous for clover of any kind.

POT EXPERIMENTS WITH ALFALFA (*Medicago sativa*).

Alfalfa was grown only in Soil A., the one which for a long time had borne no legumes. Only two pots, each containing 14 pounds of earth were used. The amount of boiled or rain water was the same for both pots until after May 19, when the photograph shown in figure 12 was taken.

After that time the inoculated plants, which were several times larger than the others and which consequently had suffered when confined to the limited amount of water needed by the smaller untreated plants, were given larger amounts of water than the others, as their greater size required.

Alfalfa seed under treatment were planted in both pots February 26, 1897. Before planting, the upper layer of soil of pot A 15, had been inoculated as follows :—

Seed of bur clover (*Medicago maculata*) harvested in Starkville, Miss., the preceding spring were placed in a sifter and the adhearing dust sifted out February 26, 1897. Of this dust, one-fourth ounce was incorporated with the upper portion of the soil of pot A 15. The soil of pot A 16 was not treated. Even as early as April 5, only 35 days after planting the seed, the inoculated plants were twice as tall as those not inoculated. The photograph shown in figure 12 was taken May 19. Later, with a liberal supply of water and removal from greenhouse to the open air, the inoculated plants made a steady growth until July 22, when the plants in both pots were cut.

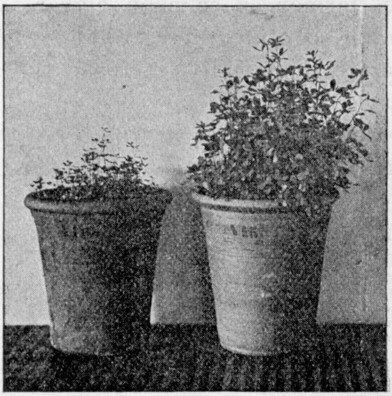


FIG. 12. Alfalfa.
A 16, not inoculated.
A 15, inoculated.

At that date the inoculated plants averaged 15 inches high while the average height in the other pot was only about 5 inches. A number of the inoculated plants were in bloom and a few seed pods had formed. Not a sign of blooming was visible on the untreated plants.

The results of the first cutting, expressed in apothecaries' grains, were as follows :

Results of inoculating alfalfa with dust from bur clover.

	Green material.	Cured hay.	Increase in hay attributable to inoculation.
	Grains.	*Grains.*	*Per cent.*
Not inoculated......	174.5	40	....
Inoculated.........	965.5	174.4	336

After the first cutting the inoculated plants put out shoots more vigorously than the others. Of the untreated plants about half died, without throwing out new sprouts.

At the present writing (August 20), there promises to be in the second cutting fully as much difference in favor of the inoculated pot as there was at the first cutting.

As the roots were not washed out, but left to continue growth, it cannot be stated whether or not the uninoculated plants had tubercles. The appearance of the plants suggests that there has been no general infection of the roots of the inoculated plants, but that tubercles are abundant on the treated plants.

POT EXPERIMENTS WITH WHITE LUPINS (*Lupinus albus*).

This plant was grown only on the soil that had been for many years free from leguminous plants. Here the tubercles developed without, as well as with, inoculation, and there was no gain in yield of either roots or tops as the result of inoculation with lupin nitragin.

POT EXPERIMENTS WITH LESPEDEZA (*Lespedeza striata*).

Seed of lespedeza, also known as Japan clover, old field clover, and wild clover, were planted in small pots on all soils. The inoculating material for each odd-numbered pot was 2 ounces of Soil D from a lespedeza pasture. In no case could the eye detect any difference between the growth of treated and untreated plants. In every soil, whether inoculated or not treated, tubercles developed in abundance.

Only the tops were weighed, and these showed no difference in yield attributable to inoculation. Apparently the germs required to cause the growth of tubercles on lespedeza were present in all of these soils, either through the previous growth of native species of lespedeza, or carried thither in the dust blown from the old fields, pastures, and roadsides, which in this locality as so generally covered with this plant, or else carried into all pots in the form of dust adhearing to the seeds that were planted.

POT EXPERIMENTS WITH COWPEAS (*Vigna catjang*).

Cowpeas were grown in large pots on all soils. The inoculating material used was for each odd numbered pot 6 ounces of Soil E., from a field where cowpeas grew in 1896 and where this plant always develops an abundance of tubercles. At no period of growth could there be seen any marked difference in growth of plants on treated and untreated plots.

The results show no advantage in inoculating cowpeas on any of these soils, a result that is not strange in view of the fact that cowpeas are so generally grown in this locality and that the dust from cowpea fields, probably containing the necessary micro-organisms, has been scattered far and wide by the wind.

METHODS AND COST OF INOCULATION.

Inoculating material is of two general kinds, (1) the prepared article, which is for sale in bottles under the name nitragin or germ fertilizer, and (2) the earth from around the roots of mature leguminous plants of the same or closely related kind as the plant to be inoculated.

The nitragin used in these experiments was purchased from Lucius and Bruening, Hoechst on Main, Germany. through their American agents, Victor Koechl & Co., 79 Murray street, New York city. The cost was $1.25 per bottle, plus express from New York. The manufacturers' directions state that one bottle is sufficient for five-eighths of an acre. Adding 10 per cent to the price in New York to cover express from that point, the cost would be $2.20 per acre for nitragin.

This outlay, while it would doubtless often prove profitable, is greater than the writer is prepared to advise for large areas. This is in view of the fact that cheaper, although apparently somewhat less effective, methods of inoculation can be adopted. Inoculation as applied to the field of hairy vetch noted on page --, cost nothing except labor. A better method consists in spreading broadcast a ton or two per acre of earth from an old clover field on land intended for clover, the same quantity of earth from an old vetch field for a new seeding of vetch, and so for other leguminous plants.

If no field of red or crimson clover is convenient, spots of low white or creeping clover (*Trifolium repens*), or of Carolina clover (*T. Carolinianum*) may perhaps be found in pasture or lawn, and the earth of these spots used as inoculating material for red or crimson clover.

In a similar manner one wishing to sow hairy vetch in a field where no similar plant had recently been grown could use earth from around the roots of common vetch, or even from that part of the garden where English peas have recently grown and developed tubercles. For alfalfa, earth from a spot where alfalfa, bur clover, or black medic (*Medicago lupulina*) had grown might be used.

Having once started on the farm a small plot of the desired leguminous plant and insured the abundant production of tubercles on plants growing there, the soil of this small spot could be used in future years as inoculating material for a number of acres.

If earth for inoculation purposes were scare, partial inoculation could doubtless be effected by simply using enough earth to sow with the seed, dampening the seed to cause the earth to adhere. Extreme dryness or long exposure to bright sunlight injures or destroys the germs that cause tubercles on leguminous plants. Hence the inoculating material should be worked in deep enough to come in contact with the moist soil. The spreading and harrowing in of the earth should be thoroughly done. For this work cloudy days, or some other time than the middle of the day, and prompt covering of the inoculating material have been recommended.

CROPS AND SOILS THAT NEED NO INOCULATION.

Not every leguminous plant requires inoculation in order to produce tubercles. Many soils are naturally supplied with the tubercle-producing germs through the growth of wild leguminous plants. Moreover where a given legume is extensively grown there is probably a wholesale inoculation of surrounding soils by means of the wind, which carries the germ-laden dust. This seems the explanation of the fact that on no soil has the writer been able to find cowpeas free from tubercles, and many observations have been made, all in localities where the culture of this plant is general. The seed of certain legumes may also be the means of conveying the necessary germs to a soil lacking the appropriate form of germ life. This seems the true explanation of the fact that lespedeza (and bur clover from unhulled seed) have developed tubercles in all soils where we have thus far tested them. Seeds of both these plants are borne in close contact with the ground where particles of the germ-laden soil easily lodge upon the burs or seed coats.

Even though few or no tubercles may be produced the first year where a rare legume is grown for the first time, there is an increase in the number of tubercles from year to year if the same legume continues to occupy the land. Hence we should not look upon inoculation as needing to be repeated, but as a procedure useful only or chiefly in the first year's growth of a rare legume.

Experimenters have been studying the tubercles of leguminous plants for only a few years and much is yet to be learned about every phase of this subject. Some of the readers of this bulletin can aid in gathering facts relative to the distribution of tubercle-producing organisms in this State by sending to the writer specimens of the roots of the less generally grown leguminous plants, as clover, alfalfa, beggar weed, soja bean and vetch, labelling the specimens with the sender's address and writing fully in regard to the crops previously grown on the land from which the specimen is taken. Many observations will perhaps help to answer the very practical question "What classes of soils in Alabama would be benefitted by inoculation for clover, vetch, etc."

SUMMARY.

Cowpeas, clovers, vetches and other plants, known as leguminous plants or legumes, when plowed under enrich the soil by adding nitrogen, a large proportion of which they have obtained from the atmosphere.

The enlargements or tubercles on the roots are the means by which the free nitrogen of the air is made available to leguminous plants. If these tubercles are wanting on a leguminous plant, the nitrogen of the air is unavailable to that plant, just as it is to cotton, grass, and all other higher plants that are not leguminous.

On some soils these normal tubercles do not develop on the roots of such legumes as have never before been grown in that locality. The growth of tubercles can be induced by adding certain germs to the soil, a process which is called inoculation.

In Alabama the cowpea is the most generally satisfactory renovating plant for summer growth. There is also need

for winter growing leguminous plants, such as hairy vetch and crimson clover, to occupy the land in winter between two sale crops, in order to decrease washing and leaching of the soil and to add vegetable matter rich in nitrogen.

Hairy vetch, without fertilizer, yielded on a field where this plant had been repeatedly grown 17,765 pounds of green forage or 4,174 pounds of hay per acre.

On a field where hairy vetch had never before been grown and where the fertilizer applied contained phosphoric acid and potash but no nitrogen, the yield was only 235 pounds of hay per acre; on an adjoining and similar plot, the seed for which were inoculated with earth from an old vetch field, the yield of hay was 2,540 pounds, an increase of 995 per cent following a treatment which cost nothing except a small amount of labor. On the inoculated plot the plants were well supplied with tubercles, while on the plot not treated the plants were bare of tubercles.

A germ fertilizer, intended to make available the free nitrogen of the air by inducing the growth of tubercles on legumes grown in soils not already stocked with the proper forms of germ life, was purchased in Germany and used in Auburn in pot experiments with hairy vetch, Canada field peas and crimson clover.

Inoculation with this germ fertilizer or nitragin greatly increased the yields of all of these plants as compared with untreated plants.

This increase in the weight of inoculated plants, after thorough drying, was as follows:

Hairy vetch, increased by 89 per cent.

Canada field peas, increased by 138 per cent.

Crimson clover (young plants), increased by 146 per cent.

Lupins (tested on only one soil), not increased.

Germ fertilizer prepared for vetch, was effective on Canada field peas.

Inoculation material procured without cash outlay acted like nitragin, and greatly increased the yields of hairy vetch and alfalfa.

Soil from a field where a given leguminous plant has recently been successfully grown is an effective inoculating material for the same kind of plant when first sown in a soil not already naturally supplied with the required form of germ life.

The dust adhering to the seed of bur clover was an effective inoculating material for alfalfa; the increase in the first cutting of alfalfa hay following this inoculation was 336 per cent.

Inoculation for cowpeas and lespedeza was apparently unnecessary in the soils used in these experiments. In or near all of these soils these two plants have been growing for years. Hence we may infer that these soils have been previously inoculated by germ-laden dust or by some other natural agency.

In a soil which for many years had borne no leguminous plants, tubercles developed without intentional inoculation on hairy vetch, Canada field peas, crimson clover and lupins, as well as on cowpeas and lespedeza. This soil was more nearly independent of inoculation than any other soil tested, and yet even on this soil the increase in the weight of inoculated plants over plants not inoculated was 38 per cent. with hairy vetch, 58 per cent. with Canada field peas, and 79 per cent. with crimson clover.

Many soils are naturally inoculated as regards the most commonly grown leguminous plants and hence are not benefitted by artificial inoculation.

APPENDIX.

NOTE 1.—As it was impossible to obtain sufficient distilled or thoroughly sterilized water it was necessary to use part of the time boiled water and part of the time rain water. So far as was possible without special facilities for this kind of work, precautions were taken to reduce the chances of accidental infection. When rain water was used it was caught from the greenhouse roof after the latter had been washed by the first portion of the rainfall.

Apparently the inoculation of all the even-numbered pots of crimson clover was accidental, a suspicion which was confirmed as regards Soil E., by the fact that crimson clover plants growing in this soil in the field produced no tubercles. The suspected source of accidental inoculation of the clover plants was the boiled water. This was taken from a well in a pasture containing some tubercle-bearing plants of creeping clover. The water was boiled and cooled in this pasture, and germ-laden dust may have been blown into the water while cooling.

The fact that all the plants in some of the untreated pots of vetch and Canada field peas were devoid of tubercles indicates that the germ required to induce the growth of tubercles on these two plants was not present in the water applied.

NOTE 2.—The following table gives the number of plants left in each pot after thinning, amount and kind of soil in pot, and yields of air dry tops, roots, and entire product of plants grown in pots. All pots containing cowpeas and lespedeza were carried entirely through the experiment, but the results appearing so uniform and other duties claiming the experimenter's attention, the weights of the roots of these two plants and also some of the weights of the tops of the cowpeas were omitted:

	No. of soil and pot.	Lbs. soil in pot.	No. of plants left.	Yield of air dry material in apothecaries' grains.		
				Tops.	Roots	Entire plant.
				Grains.	*Grains.*	*Grains.*
Hairy vetch, inoc........	A 9	8	9	141.6	114.2	255.8
" " not "	A 10	8	9	116.6	68.7	185.1
" " inoc........	C 7	8	8	191.1	96 5	289.6
" " not "	C 8	8	8	154 1	57.0	211.1
" " inoc........	D 7	8	9	71.8	60 2	132.0
" " not "	D 8	8	9	10.6	35.5	46.1
" " inoc........	E 9	8	5	144 0	92.1	236.1
" " not "	E 10	8	5	14.0	27.7	41.7
Canada f. peas, inoc........	A 7	8	7	181.5	86.3	267.8
" " " not "	A 8	8	7	68.4	101.1	169.5
" " " inoc........	B 7	8	9	148.0	107.4	255.4
" " " not "	B 8	8	9	40.2	45 0	85.2
" " " inoc........	C 5	8	10	84.6	113.0	197.6
" " " not "	C 6	8	10	33.6	19.0	52.6
" " " inoc........	D 5	8	9	74.7	54.7	129.4
" " " not "	D 6	8	9	22 3	28.1	50.4
Crimson clover, inoc	A 3	3	1	29 3	21.8	51.1
" " not "	A 4	3	1	17.0	12.8	29.8
" " inoc......	B 1	14	6	190.0	75 0	265 0
" " not "	B 2	14	6	82.5	69 6	152.1
" " inoc......	C 3	3	5	57.0	37.1	84.1
" " not "	C 4	3	5	22.8	6.1	28.9
" " inoc......	E 1	14	13	153.6	56.6	209.6
" " not "	E 2	14	13	29.3	38.2	67.5
" " inoc... ..	E 3	3	5	35.7	21.9	57.6
" " not "	E 4	3	5	4.0	4.9	8.9
White lupins, inoc......	A 17	14	18	112.0	82.5	194.5
" " not "	A 18	14	18	140.0	96.7	236.7
Alfalfa, 1st cut, inoc......	A 15	14	....	276.6	....	....
" not "	A 16	14	....	40.	....	....
Cowpeas, (Backwoods) inoc.	A 5	14	7	119.0	31.0	150.0
" " not "	A 6	14	7	108.8	58 0	166.9
" " inoc.	B 5	14	8	....	....	....
" " not "	B 6	14	8	....	....	....
" " inoc.	C 1	14	10	....	....	....
" " not "	C 2	14	10	....	....	....
" " inoc.	D 1	14	7	91.5	43.6	135.1
" " not "	D 2	14	7	95.	55.8	150 8
" " inoc.	E 5	14	5	....	....	....
" " not "	E 6	14	5	....	....	....
Lespedeza striata, inoc......	A 19	3	....	42 5	....	....
" " not "	A 20	3	....	36 3	....	....
" " inoc......	B 9	3	....	29.	....	....
" " not "	B 10	3	....	16.9	....	....
" " inoc......	C 9	3	....	37.0	....	....
" " not "	C 10	3	....	50.8	....	....
" " inoc	D 9	3	....	32.7	....	....
" " not "	D 10	3	....	27.0	....	....
" " inoc......	E 11	3	....	22.0	....	....
" " not "	E 12	3	....	24.3	....	....

NOTE 3.—That dust from unhulled bur clover was able to inoculate alfalfa plants is not strange in view of the fact that both belong to the same genus, and that bur clover seed are borne near the ground and not harvested until after the vines are thoroughly dead, when the burs are swept up with brooms, thus mixing considerable earth with the seed.

The most unexpected point in this experiment is that the organism adhearing to perfectly dry bur clover seed retained its vitality from the time of harvesting bur clover (May or June) until late in the following October. The bag containing one bushel of bur clover seed was kept in a dark, airy storage room about three-fourths of the time, and in a very light room the rest of the time.

Our experiments in the field had previously shown that bur clover seed, without inoculation, developed tubercles on all soils tested, and that these tubercles first appeared in immediate contact with the old seed-bur.

NOTE 4.—The average increase for all soils resulting from inoculation has been calculated by comparing directly the weight of tops, roots, and entire product of inoculated and uninoculated plants, and not by averaging together the percentages given respectively on pages 471, 472 and 476.

In calculating this average for crimson clover, it was thought best to make allowance for the smaller size of some of the pots of crimson clover.

BULLETIN No. 88. DECEMBER 1897.

ALABAMA

Agricultural Experiment Station

OF THE

AGRICULTURAL AND MECHANICAL COLLEGE,

AUBURN.

EXPERIMENTS WITH CORN

J. F. DUGGAR, AGRICULTURIST.

BIRMINGHAM
ROBERTS & SON.
1897.

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Experiments With Corn.

BY J. F. DUGGAR.

SUMMARY.

Seed corn from Illinois gave a slightly larger yield than seed corn grown in the South.

In 1897 the most productive varieties were Mosby Prolific, Cocke Prolific and Renfro.

Kernels from the middle portion of the ear used as seed failed to show any superiority over seed from the tip or butt end of the ear.

Topping, and also cutting corn and curing it in shocks, slightly decreased the yield of grain. The combined value of grain and stalks, valuing the stalks at 25 cents per 100 pounds, was greater by $2.95 per acre than the value of the grain from the plot where only the ears were harvested.

When each plant was allowed 15 square feet of space, narrow rows and wide spacing in the drill gave slightly better average results than wide rows and close planting in the drill. Having regard to convenience of cultivation, as well as to yield, rows practically 5 feet apart, with plants 3 feet apart in the drill, gave most satisfactory results on poor sandy land.

Cotton seed meal alone was the most profitable fertilizer for corn in 1897. Acid phosphate and kainit failed to increase the yield. Cotton seed placed in the ground so late as to germinate had considerable fertilizing value.

The Rainfall During the Growing Season of 1897.

The following is the condensed record of rainfall at Auburn, April to September inclusive, as observed by Dr. J. T. Anderson, of the Chemical Department:

	Rainfall in inches
April	5.82
May	1.09
June	3.46
July	5.01
August	6.37
September	.44

The longest periods of extremely slight rainfall were: (1) The 20 days just preceding June 4, during which period less than one-tenth inch of rain was recorded; (2) the 15 days ending with a moderate and insufficient rain July 19; and (3) the 20 days immediately following the date just referred to. These last two periods may be regarded as forming practically a continuous dry season, extending from July 3 to August 10, when a slight rain fell, or to August 16, when a heavy rainfall was recorded. The drought of September was probably without notable effect on the yield of corn planted in the first half of April.

Variety Test of Corn, 1897.

Fifteen varieties were tested on 20 plots, each one-twentieth acre in area. The distance between rows was five feet, and no cow peas were planted between the corn rows.

The stand of plants was nearly uniform on most plots, but slightly defective on plots 3, 4 and 17.

Experiment Station Yellow corn was planted on four plots as a check on the fertility of the land, which was found to be quite uniform, except on plots 17, 18, 19 and 20, where there was a decline in fertility.

The following table gives the number of pounds of thoroughly dry unshucked corn required to afford 56 lbs. of shelled corn, the percentage of grain in the unshucked corn, and the yield per acre of each variety, arranged in order of productiveness:

Pounds unshucked corn per bushel, per cent. grain and yield of fifteen varieties of corn.

Plot No.	VARIETY.	Unshucked corn per bushel.	Grain in unshucked corn.	Yield of shelled corn per acre.
		Pounds.	*Per cent*	*Bushels.*
11	Mosby Prolific....................	72.5	77.3	25.4
12	Cocke Prolific....................	75	74.7	23.7
4	Renfro	74.8	74.8	23.6
6	Cade Prolific....................	74.3	75.5	23.0
14 and 15	Blount Prolific (av. Ill. & Ga. seed)	75.5	74.1	19.0
5	Farmers' Pride.................	76.1	73.5	18.6
3, 8, 13, 18	Experiment Station Yellow......	78.4	71.4	18.4
1	Shaw Improved.................	77.9	71.7	18.3
2	St. Charles......................	74.3	75.4	18.1
10	Jones Prolific...................	78.2	70.7	17.9
7	Strawberry......................	80.4	70.3	17.8
16	Welborn Conscience............	92.8	73.2	16.1
9	Champion White Pearl..........	79.2	70.7	14.5
19 and 20	Hickory King (av. Ill. & Ala. seed)	75.7	74.1	13.2
17	Early Mastodon.................	78	71.9	11.1

In this test Mosby Prolific stood first, followed by Cocke Prolific, Renfro and Cade Prolific. It will be noticed that of the varieties standing near the head of the list, all except Renfro bear the name of "prolific," indicating that they produce several ears to the plant. In partial explanation of this it must be said that the land on which this experiment was conducted was in fairly good condition for upland, having borne a crop of cow peas in 1896, the vines of which were plowed under after the peas were picked. Fertilization, with a complete commercial fertilizer, was more liberal than is our custom with corn. For upland fields in poor condition the writer does not feel warranted in recommending varieties bearing several ears per plant, but regards the results of the test made here in 1896 as more generally applicable. In that test St. Charles afforded the largest yield.

Doubtless the very different positions which the several varieties take in the two tests is largely due to differences in the weather conditions. As a rule the medium maturing varieties stood highest in 1896, the late varieties in 1897.

The following table shows the number of ears and nubbins required to yield a bushel of grain, and also shows the chief characteristics of ears and cobs of the varieties tested:

Size and color of ears and cobs of fifteen varieties of corn.

VARIETY.	No. of ears and nubbins per bu.	*EAR			*COB	
		Size	Color	Rough or smooth	Size	Color
Mosby Prolific..........	146	M	W	R	S	W
Cocke Prolific	153	M	W	S	M	W
Renfro................	135	L	W	R	L	W
Cade Prolific...........	153	L	W	S	M	W
Blount Prolific..........	204	M	W	S	S	W
Farmer's Pride.........	133	M	W	R	M	W
Experiment Sta. Yellow.	147	M	Y	S	M	W
Shaw Improved.........	135	L	W	R	L	W
St. Charles.............	142	M	W	I	M	R
Jones Prolific...........	138	M	W	S	M	R
Strawberry.............	106	L	R	R	L	R
Welborn Conscience....	186	M	W	R	L	W
Champion White Pearl..	173	S	W	R	M	W
Hickory King..........	220	S	W	S	S	W
Early Mastodon........	155	S	Y	R	L	R

*L, large; M, medium; S, small; R, red, except when in column showing whether the ear is rough or smooth; S, smooth; I, intermediate; Y, yellow; and W, white.

SEED CORN FROM DIFFERENT LATITUDES.

In this test were used Blount Prolific corn from Illinois and Georgia, and Hickory King corn from Illinois and from Pickens county, Alabama.

Seed corn from different latitudes.

	SHELLED CORN PER ACRE.	
	Yield.	Increase (+) or decrease (—) with Northern seed.
Hickory King.	*Bus.*	
From Pickens County, Alabama.......	12.1	....
From Voorhies, Illinois...............	14.3	+2.2
Blount Prolific.		
From Voorhies, Illinois...............	19.1	+0.2
From Herndon, Georgia..............	18.9	....

This experiment agrees with a similar test in 1896 in showing a slightly larger yield from the use of Northern seed. With the Hickory King variety the difference in yield seems too great to be attributed to variations in the fertility of the two plots, which lay side by side. With the Blount Prolific variety the difference is so small that we are justified in regarding the yields as indicating no superiority of seed of that variety from either source.

"The results recorded in the preceding table do not confirm the common belief that Northern seed corn is inferior to pure Southern varieties.

"Differences in yield between the same varieties from different latitudes are not wholly due to climate, but also to the kind of soil and culture which produced each strain. Thus seed of the same variety grown on adjacent farms may vary in productiveness—an encouraging fact for one who may desire to improve his corn by good culture and careful selection."—Ala. Sta. Bul. No. 75.

Where to Get Seed.

As the Alabama Experiment cannot offer seed either for sale or distribution, a list is given below of parties from whom our seed corn was originally obtained :

Shaw, Farmers' Pride and Cade's Prolific were donated by H. H. Arrington, Summerville, Ga.

St. Charles, Champion White Pearl, Blount Prolific and Hickory King were from J. C. Suffern, Voorhies, Ill.

Strawberry was supplied by T. A. Whatley, Opelika, Ala.

Jones Prolific and Blount Prolific came from H. P. Jones, Herndon, Ga.

Cocke Prolific and Welborn Conscience were bought of Mark W. Johnson Seed Co., Atlanta, Ga.

One sample of Hickory King was furnished by C. C. L. Dill, Dillburg, Ala.

Butt, Middle and Tip Kernels for Seed.

A number of experiments have been made at different Experiment Stations to determine whether there is any difference in the crop grown from kernels produced on different parts of the cob. While these results vary considerably with different varieties and in different years, they tend on the whole to show that there is no marked or constant superiority of middle kernels over those from either end of the ear.

In 1897 butt grains were obtained from a space of about one-half inch at the large end of the ear, tip kernels from a similar space at the extreme small end of the ear, and middle grains from near the center of the same ears.

Six plots, each one-sixteenth acre in area, were used, and each kind of seed was planted on duplicate plots, the arrangement of plots being such as to distribute equally to all classes of seed any advantage due to differences in the fertility of the different plots.

Culture and fertilization were identical for all plots. The variety used was Experiment Station Yellow, which, although placed in the dent class, has some qualities which suggest some degree of kinship to the flint varieties.

The yields, on a basis of 80 pounds of unhusked corn per bushel of grain, were as follows:

Yield obtained from planting middle, butt and tip kernels.

KIND OF SEED.	Yield per acre
	Bus.
From middle kernels (average of 2 plots)	17.2
From butt kernels (average of 2 plots)	17.4
From tip kernels (average of 2 plots)	19.2

The yield was largest when tip kernels were planted. In so far as this indicates that sound tip kernels are equally as valuable for seed as those from other parts of the cob, it accords with last year's results and with the average results of numerous tests compiled by the writer in Bulletin 75.

A similar experiment with the variety Renfro was begun, in 1897, but the stand was so poor that the results of the test with Renfro corn were valueless.

Taken as a whole, the experiments thus far made in several widely separated states fail to show any decided advantage in planting kernels from any special portion of the cob. This has been true even when the tip, butt and middle kernels planted had been propagated for several generations from tip, butt and middle kernels respectively.

Methods of Harvesting Corn.

This is a repetition of a similar experiment conducted in 1896. It was conducted on the same piece of branch bottom land, and the same variety, Mosby Prolific, was employed in both tests.

Corn was planted April 12 in rows 4½ feet apart. Equal weights of a complete home mixed commercial fertilizer were used on all plots.

August 24 on a portion of the field the tops were cut just above the ear. At that date the lower leaves had "fired" too much to make good fodder.

August 30 on other rows the entire stalks were cut, put into large shocks and left until September 24.

A third set of rows remained undisturbed until September 24. On this last date the ears were pulled from all three classes of plants, viz: (1) Those not previously disturbed; (2) those plants which had been topped, and (3) those stalks which had been cut near the ground and shocked.

Weather conditions were favorable to the curing of the stalks.

The following table gives the yield per acre both of grain and forage in 1897 on the plots differently treated:

Yield per acre of corn and forage from different methods of harvesting.

METHOD OF HARVESTING.	Corn per acre.	Forage per acre.
	Bus.	*Lbs.*
Only ears harvested	31.0	00
Tops cut and ears harvested	29.2	509 (tops)
Entire stalks cut and ears afterwards harvested	29.5	1355 (stalks)

Apparently both topping and cutting the stalks before pulling the ears slightly decreased the yield of grain, the loss being 1.8 bushels per acre with topping and 1.5 bushels with cutting.

We have next to consider whether the forage gained by harvesting tops or stalks exceeds in value the grain which seems to have been lost by these processes.

With corn at 45 cents per bushel, tops at 50 cents per 100 lbs., and entire stalks with adhering blades at 25 cents per 100 lbs., and assuming that the different plots were uniform in fertility, we obtain as the average for two years the following results:

Average results of two years' test of methods of harvesting corn.

METHOD OF HARVESTING	YIELD PER ACRE		VALUE PER ACRE		
	Corn	Forage	Corn	Forage	Total Product
	Bus.	*Lbs.*			
Only ears harvested.....	33.0	....	$14 85	....	$14 85
Ears and tops harvested.		411	13 36	$2 05	15 41
Ears and entire stalks	29.7				
harvested............	29.4	1,829	13 23	4 57	17 80

At the prices assumed above, the highest average value was secured by cutting and curing the entire stalks, this process showing a gain of $2.95 per acre over harvesting only the ears. "Will this amount cover the cost of handling a weight of fresh stalks sufficient to produce about one ton of cured stalks? That is a local question the answer to which is largely dependent on the price and efficiency of labor. The value assumed for entire stalks, or stover, is necessarily only an estimate.

The low price of 25 cents per 100 lbs. of stalks has been assumed because of the immense waste in feeding the coarse forage, a waste which is inevitable unless one purchases a shredding machine and expends considerable labor in preparing shredded forage. Chemical analysis shows that even the butt of the stalk, the part which, unless shredded, is rejected by cattle, has some feeding value." (Ala. Sta. Bul. 75.)

Distance for Upland Corn.

This experiment occupied 6 plots, each one-twelfth acre in area. It was located on the same land as a similar experiment made in 1896. The location of the separate plots, however, was so changed that the thicker planting of 1897 occurred on the plots which had been most thinly planted the preceding year. This tends to equalize inequalities of soil and to make the average results for two years more reliable than those for either year taken alone.

The land was sandy, and very poor. Fertilization was the same for all plots, viz:

50	lbs. nitrate of soda per acre.
80	lbs. cotton seed meal per acre.
160	lbs. acid phosphate per acre.
30	lbs. muriate of potash per acre.
Total, 320	lbs. complete fertilizer per acre.

All plots received the same cultivation, and all were planted March 27, 1897, with Champion White Pearl, an early variety with small stalk, which in the variety test of the present year took a low rank.

A single plant was left in each hill and the stand was regular. On plots 1, 2 and 3, the distance between the rows was the same, 5 feet, but the distance between the plants in the drill varied from 4 to 2 feet, affording wide variations in the number of plants per acre. On the other hand the thickness of planting was the same on each of plots 4, 5 and 6, but the distribution or arrangement of plants was different.

The following table gives the number of stalks and the yield of corn per acre when the plants stood at different instances apart:

Yield of corn when plants stood at different distances apart.

DISTANCE		Number of plants per acre	YIELD PER ACRE		
Between rows	Between plants		1896	1897	Average 2 years
			Bus.	*Bus.*	*Bus*
5 feet	4 feet	2,178	12.4	15.3	13.9
5 feet	3 feet	2,904	12.9	15.7	14.3
5 feet	2 feet	4,356	9.8	16.7	13.3
6 feet	2 feet 6 in.	2,904	13.1	15.5	14.3
4 feet 10 in.	3 feet $1\frac{1}{2}$ in.	2,904	15.6	16.7	16.7
4 feet	3 feet 9 in.	2,904	16.9	17.8	17.4

In both seasons the yield was largest when the constant area devoted to each plant approached a perfect square in shape. In other words, a plant having 15 square feet of space was most productive when so planted that the distance in the drill nearly equaled the distance between rows.

This distance of 4 feet by 3 feet 9 in. affords the largest average yield for two years, but for cheapness of cultivation rows 5 feet wide, with plants about 3 feet apart, are to be preferred to narrower rows on such soil as that used for this test. On poor land a row of cow peas should usually be planted between the corn rows, which was not done in this experiment. With a row of cow peas between the corn rows the distance should be at least 5 feet on such lands as this.

Fertilizer Experiments With Corn.

The soil used for this purpose contained more clay than most of the fields on the station farm. It was a piece of nearly level, rocky upland, adjoining and similar to that used for testing fertilizers with cotton. (See Bulletin No. 89.) It was apparently quite uniform in fertility. The soil is reddish, and the surface is nearly covered with flint stones. It was decidedly richer than the average hill land of this locality.

Preceding crops were: In 1895, corn; in 1896, wheat; and in the winter of 1896 and early spring of 1897 it was in rye, which was grazed off with cattle during the early part of March.

Commercial fertilizers, consisting largely of acid phosphate, had been regularly used on this field for a number of years, the average annual quantity being estimated at about 300 pounds per acre. When, in previous years, corn had occupied this field, cow peas had been planted between the rows.

After grazing off the rye the tall stubble was turned under April 5, leaving the land too loose and open. This condition and the depredations of bud worms made it impossible to get a good stand of corn, even after replanting. An effort was made to leave the same number of plants on all rows, but exact uniformity of stand was not obtained.

April 7 rows 4 feet 8 inches apart were marked off with a shovel plow and the fertilizer drilled. A scooter plow was then run in this drill to mix the fertilizers with the soil. Seed of Experiment Station Yellow Corn was dropped and covered with a double-foot plow. Planting was done on a level.

The following table gives the yields in bushels of shelled corn per acre:

Yield of corn per acre with different fertilizers.

FERTILIZERS.		
Amount per acre.	Kind.	Yield per acre.
Lbs.		*Bus.*
434	Green Cotton Seed (germinated)	
240	Acid Phosphate	26.0
200	Kainit	
200	Cotton Seed Meal	26.4
240	Acid Phosphate	20.1
00	No Fertilizer	17.8
200	Kainit	17.6
200	Cotton Seed Meal	22.6
240	Acid Phosphate	
200	Cotton Seed Meal	22.3
200	Kainit	
240	Acid Phosphate	17.9
200	Kainit	
00	No Fertilizer	19.3
200	Cotton Seed Meal	
240	Acid Phosphate	21.8
200	Kainit	
200	Cotton Seed Meal	
240	Acid Phosphate	22.0
100	Kainit	

Apparently neither acid phosphate nor kainit was beneficial to corn. Cottonseed meal increased the yield in every instance whether applied alone or in combination. The increase was sufficient to pay a profit when cottonseed meal was used alone. Apparently unrotted cottonseed were quite effective, notwithstanding the fact that they germinated in the soil. Doubtless rotted cottonseed are preferable for use as a fertilizer whenever the date of application is so late that unrotted seed would germinate.

The failure of acid phosphate to increase the corn crop in this exceptional season and on soil which for years past had been liberally fertilized with this material, should not influence farmers to omit acid phosphate on poorer soils used for corn.

It should be stated here that in a similar experiment with cotton conducted on land adjacent to that used for the test of fertilizers under corn, kainit alone and cottonseed meal applied alone were the most profitable fertilizers, and that acid phosphate was not beneficial.

BULLETINS

OF

ALABAMA

Agricultural Experiment Station.

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VOL. VI.

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JANUARY, 1898, TO DECEMBER, 1899.

MONTGOMERY, ALA.:
THE BROWN PRINTING COMPANY, PRINTERS
1899.

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BULLETIN No. 89. JANUARY, 1898.

ALABAMA

Agricultural Experiment Station

OF THE

AGRICULTURAL AND MECHANICAL COLLEGE,

AUBURN.

EXPERIMENTS WITH COTTON

J. F. DUGGAR, AGRICULTURIST.

BIRMINGHAM
ROBERTS & SON.
1898.

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☞ The Bulletins of this Station will be sent free to any citizen of the State on application to the Agricultural Experiment Station, Auburn, Alabama.

Experiments With Cotton.

BY J. F. DUGGAR.

SUMMARY.

The group of varieties yielding most lint were Texas Oak, Griffin, Hawkins, Deering, Mell Cross No. 15, Jones Re-improved, Duncan, Hutchinson, Peterkin, Truitt and Whatley.

Seed of the same original stock, but grown for one year in different parts of the Cotton Belt, when planted at Auburn, showed no marked difference in productiveness.

The yields obtained by planting fresh, one-year-old and two-year old seed were nearly identical.

With late cultivation the yield of cotton was slightly larger than with ordinary cultivation.

Truitt cotton in narrow rows on upland of medium quality gave practically the same yields whether the single plants stood 12, 18 or 24 inches apart in the drill. The yield decreased when the distance between plants was increased to 30 or 36 inches. The crop matured earlier with thick planting.

Topped cotton plants yielded less than those not topped.

The use of 640 pounds of slaked lime, applied broadcast in 1896, failed to increase the crop that year. But cotton following broadcast cow peas, turned under in the spring of 1897, afforded a larger yield on the plot limed the previous year than on the plot not limed.

Subsoiling in January, 1896, was decidedly beneficial to the first crop of cotton, but afforded no increase in the second crop, grown in 1897.

A mixture of stable manure, cottonseed meal and acid

phosphate, applied without composting, afforded a slightly larger yield than did exactly the same materials made into compost about one month before using.

Composting increased the efficiency of Florida soft phosphate, but not of acid phosphate.

Slightly larger yields were obtained by bedding on all the fertilizer than by reserving one-fourth and applying this portion in the seed drill at planting time.

One hundred and fifty pounds per acre of cottonseed meal afforded a larger yield of seed cotton than 316 pounds of cottonseed or 70½ pounds of nitrate of soda. These amounts of the above-named fertilizers contained equal quantities of nitrogen; hence cottonseed meal was the source whence the most effective form of nitrogen was obtained.

Acid phosphate was more effective pound for pound than Florida soft phosphate, except when the crude phosphate was employed in compost.

A mixture of acid phosphate and Florida soft phosphate was less effective than an equal weight of acid phosphate, and more valuable than an equal weight of Florida soft phosphate.

Acid phosphate alone failed to increase the yield. Cottonseed meal was highly beneficial. Kainit, alone and in combination, greatly increased the yield. Kainit decreased the injury from "black rust," and this is apparently the explanation of the large increase in yield on the plots receiving kainit.

The Weather in the Growing Season of 1897.

The rainfall for each month is recorded in Bulletin No. 88. There were several periods in May and in the first half of the summer when cotton suffered greatly from dry weather. However, up to the latter part of July there was every prospect for large yields. A severe drought, ending about the middle of August, followed by a week of rainy weather, resulted in great damage in shedding of forms and in the rapid spread of "black rust" on the leaves.

A second growth was made later in the season, but on the Station Farm a large proportion of the bolls then formed failed to open.

VARIETIES.

In 1897 the number of varieties tested was 32, of which 17 were well-known varieties and 15 crosses originated several years ago by the station botanist, Prof. P. H. Mell. The parentage of these varieties was noted in Bulletin No. 56 of this Station.

The rows were 3½ feet apart. Thinning was done after counting the plants, so as to leave an equal number on each plot. The average distance between plants was 18 inches on all plots, except on those planted in Bates and Griffin, where a poor stand was obtained, the average distance between plants being nearly 24 inches with Griffin and nearly 40 inches with Bates. No corrections have been made for this very defective stand on these two plots, although it is evident that both varieties are at a disadvantage.

Peerless côtton was planted on 7 plots as a means of ascertaining the amount of any variations in the natural fertility of the field. The field was found to vary so much that one variety could not fairly be directly compared with all others.

However, the frequently repeated Peerless plots enable us to calculate approximately what would be the yield of each plot if planted with the Peerless variety. In so doing the actual yield of the Peerless plot on either side is given a weight inversely proportional to its distance from each plot for which the calculation is made. The amount by which any variety exceeds the calculated yield of Peerless on a given plot is believed to be the best measure of the natural productiveness of that variety under the weather conditions prevailing in 1897. Therefore in this bulletin the varieties are ranked in order of productiveness according to the amount of lint by which they exceed Peerless in that part of the field. The actual yields, both of seed cotton at the time of ginning, and of lint, are also given.

The following table contains these data, and also figures indicating the percentage of lint in seed cotton and the relative earliness of each variety, as indicated by the percentage of the total crop obtained at the first picking, August 31:

Yield per acre, relative earliness, percentage of lint, and relative productiveness compared with Peerless, of 32 *varieties.*

Plot No.	VARIETY.	Actual yield of seed cotton.	Percentage of total crop at first picking.	Percentage of lint.	Actual yield of lint per acre.	Gain (+) or loss (—) per acre over Peerless.	Calculated yield of Peerless, lint.
		Lbs.			*Lbs.*	*Lbs.*	*Lbs.*
16	Texas Oak	707	47	36.2	256	+29	227
5	Griffin Drought Proof Prolific	970	44	31.0	301	+28	273
7	Hawkins Imp'd	824	45	33.9	280	+20	260
15	Deering Small Seed	672	63	35.7	240	+16	224
29	Mell Cross No. 15	627	48	32.4	206	+12	194
1	Jones Re-improved	917	58	32.3	296	+11	285
2	Duncan Mammoth	898	52	34.7	296	+11	285
12	Hutchinson Storm Prolific	790	*	32.0	253	+10	243
10	Peterkin	755	31	34.4	259	+ 9	250
8	Truitt Imp'd P. Prolific	824	60	31.8	262	+ 8	254
20A	Whatley Imp'd	746	59	30.5	228	+ 7	221
31B	Mell Cross No. 3	650	40	31.0	197	+ 3	194
32B	Mell Cross No. 50	682	49	28.9	197	+ 3	194
22	Mell Cross No. 38	712	55	31.7	226	+ 2	224
32A	Mell Cross No. 14	640	52	29.1	195	+ 1	194
33	Mell Cross No. 7	669	66	29.7	195	+ 1	194
24	Mell Cross No. 58	688	51	31.9	219	0	219
30	Mell Cross No. 54	614	55	31.5	194	0	194
31A	Mell Cross No. 49	624	62	30 8	192	— 2	194
14	Dickson Cluster	710	83	31.9	227	— 3	230
6	Hunnicutt Choice	816	46	31.8	259	— 4	263
35	Mell Cross No. 55	613	75	30.8	189	— 5	194
27	Mell Cross No. 12	629	56	31.0	195	— 5	200
4	Bates Big Boll	890	34	29.6	266	—13	279
26	Mell Cross No. 43	605	55	31.5	190	—14	204
25	Mell Cross No. 61	634	48	31.3	198	—15	213
17	Allen Improved Long Staple	731	58	28.0	205	—16	221
20B	Tyler	707	61	28.5	202	—19	221
21	Mell Cross No. 76	661	51	31.2	197	—25	222
34	Mell Cross No. 11	†520	80	31.9	157	....	..
19	Allen's Hybrid Long Staple	635	60	27.2	173	—46	219
3	Peerless (check)	880	56	32.4	285	0	285
9	Peerless (check)	776	67	31.9	248	0	248
11	Peerless (check)	763	61	33.1	253	0	253
13	Peerless (check)	712	59	32 8	234	0	234
18	Peerless (check)	676	54	32.2	218	0	218
23	Peerless (check)	714	46	31.6	226	0	226
28	Peerless (check)	614	50	31 5	194	0	194
....	Peerless (average of 7 plots)	735	56	32.2	237	0	237

†This plot is not comparable with others on account of a difference in preparation.

*The percentage of total crop gathered at first picking was not

Ranking the varieties according to their excess of lint cotton per acre over Peerless in each part of the field, the varieties heading the list are Texas Oak, Griffin, Hawkins, Deering, Mell Cross No. 15 (a cross between the W. A. Cook and Cherry Chester varieties), Jones Re-improved, Duncan, Hutchinson, Peterkin, Truitt, and Whatley.

As is usual in variety tests at all experiment stations there is a great difference in the rank of varieties tested in two different seasons, 1896 and 1897. In 1897 all varieties were seriously injured by "black rust," except the very late varieties, Bates and Peterkin, of which only about 5 per cent. of the plants appeared to be seriously damaged. This disease was most prevalent on the early varieties, Dickson, Deering, and Peerless.

Classification of Lint.

The numbered samples of lint were classified by Mr. H. L. Bandy, a cotton buyer of Opelika, Ala. His classification was as follows:

Good Middling, $5\frac{7}{16}$c.—Duncan.

Strict Middling, $5\frac{5}{16}$c.—Jones and Texas Oak (latter rated at $5\frac{3}{16}$c.), Truitt, Peterkin, Mell Cross No. 3, and Mell Cross No. 55.

Barely Strict Middling, $5\frac{1}{4}$c.—Whatley.

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determined for the Hutchinson variety because of an error, which was discovered by the failure of the weight of seed cotton just before ginning to approximately agree with the sum of the weights of the several pickings. With all other varieties there was a close agreement between these 2 sets of figures, but with the Hutchinson there was a discrepancy of 12 pounds of lint cotton. The complete records in which the error occurs are therefore published here for this variety: First picking of one-sixteenth acre plot, 36.8 pounds of seed cotton; second picking, 20.7 pounds; third picking, 3.3 pounds; and fourth picking, 0.5 pound. The error is believed to be in the weight of seed cotton at first picking. The smaller weight (weight at ginning) is evidently correct for it is checked by the weight of lint, and is used in the above table for the Hutchinson, as well as for all other varieties.

Middling, $5\frac{3}{16}$c.—Bates, Griffin, Hunnicutt, Hawkins, Peerless, Hutchinson, Mell Cross No. 76, Mell Cross No. 38, Mell Cross No. 58, Mell Cross No. 61, Mell Cross No. 43, Mell Cross No. 12, Mell Cross No. 54, Mell Cross No. 49, Mell Cross No. 14, Mell Cross No. 50, Mell Cross No. 7, and Mell Cross No. 4.

Barely Middling, $5\frac{1}{8}$c.—Deering.

Strict Low Middling, $5\frac{1}{16}$c.—Dickson, Allen Imp. L. S., and Allen Hybrid L. S.

Where to Get Seed.

This Station cannot offer seed either for sale or distribution. Our seeds for variety tests are purchased in small quantity from the grower, originator, or seed merchant, thus keeping the variety purer than if we saved our own mixed seed. Our stock was obtained originally from the following parties:

Allen Improved L. S. and Allen Hybrid L. S., from J. B. Allen, Port Gibson, Miss.

Hutchinson, from J. N. Hutchinson, Salem, Ala.

Duncan, Bates, Griffin, Hunnicutt, Hawkins, and Dickson, from Mark W. Johnson Seed Co., Atlanta, Ga.

Peerless and Peterkin, from H. P. Jones, Herndon, Ga.

Texas Oak, from M. G. Smith, Lightfoot, Ga.

Tyler, from K. J. Tyler, Aiken, S. C.

Deering Small Seed was donated by Maj. I. F. Culver, Commissioner of Agriculture, Montgomery, Ala.

Seed from Different Latitudes.

In the early spring of 1896 seed of the variety King was bought from J. S. Blalock, Goldville, S. C., and planted the same year on the Station farm. Small quantities were also sent to the Experiment Station at Stillwater, Oklahoma, to Abbeville, in the southern part of Alabama, and to Dillburg, in the central or western part of this State. The seeds were planted in those localities in 1896, and after that crop was ginned some of the resulting seed were sent back to Auburn.

Hence the comparison below is between seed of the same original stock grown for only one year in different localities. The yields per acre were as follows:

Seed from different latitudes.

Plot No.	SEED FROM	Yield of seed cotton per acre.
1 and 7	Goldville, S. C.	950
2 and 6	Abbeville, Ala.	922
3	Auburn, Ala.	928
4	Dillburg, Ala.	948
5	Stillwater, Okla.	928

The differences are too slight to show any effect due to latitude or climate. Indeed, one year is doubtless too short a time for a seed to be modified by change of climate. A repetition of this test with seed grown for a longer time in different latitudes is planned.

OLD VERSUS NEW SEED.

This is a repetition of an experiment conducted in 1896. In the test of the present year seed from the crop of 1896 is designated as fresh seed, that from the crop of 1895 as one-year-old seed, and that from the crop of 1894 as two-year-old seed. It will be understood that seed spoken of as one year-old is really when planted about a year and a half old, and so on for seed of other ages.

With favorable weather just after planting, a good and uniform stand was secured on all plots. No differences in germination were observed. The following table gives the average results of three experiments in two years:

Yield of lint per acre produced by seed of different ages.

Age of Seed	Lint per acre			
	Whatley variety, 1896	Gold Dust variety, 1896	Dickson variety, 1897	Average of 3 experiments
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*
Fresh	272	242	259	258
One year old	237	248	269	254
Two year old	246	277	240	254

Old and fresh cottonseed were of about the same value for planting under conditions where a good stand was obtained.

Effect of Late Cultivation.

Peerless cotton planted April 19 was "laid by" July 12. One plot, however, was cultivated July 26, running a 22-inch heel scrape twice between each row.

The middle plot, not "laid by" until July 26, yielded 1,087 pounds of seed cotton per acre. Two adjacent plots "laid by" two weeks earlier, or at about the usual time, averaged 1,052 pounds. The difference of 25 pounds in favor of the plot cultivated late was more than sufficient to pay the cost of the extra cultivation.

Distance Experiments.

Truitt cotton was planted April 19 on rather medium quality reddish rocky upland. This field had been in corn in 1896, and had also borne a light crop of Whippoorwill cow peas between the corn rows. The growth of this bunch variety of cow peas, planted late and in rather thick corn, had been too insignificant to noticeably improve the character of this soil, which has always been inclined to bake. The fertilization and cultivation of all plots was identical, except that

June 1 hoeing was done in such a way as to leave two plants in a place either 12, 18, 24, 30 or 36 inches apart. June 25 the stand was reduced to a single plant in a hill. The distance between all rows was 3 feet 4 inches. The stand was practically perfect.

Fertilizers were used as follows:

160 lbs. acid phosphate per acre.
160 lbs. cottonseed meal per acre.
20 lbs. muriate of potash per acre.

Total, 340 lbs. of a complete fertilizer per acre.

The yields were as follows:

Yield per acre of seed cotton with single plants at different distances.

Plot No.	DISTANCE	Yield of seed cotton per acre.
		Lbs.
1	12 inches by 40 inches	928
2	18 " " 40 "	838
3	24 " " 40 "	910
4	30 " " 40 "	856
5	18 " " 40 "	936
6	36 " " 40 "	848
7	12 " " 40 "	917
8	18 " " 40 "	910
9	24 " " 40 "	926
10	30 " " 40 "	900
11	36 " " 40 "	858
12	18 " " 40 "	917
13	18 " " 40 "	960
	Average for 12 inches (2 plots)	922
	" " 18 " (5 plots)	912
	" " 24 " (2 plots)	918
	" " 30 " (2 plots)	878
	" " 36 " (2 plots)	853

The above table shows that with Truitt cotton in narrow rows there was practically no difference in yield between distances of 12, 18 and 24 inches in the drill. When the space was increased to 30 inches a decided reduction in yield followed. When the distance became 36 inches a further reduction occurred, which, however, was only slight. The yield per plant increased rapidly as the space allowed to each was enlarged.

It should be remembered that the Truitt variety makes a large growth, and that its originator recommends thin planting for this variety. With Peerless, a smaller variety, planted in 1896 on a more sandy soil, best results were obtained by spacing either 12 or 18 inches in rows 42 inches apart.

The average percentages of the whole crop that were obtained at the first picking, August 26, were as follows: 42 per cent. for plants 12 inches apart; 38 per cent. for plants spaced 18 inches; 30 per cent. for plants 24 inches apart; 26 per cent. for plants spaced 30 inches; and 28 per cent. for plants 36 inches apart. These averages suggest that thin planting retarded opening and that very thick planting decidedly hastened the maturity of the plants. However, different plots planted at identical distances varied considerably in the percentage of the total crop which was open at the time of the first picking.

Topping.

One plot of Truitt cotton planted April 19 in a part of the field used for distance experiments was topped July 22, and another plot was topped August 19. Two plots were not topped. The distance between plants was 18 inches, and the rows 3 feet 4 inches apart.

The following table gives the results:

Topping vs. not topping cotton.

Plot No.	Treatment.	Yield of seed cotton per acre.	Per cent. of total crop at first picking, Aug. 26.
13 and 15	Not topped	946	45
14	Topped August 19	906	43
16	Topped July 22	710	46

The results are decidedly in favor of the plants not topped. Topping early was apparently more injurious than topping after the first bolls had begun to open.

Topping did not hasten maturity.

SUBSOILING AND LIMING.

This is a continuation of an experiment begun in 1896 on red, rather stiff, shallow soil, inclined to bake and sensitive to drought. The surface is decidedly rocky.

"On January 29, 1896, one plot was broken to the usual depth, 3 or 4 inches, with a one-horse turn plow. In this furrow followed a scooter drawn by one mule, which loosened a part of the soil to an additional depth of 3½ inches. In this way the soil was loosened to a depth of about 7 inches without throwing up to the surface the clay of the subsoil, which is temporarily poorer than the surface soil.

"At the same time two other plots were broken with a one-horse turn plow in the usual way without the subsoiling scooter, and on one of these slaked lime was applied broadcast at the rate of 640 lbs. per acre."

The crop preceding the cotton of 1897 was broadcast cow peas, picked, and the vines plowed under in the early part of spring.

All plots were prepared alike in 1897 in the usual way, using a one-horse turn plow.

The results for both years are given below :

Yield per acre of seed cotton on plots limed, subsoiled and not treated in 1896.

TREATMENT IN 1896	SEED COTTON PER ACRE		
	1896	1897	Average for 2 years
	Lbs.	*Lbs.*	*Lbs.*
Neither limed nor subsoiled	637	723	680
Subsoiled	776	730	753
Limed	653	821	737

The application of 640 pounds of lime, which is a much smaller amount than that usually applied, was followed by an insignificant increase of the first crop and by considerable increase of the second crop after liming. The average increase tor the two years is 57 pounds of seed cotton per acre. The combined increase for the two years is 114 pounds of seed cotton.

The better effect of lime in 1897 than in 1896 is probably due to the fact that in 1897 cotton followed broadcast cow peas, thus giving the lime a supply of vegetable matter to decompose.

The increase attributable to subsoiling was 139 pounds of seed cotton the first year and only 7 pounds the second year after subsoiling, the average annual increase per acre being 73 pounds of seed cotton. The total increase attributable to subsoiling is 146 pounds of seed cotton per acre, which is sufficient to pay a profit over the cost of subsoiling.

Light soils would probably not be benefited by subsoiling. If subsoiling is practiced, it should be done early enough in the winter to allow the rains to moisten and settle the deeply stirred soil before planting time.

Composting versus Mixing in the Furrow.

April 16, on land previously broken with a turn plow, rows were laid off $3\frac{1}{2}$ feet apart with a shovel plow. In these furrows were placed the fertilizer, composts and manure referred to below.

On each of plots 1, 2, 3, 4 and 5 were used, either fresh or in compost, 150 pounds per acre of cotton seed meal and 240 pounds per acre of either acid phosphate or Florida soft phosphate. Each of these plots also received stable manure, fresh or composted, at the rate of 1,500 pounds per acre. To plots 2 and 5 the stable manure was applied fresh, being removed from the mules' stalls and put in the ground the same day, April 16. On plots 1, 3 and 4 compost was applied. This compost had been made March 18 by taking fresh horse manure at the rate of 1,500 pounds per acre from the same stalls as above, and immediately mixing it with cotton seed meal and phosphate. The three lots of compost were kept on a board floor and given only sufficient moisture to insure active fermentation without leaching. In other words, the composts were kept under the most favorable conditions for about one month, or until April 16, when composts, fresh manures and commercial fertilizers were placed in the drill. Low beds were then thrown up above the fertilizers. Peerless cotton was planted April 19 in a seed bed, that was too loose on all plots.

The following table shows the character of fertilization and the yields of seed cotton:

Composting vs. mixing in the furrow.

Plot No.	Amount per acre.	FERTILIZERS.	Composted.	Applied.	Yield of seed cotton per acre.
	Lbs.				*Lbs.*
1	1,500	Stable manure	March 18	April 16	1,050
	240	Acid phosphate			
	150	Cottonseed meal			
2	1,500	Fresh stable manure	........*	April 16	1,144
	240	Acid phosphate			
	150	Cottonseed meal			
3	1,500	Stable manure	March 18	April 16	1,081
	240	Acid phosphate			
	150	Cottonseed meal			
4	1,500	Stable manure	March 18	April 16	1,125
	240	Florida soft phosphate			
	150	Cottonseed meal			
5	1,500	Fresh stable manure	........*	April 16	1,093
	240	Acid phosphate			
	150	Cottonseed meal			
		Averages.			
2 and 5	......	Materials not composted			**1,119**
1 and 3	......	Compost of acid phosphate, etc			**1,065**
4	......	Compost of Florida soft phosphate, etc			**1,125**

*Not composted.

The figures in the above table show plainly that there was no advantage in composting acid phosphate, stable manure, and cottonseed meal, but that on the other hand the plots receiving this compost yielded 54 pounds of seed cotton per acre less than the plots to which the same fertilizing materials were applied in the fresh condition. The result for a somewhat similar comparison between composting and mixing in the furrow was made on lighter soil in 1896, and the result agreed with those of the present season in showing a decreased yield on the plots receiving compost.

The figures in the table show that when composted a pound of the cheaper Florida soft phosphate was slightly more effective than a pound of the more costly acid phosphate. Doubtless the decaying vegetable material of the stable manure has made the raw or crude Florida soft phosphate more soluble and hence of more value to the plant than it would be if used without an abundant supply of vegetable matter. The raw phosphate contains about twice as much total phosphoric acid as acid phosphate, but most of it is classed as insoluble.

One-fourth of Fertilizer in Seed Drill.

This is a repetition with slight changes of an experiment conducted in 1896. For each of three plots equal quantities of fertilizers were weighed out, viz:

150 lbs. cottonseed meal per acre.
240 lbs. acid phosphate per acre.
30 lbs. muriate of potash per acre.

Total, 420 lbs. complete fertilizer per acre.

From the fertilizers intended for two plots there was reserved one-fourth to be applied in the seed drill in immediate contact with the seed. On the middle plot all the fertilizer was drilled as usual in the "marking off" furrow, under the seed bed; three-fourths of the fertilizers for the other two plots was also placed in that position.

The plot receiving all its fertilizer in the "marking off" furrow yielded 1,132 pounds of seed cotton per acre; the plots with one-fourth of the fertilizer in the seed drill averaged 1,098 pounds per acre, a loss of 34 pounds of seed cotton per acre following a division of the fertilizer. A similar result was reached in 1896.

Relative Values of Cottonseed, Cottonseed Meal and Nitrate of Soda.

Such quantities of cottonseed, cottonseed meal and nitrate of soda as contained equal amounts of nitrogen were used on different plots, and on all plots 240 pounds of acid phosphate and 30 pounds of muriate of potash per acre were also applied. The amounts used per acre were 316 pounds of air dry cottonseed, or 150 pounds of cottonseed meal, or 70½ pounds of nitrate of soda. The cottonseed were bagged and moistened about a month before they were applied to the field. All fertilizers were put in the drill April 16.

The results are shown in the following table:

Results with different forms of nitrogen.

Plot No.	Amount per acre	Fertilizers	Yield seed cotton per acre	Per cent. of crop at first picking	Per cent. of "rusted" plants
	Lbs.				
6	150	Cottonseed meal........	1,074	35	10
	240	Acid phosphate..........			
	30	Muriate of potash........			
7	316	Cottonseed, rotted.......	858	45	20
	240	Acid phosphate..........			
	30	Muriate of potash........			
8	70½	Nitrate of soda..........	1 035	40	10
	240	Acid phosphate..........			
	30	Muriate of potash........			

In this test cottonseed meal proved the best of the three fertilizers compared. As a partial offset, there undoubtedly remains in the soil a portion of the fertilizing material of the cottonseed which may be expected to benefit the succeeding crop. "Rust" was more abundant on the plot receiving cottonseed, the amount on this plot being estimated at twice that on either of the other plots.

Relative Values of Different Phosphates.

Equal weights of Edisto high grade acid phosphate, Florida soft phosphate and Tennessee crude phosphate were compared. At the suggestion of the Station Chemist, Prof. B. B. Ross, a mixture of one-half acid phosphate and one-half Florida soft phosphate was prepared as follows: Equal quantities of the two phosphates were thoroughly mixed and moistened about one month before being applied to the soil. The mixture was then allowed to dry thoroughly, after which it was pulverized as thoroughly as practicable. This was done in order that reverted phosphate might be formed from some of the phosphoric acid previously existing in an insoluble form in the Florida soft phosphate.

Florida soft phosphate was compared with an equal weight of acid phosphate in a fertilizer mixture containing no vegetable matter and also in combination with cottonseed meal, the decomposition of which, if enough meal is used, is probably favorable to the effective action of the crude phosphate.

The following table presents the data of these experiments:

Results of comparisons of different phosphates.

Plot No.	Fertilizers. Amount per acre.	Fertilizers. Kind.	Yield of seed cotton per acre.
	Lbs.		*Lbs.*
8	240	Acid phosphate	1,035
	70½	Nitrate of soda	
	30	Muriate of potash	
9	240	Florida soft phosphate	967
	70½	Nitrate of soda	
	30	Muriate of potash	
10	240	Florida soft phosphate	792
	150	Cottonseed meal	
	30	Muriate of potash	
11	120	Acid phosphate	892
	120	Florida soft phosphate	
	150	Cottonseed meal	
	30	Muriate of potash	
12	240	Acid phosphate	972
	150	Cottonseed meal	
	30	Muriate of potash	
13	120	Acid phosphate	946
	120	Florida soft phosphate	
	150	Cottonseed meal	
	30	Muriate of potash	
15	240	Acid phosphate	1,132
	150	Cottonseed meal	
	30	Muriate of potash	
17	240	Tennessee phosphate	1,116
	150	Cottonseed meal	
	30	Muriate of potash	

Although variations in fertility of the field undoubtedly affected the yields on certain plots, some of the comparisons originally intended are practicable. With acid phosphate, in combination with other commercial fertilizers, the yields were larger than with Florida soft phosphate in a similar combination.

With a mixture of these two kinds of phosphates the yields were larger than with an equal weight of Florida soft phosphate, but smaller than with an equal weight of acid phosphate.

Experiment with Fertilizers.

The field used for this experiment was in corn in 1895, in wheat in 1896. A few months after wheat harvest buckwheat was sown. This crop failed almost completely, and was followed by rye in the fall of 1896, which was pastured in March, 1897. A thick stubble was turned under a few days before cotton was planted. This field had received liberal applications of fertilizers, chiefly acid phosphate and cottonseed meal, with all crops of recent years. The soil of this field is a red loam, containing more clay than most soils in this immediate vicinity. The surface is nearly covered with flint stones.

After the land was turned rows 3½ feet apart were laid off with a shovel plow. In these furrows the fertilizers were drilled, after which beds were thrown up over the lines of fertilizer. These beds were then flattened with a harrow and Peerless cotton was planted April 19.

At the final thinning 560 plants were left on each fifteenth-acre plot, which is at the rate of 8,400 plants per acre.

June 29 plants on all plots were in bloom, but the blooms were few on the unfertilized plots. There was promise of a large crop, estimated at a bale per acre, on the best plots, until the 1st of August. From August 1 to August 15 shedding of bolls went on rapidly as the result of a dry season, which, broken only by light showers, had extended over more than a month.

It was doubtless during the last week of this drought that a leaf disease became widely spread over this field. During a week of almost continuous rain, beginning August 16, this leaf disease spread so rapidly that the leaves died in large areas over the field, and a large percentage of the plants dropped every leaf. The appearance of the affected plants seemed to justify the local name of "black rust" for the disease which, although not carefully observed in its early stages, was apparently the same as the disease described by Prof. G. F. Atkinson in Bulletin No. 41 of this Station as "yellow leaf blight," or "mosaic disease."

August 21 an estimate was made of the percentage of seriously diseased plants on each plot. At that date the plot receiving 240 pound per acre of acid phosphate, and the plot supplied with both acid phosphate and cottonseed meal, had been most injured. Next in extent of injury were the unfertilized plots.

The plots least injured were Nos. 4 and 6, the one treated with kainit alone, the other with kainit and cottonseed meal. The next healthiest plots were Nos. 1 and 7, the former being the cottonseed meal plot, the latter the cottonseed meal and acid phosphate plot.

The results on plot 10 are considered unreliable, because a part of this plot consisted of a strip of land which in the preceding year had received treatment different from the balance of the field, and because the growth of plants and the prevalence of leaf disease were so different on the two portions of this plot.

The following table gives the yield of seed cotton per acre; the calculated* increase; the value of the increase at 2 cents per pound of seed cotton ($5\frac{1}{4}$ cents per pound for lint and $7.50 per ton for seed); the actual cost of fertilizers delivered in Auburn in carload lots; and the "profit from fertilizers," or difference between value of increase and cost of fertilizers:

---

*Increase of plots 4–7 inclusive is calculated by giving to the figures for each unfertilized plot a weight inversely proportional to its distance from each in turn of the fertilized plots.

Yield of seed cotton, increase per acre, and financial results from use of different fertilizers.

Plot No.	Fertilizers. Amount per acre.	Fertilizers. Kind.	Seed cotton. Yield per acre	Seed cotton. Increase over unfertilized plots.	Financial results. Value of increase at 2c per lb.	Financial results. Cost of fertilizers per acre.	Financial results. Profit from fertilizers.
	Lbs.		*Lbs.*	*Lbs.*			
1	200	Cottonseed meal........	1,024	310	$6.20	$1.90	$4.30
2	240	Acid phosphate.........	774	60	1.20	1.32	—.12*
3	......	No fertilizer...........	714	......	......	......	......
4	200	Kainit.................	1,075	354	7.08	1.38	5.70
5	200 240	Cottonseed meal...... Acid phosphate.......	849	120	2.40	3.22	—.82*
6	200 200	Cottonseed meal...... Kainit....	1,099	363	7.26	3.28	3.98
7	240 200	Acid phosphate....... Kainit...............	919	175	3.50	2.70	.80
8	......	No fertilizer..........	751	......	......	......	......
9	200 240 200	Cottonseed meal...... Acid phosphate....... Kainit...............	1,011	260	5.20	4.60	.60
10	200 240 100	Cottonseed meal...... Acid phosphate....... Kainit...............	1,077	......	......	3.90	......

* Loss.

Kainit alone was most profitable. Cottonseed meal, used alone, was second in point of profit. A combination of both kainit and cottonseed meal afforded a larger yield than either alone, but the cost was also greater, giving to this combination the third place as regards profit.

The following analysis of the above table brings out clearly the effect of each fertilizer under four different conditions:

Cottonseed meal apparently increased the yield of seed cotton per acre when added—

	Pounds.
To unfertilized plots	310
To kainit plot	9
To acid phosphate plot	60
To kainit and acid phosphate plot	85
Average increase from cottonseed meal	**116**

Kainit apparently increased the yield of seed cotton per acre when added—

	Pounds.
To unfertilized plots	354
To acid phosphate plot	115
To cottonseed meal plot	53
To acid phosphate and cottonseed meal plot	85
Average increase from kainit	**151**

Acid phosphate apparently increased the yield of seed cotton per acre when added—

	Pounds.
To unfertilized plots	60
To kainit plot	—179
To cottonseed meal plot	—190
To kainit and cottonseed meal plot	—103
Average *decrease* from acid phosphate	**103**

The favorable effects of kainit and cottonseed meal and the unfavorable effects of acid phosphate are probably not indications that this soil is notably lacking in potash and nitrogen and abundantly supplied with phosphoric acid. The most profitable fertilizer in 1897 was the one which was best able to fortify the plant against the attacks of the prevalent leaf disease. Under the weather conditions of 1897 kainit and cottonseed meal were best able to do this. Their favorable effect was doubtless due largely to the fact that they tended to delay maturity or to keep the plant growing longer than was the case with acid phosphate. On the other hand, acid phosphate hastened maturity to such an extent that when unfavorable weather occurred in August the plants fertilized with phosphate had reached such a stage of fruiting that they were unable to resist disease to the same extent as the less completely developed plants on other plots.

That there is some correspondence in 1897 between yield, late maturity and freedom from disease is suggested by the data in the following table, which shows the yield in pounds of seed cotton per acre, percentage of total crop gathered at first picking, August 26, and percentage of plants seriously injured by "rust" as estimated August 21:

Relation between yield, earliness, and amount of "rust."

Plot No.	Fertilizer. Amount per acre.	Fertilizer. Kind.	Yield of seed cotton per acre.	Percentage of crop at first picking.	Percentage of seriously diseased plants.
	Lbs		*Lbs.*		
1	200	Cottonseed meal	1,024	24	20
2	240	Acid phosphate	774	26	90
3	......	No fertilizer	714	30	80
4	200	Kainit	1,075	22	10
5	200	Cottonseed meal	849	44	90
	240	Acid phosphate			
6	200	Cottonseed meal	1,099	25	10
	200	Kainit			
7	240	Acid phosphate	919	34	15
	200	Kainit			
8	......	No fertilizer	751	27	80
9	200	Cottonseed meal	1,011	40	75
	240	Acid phosphate			
	200	Kainit			

Apparently this red soil was not particularly deficient in potash. For in 1897, in a part of the same field, with identical previous treatment, kainit, alone and in every combination, failed to increase the yield of corn over that of the unfertilized plots.

Our results in the above table seem to confirm those of

Dr. G. F. Atkinson (published in Bulletin Nos. 27, 36 and 41 of this Station) in showing the favorable effects of kainit in checking the disease which that authority designated as yellow leaf blight. But kainit at the rate of 200 pounds per acre was not a preventive of the form of leaf disease which was most abundant on the Station farm in 1896, a disease which effected little injury in comparison with that wrought by the widely prevalent disease of the present year.

A careful inspection of the field where the fertilizer experiments were conducted in 1897 led to the conclusion that the fertilizer was by no means the only factor in determining the extent and distribution of the disease. The belts in which the disease was most serious were not well defined, but extended diagonally across certain parts of the field, embracing plots differently fertilized. The fact that certain irregular areas were especially liable to this disease, regardless of the kind of fertilizer used, is not necessarily in conflict with the tendency of kainit to check the disease under certain conditions.

The subject of diseases of cotton is under investigation by the Station Biologist, Prof. F. S. Earle, and the Agriculturist will co-operate as far as possible in that work.

We are not prepared to advise farmers to buy kainit simply for its "rust resisting" properties. On soils deficient in potash it is a profitable fertilizer, and apparently it may also some years be profitable for cotton in fields inclined to rust, even if no marked deficiency of potash is indicated by other crops. Unfortunately destructive outbreaks of rust cannot be foretold. The minimum amount of kainit that can be effectively used for rust has yet to be determined.

BULLETIN NO. 90. JANUARY, 1898.

ALABAMA

Agricultural Experiment Station

OF THE

AGRICULTURAL AND MECHANICAL COLLEGE,

AUBURN.

I. THE PEACH TREE BORER.

II. THE FRUIT BARK BEETLE.

C. F. BAKER.

BIRMINGHAM
ROBERTS & SON.
1898.

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☞ The Bulletins of this Station will be sent free to any citizen of the State on application to the Agricultural Experiment Station, Auburn, Alabama.

The Peach Tree Borer.

Of the insect pests infesting our fruit trees, the peach tree borer is one of the worst, for, while its work is not so much in evidence as that of those insects which defoliate the trees or attack the fruit, the injury is of a more serious nature and more likely to be permanent, because it is the base of the trunk itself which is attacked. The worms, or larvæ, live just beneath the bark, at and below the surface of the ground, eating away the tissues, and thus, in bad cases, eventually completely girdling and killing the tree. The injury in any case results in weakening the tree to a greater or less extent, making it far more susceptible to the attacks of other pests and to the influence of various adverse conditions.

It is too often the case that an orchard is considered similar to a paid-up investment which should yield a constant income without any outlay in either labor or money. In other words, the orchardist too often expects to receive "something for nothing." This is a great mistake always, and in the case of peach orchards the peach tree borer is one of the living evidences of that fact. An uncared-for peach orchard is almost certain to suffer, and suffer severely, from the attacks of this insect; and conversely the presence of this insect in considerable numbers in an orchard is but a too palpable reflection on the energy and thrift of the owner.

Here in the South, with our mild winters, there is abundant opportunity for owners of orchards to amply protect their property in peach trees by dealing with this pest as it should be dealt with, and this can be done at little or no expense.

This pest is not by any means confined to the South, but occurs almost everywhere peaches are grown, from the Atlantic to the Pacific. It apparently originated in the northeastern United States, having been first noticed from Pennsylvania.

All peach growers are familiar with the borer in the larval stage. For, as among most other insects, there are four stages in its life history: first, the egg; second, the larva; third, the pupa, and fourth and last, the imago, or perfect insect, which in this case is a swift flying, bright colored little moth, measuring an inch to an inch and a half across the expanded wings, and strongly resembling a wasp in appearance. The moths are not often seen, and even then few know of the relation they bear to the peach tree borer itself. The waspish appearance is undoubtedly a protection in many ways. They should be invariably destroyed when found. These moths are very prettily colored, and the male differs most remarkably from the female. The wings of the male (see Fig. 2 *a*) are transparent and only bordered with blue, while the fore wings of the female (see Fig. 2 *b*) are blue throughout. The abdomen in both cases is blue, but that of the female is encircled by a broad orange band.

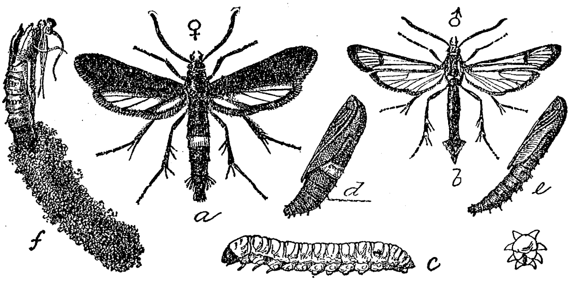

Fig. 1—The Peach Tree Borer in all its stages of growth; *a*, adult female; *b*, adult male; *c*, full-grown larva; *d*, female pupa; *e*, male pupa; *f*, pupa skin extended partially from cocoon; all natural size. (This and Figs 4, 5, 6 and 7 through courtesy of Div. of Illustrations, U. S. Dept of Agriculture.)

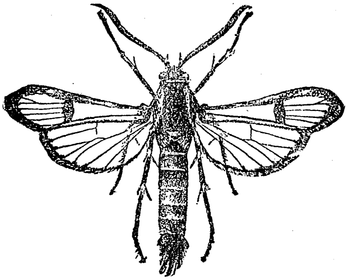
Fig. 2 *a*—Moth of the Peach Tree Borer; male. (From Smith's Economic Entomology.)

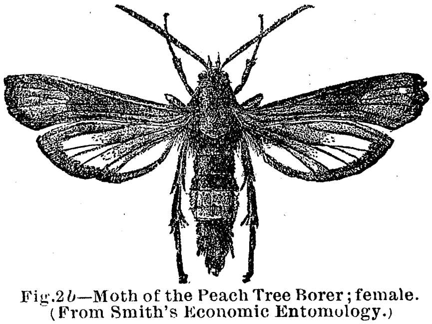
Fig. 2 *b*—Moth of the Peach Tree Borer; female. (From Smith's Economic Entomology.)

Life History.

During the spring these moths lay their eggs, which are yellowish brown in color and very small, on the bark at or near the surface of the ground. The eggs soon hatch, and the minute larva makes its way as rapidly as possible beneath the bark of the tree, where it at once begins feeding. It is at this point we look for a reason foi the deposition of the eggs near the surface of the ground. We find it in the fact that the jaws of the young larvæ are too weak to pierce the tough and hardened bark above, but just beneath the surface of the ground they find entrance an easy matter.

Underneath the bark the larvæ feed through the summer, and in the extreme south off and on all winter. At the opening of the burrow there usually occurs a more or less copious exudation of gum, which is usually mixed with the droppings of the larva and with borings from the hole. This external evidence of the presence of the new worm is first observable about the middle of the summer. The larva frequently works well down into the main roots.

The next spring regular feeding is resumed, and continued until full growth is reached. In the far North this occurs in July or later. In the South the first larvæ mature very much earlier, and continue "coming on" throughout the summer. Here at Auburn larvæ of all sizes may be found in the trees at almost any time during the summer, thus rendering it very difficult to outline any well-defined brood.

As soon as full growth is attained, the larva forms about itself a protecting cell wall or cocoon of silk (see Fig. 1) and refuse, and within this changes to a pupa. In the pupal stage the larva loses largely its power to move, and takes on characters which somewhat roughly outline the future moth. It remains in this stage usually but a very few days, soon shedding its pupal skin and appearing as the moth we have already described, thus completing its life cycle.

It is very evident that with such an extended term of life allotted it, a great deal of injury is possible with even a single larva. The chances of life are indeed small for trees infested as, for instance, those of a very badly neglected orchard in Alabama examined by Prof. Earle, some of which had as many as fifteen and sixteen worms each.

Remedies.

In connection with remedies, two questions will naturally be asked. First, what is to be done with larvæ now in the tree and second, what must be done to prevent further attack. The method of dealing with larvæ, now most widely practiced, seems a rather heroic one, but is, on the whole, the most satisfactory. This consists in cutting the worms out with a sharp knife. To be properly done the work requires the personal supervision of the orchardist, for, when left in careless hands it will likely not only be half done, but probably result in more harm than good.

First remove the earth from about the base of the tree; then, by means of the exuded gum and refuse, locate the burrow, and by a *few* careful cuts follow it up until the worm is reached. Some orchardists prefer other measures than the employment of the knife. Removing the earth and painting the tree about the collar with kerosene has been recommended. Pouring hot water or kerosene emulsion about the base of the tree has also been mentioned. Some have removed the earth, put in a generous dressing of wood ashes, and replaced the earth over them. The ashes, by the action of water, produce a caustic lye, which, if it reaches them, will kill the borers, and at the same time will act as a fertilizer. Cutting the worms out, however, is by far the most satisfactory, certainly the most effective, method. It should be done during late fall or winter; *surely* before the middle of April in this latitude.

Just at this point comes the consideration of applications to prevent further injury, either by preventing the moths from laying their eggs on the bark, or by covering the bark with some mixture which will poison the newly hatched larva as soon as it attempts to bore in. We have some very simple applications, which combine both these qualities. This preventive measure should, as a rule, be applied before the earth is turned back against the tree. Many follow the practice of simply turning the earth back and mounding it up about the tree, doing nothing more than this. In this case the moth will deposit its eggs at the summit of the mound, where the newly hatched larva will usually be unable to bore through the hardened bark.

The most approved method consists in either tying tightly about the tree a broad piece of tar or other building paper, or coating the tree trunk with a mixture which shall either poison the larva or prevent its boring in. These should be applied before the earth is turned back, and should extend at least two inches below the surface of the soil and two feet above it. If the building paper is used it may be removed during the winter. Where other things are lacking straw, newspapers or old cloths bound tightly about the trunk will answer the purpose. Ordinary whitewash is cheap and easily prepared, and will serve the purpose admirably. To it should be added a small proportion of Paris green and some soft soap or cheap glue to prevent cracking or crumbling. This will have to be renewed if it should break up or fall off before the summer is through. Prof. Smith recommends white lead paint in boiled linseed oil as being serviceable on old trees, but adds that it should not be used on young trees, nor should turpentine be used to thin out the lead in any case. Extreme caution should always attend the use of white lead, and the fact that only *old* trees will stand it should be emphasized. An orchardist near Montgomery attempted its use on young trees. I am told that the orchard was completely ruined.

Experiments at Auburn.

The peach tree borer is abundant in the vicinity of Auburn, so that a variety of experiments in connection with it have been possible. These have been carried out under the direction of Prof. Earle, who has kindly furnished the data for the following notes. Attention will be here called to two of these which have yielded important results.

On April 7, 1896, an orchard was gone over thoroughly and carefully "wormed" with the knife, some trees yielding as many as five and six worms each. A short time before this the orchard had been sprayed with Bordeaux mixture* for various fungous diseases. After the trees were "wormed" the rather thick and sticky "tailings" or sediment, left from this Bordeaux mixture, was painted over the trunks and lower branches of the trees. This might have been improved somewhat by the addition of a small amount of Paris green. The trunks were painted to about two inches below the surface of the ground and the earth mounded back as usual. On March 26, 1897, the orchard was again gone over and carefully "wormed," but this time the two hundred and twenty trees yielded but forty worms, and eight of these worms came from two trees, which had evidently not been properly treated the preceding year. The treatment was considered successful—complete extermination the first year was not expected.

A substance called "Dendrolene" or "Insect Lime," and which has something the appearance and consistency of axle grease, has been used for this and similar purposes, as a coating for fruit tree trunks. It has been somewhat widely recommended through bulletins from various sources, more especially those from New Jersey and the Department of Agriculture. Its use may have been attended with success in New Jersey, but our tests of it here have resulted most disastrously. On April 5, Prof. Earle had it applied in the prescribed manner on several mature peach and plum trees. It killed about one-half of these outright and very seriously injured the remainder. In consequence of these results we do not recommend its use in Alabama.

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*Bordeaux mixture, much used for various rusts, leaf-spots, or other fungous diseases, is prepared as follows: Thoroughly dissolve in separate receptacles, each with 25 gals. water, 6 lbs. copper sulphate and 6 lbs. *fresh* lime. Then pour together in a third vessel. Stock solutions of each may be kept on hand, but should not be mixed until wanted for use.

The Fruit Bark Beetle.

Although not as well known as the peach tree borer, the fruit bark beetle is almost as widely distributed through the South. At Auburn it is very abundant. Inquiries regarding it have come from other portions of the state also. Dr. Riley reported it from Macon, Georgia, as early as 1883. It has proven a serious pest in many portions of the eastern United States, and has been the subject of extended investigations, especially by the entomologists of Illinois and New Jersey.

The evidences of its work are very characteristic. A badly infested tree looks as if it had received a charge of fine shot (see Fig. 3), the holes being about the size of the head of a pin and larger. This appearance has given rise to the names "shot-hole borer" and "pin-hole borer."

As far as has been observed in this section, its attacks have been confined largely to peach, plum and cherry, the first mentioned being usually most affected. However, it is known to attack most other fruit trees also, including the apple, pear, quince, nectarine, etc. A close examination only will reveal its presence, although a casual glance may show the general health of the tree to be poor. It is, however, often the case that trees apparently in perfect health are found affected.

The fruit bark beetle is a very small dark brown beetle (see Fig. 4) about a tenth of an inch in length. The female, when ready to deposit her eggs, forces a hole through the bark, after passing which it turns sharply at right angles, and runs but a short distance farther. Along the sides of this tunnel, which has been called the "brood chamber," she lays (according to Prof. Smith) about eighty eggs. The eggs hatch in about three days though this occurs before the last eggs in the same brood chamber are laid. Each minute white grub

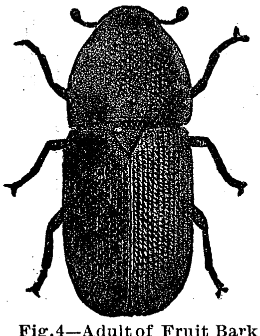

Fig. 4—Adult of Fruit Bark Beetle, greatly enlarged.

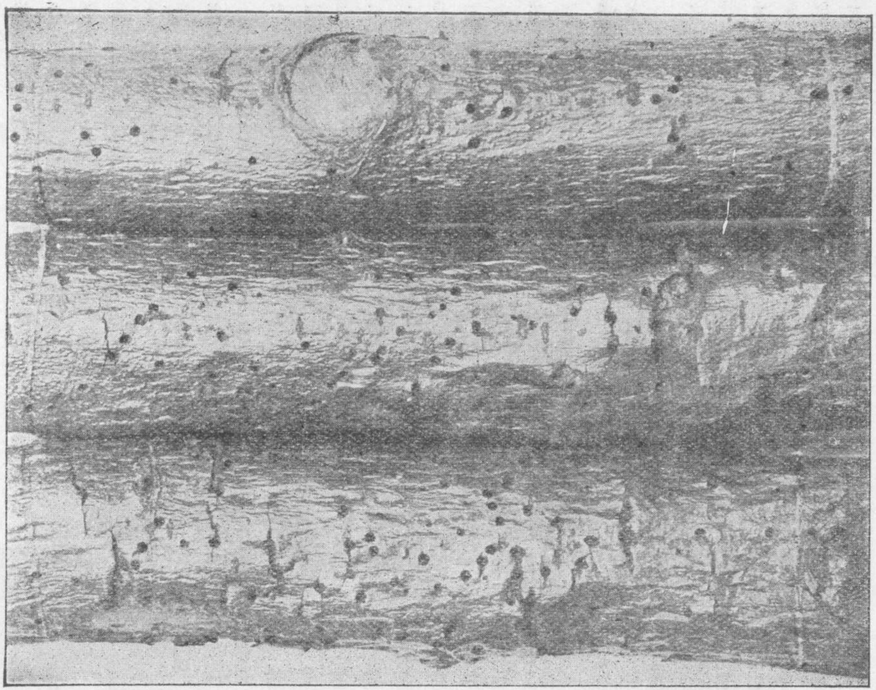

Fig. 3—External appearance of branches infested by the Fruit Bark Beetle.
(This and Fig. 2 through courtesy of Prof. J. B. Smith.)

(see Fig. 5) then begins the construction of a tunnel of its own, directed at nearly right angles away from the parent brood chamber. These tunnels become more or less tortuous in their course, being continued to a length varying from one to two inches before the larva reaches maturity. In the slightly enlarged terminus of the tunnel the larva changes to a pupa (see Fig. 6), in which condition it continues for about ten days, at the end of which time it usually bores its way out as a perfect beetle, ready to carry on the work of constructing brood chambers elsewhere.

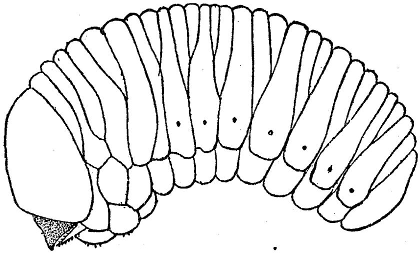

Fig. 5—Larva of the Fruit Bark Beetle, greatly enlarged.

By carefully removing the bark on a portion of an infested limb or trunk, a good view can be had of the peculiar appearance (see Fig. 7) produced by these radiating galleries. When there are many brood chambers near each other, the result is a confused network in which it is difficult to trace the separate galleries. In cases of this sort, which frequently occur, the bark becomes almost entirely separated from the tree, girdling and killing it. In some bad cases observed at Auburn there have appeared on the bark from thirty to forty of these exit holes to the square inch.

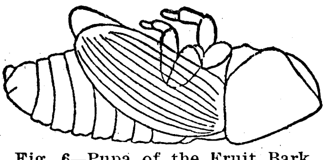

Fig. 6—Pupa of the Fruit Bark Beetle, greatly enlarged.

In the extreme South it is almost impossible to trace any broods. They seem to breed continuously through the spring, summer and fall. We have found here at Auburn in December, females in newly formed brood chambers, with males in attendance at the mouth of the burrow. We have found at this time larvæ also, so the insect must pass the winter in both egg and larval stages.

Remedies.

It seems very likely that the presence of this insect, as in the case of the peach tree borer, is an evidence of a lack of proper care. It is the opinion of most observers that the fruit bark beetle will not attack trees that are in a perfectly healthy condition. But, given a tree ill conditioned from lack of proper or sufficient food or other causes, and its liability to attack is very great. Very often such a tree might be saved by proper treatment, whereas given over to the tender mercies of this prolific little pest it soon perishes.

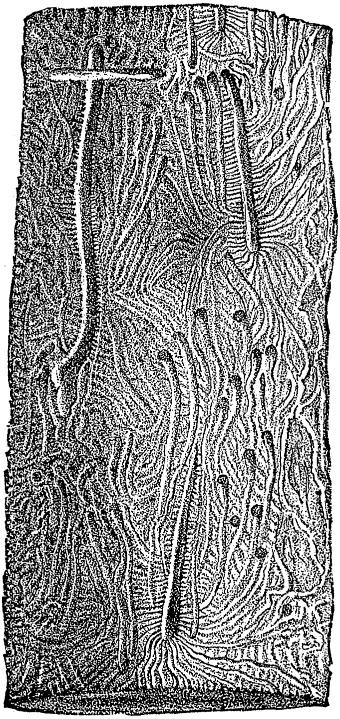
Fig. 7—Showing the peculiar appearance underneath the bark, resulting from the work of the Fruit Bark Beetle.

We have a good illustration here at Auburn of the relation of proper treatment of an orchard to the presence of this insect. In an orchard of mixed peaches, plums and cherries, which is properly pruned, cultivated and otherwise cared for, there is not a sign of this beetle. Not far distant is a similar orchard unpruned, uncultivated and uncared for. The bark of these trees looks like the top of a pepper box, and they are rapidly dying. In regions where the fruit bark beetle occurs, old, uncared for trees, along fence rows and in similar places, are almost sure to serve as breeding places and points of distribution for this insect.

The treatment for peach tree borer, so far as the application of whitewash is concerned, makes a good preventive measure for the fruit bark beetle also. This application should be carried above the origin of the main branches. But, further, all dead branches should be pruned out and burned *at once.* If they be allowed to lie or are piled up for use as fire wood, the beetles will escape and go on with their nefarious work. So burn them immediately. This work should certainly be done in this latitude before the first of March. If a tree is found very badly infested cut it down and burn it up, trunk and branch. If such a tree be left, its death will shortly follow, and it will but aid in spreading the trouble. If the injury is confined to but limited portions these can be cut away and whitewashed over.

WHENEVER YOU ARE TROUBLED BY INSECTS

of any kind whatever, in the house or barn, on the farm or garden, in the orchard, in the store, warehouse, or mill, or anywhere else, send specimens at once, safely packed in a small *wooden* box, with the facts concering them, to the Entomologist, Agricultural College, Auburn, Ala. He is stationed here at your service, and will give prompt attention to all communications, furnishing you with information regarding the insects and remedies for them, free of all charge.

BULLETIN No. 91. FEBRUARY, 1898.

ALABAMA

Agricultural Experiment Station

OF THE

AGRICULTURAL AND MECHANICAL COLLEGE,

AUBURN.

CO-OPERATIVE FERTILIZER EXPERIMENTS WITH COTTON IN 1897.

J. F. DUGGAR, Agriculturist.

BIRMINGHAM
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1898

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☞ The Bulletins of this Station will be sent free to any citizen of the State on application to the Agricultural Experiment Station, Auburn, Alabama.

CO-OPERATIVE FERTILIZER EXPERIMENTS WITH COTTON IN 1897.

J. F. DUGGAR.

SUMMARY.

Under the direction of the Alabama Experiment Station fertilizer experiments with cotton, or "soil tests," were made in thirty localities in the State. The object was to learn the best fertilizers for the different classes of soil.

Two hundred pounds per acre of cottonseed meal was used to furnish nitrogen, 240 pounds of acid phosphate to supply phosphoric acid, and both one hundred and two hundred pounds of kainit to afford potash. These fertilizers were applied singly, in pairs, and all three together.

Of these experiments twenty-two afforded definite indications of the manurial needs of the soils on which they were made.

Phosphoric acid was most effective on eight soils, potash on four soils, and nitrogen on four soils; phosphoric acid and nitrogen were about equally beneficial in two experiments, and four soils stood greatly in need of all three fertilizer constituents—nitrogen, phosphoric acid and potash.

The experiments in which phosphoric acid was most effective were located near Tuskaloosa, Tuskaloosa county; Clanton, Chilton county; Sterrett, Shelby county; Town Creek, Lawrence county; Lumber Mills, Butler county; Prattville, Autauga county; Brewton, Escambia county; and Burnt Corn, Monroe county.

The experiments in which potash proved most effective

were located near Dothan, Henry county; Union Springs, Bullock county; Coatopa, Sumter county; and Naftel, Montgomery county.

The experiments in which nitrogen was most effective were located near Jackson, Clarke county; Perote, Bullock county; Greensboro, Hale county; and LeGrand, Montgomery county.

The experiments in which phosphoric acid, potash and nitrogen were all greatly advantageous were situated near Berneys, Talladega county; Thomaston, Marengo county; Rutledge, Crenshaw county; and Daphne, Baldwin county.

The experiments in which nitrogen and phosphoric acid were about equally beneficial, and potash of slight or no effect, were located near Cusseta, Chambers county, and Kaylor, Randolph county.

Fertilizer experiments with cotton were made in eight other localities, in which the results were not entirely conclusive.

The fertilizer that afforded the maximum net profit in the greatest number of localities was a complete fertilizer made up as follows:

200 pounds per acre cotton seed meal,
240 pounds per acre high grade acid phosphate, and
100 pounds per acre kainit.

This fertilizer mixture contained 2.59 per cent. of nitrogen, 7.75 per cent. of available phosphoric acid, and 2.93 per cent. of potash.

The season was generally dry, and rust or other leaf disease was widely prevalent and very destructive. Under these conditions, kainit greatly reduced the injury from leaf diseases in 61 per cent. of the experiments, or eight out of thirteen experiments of which complete reports were made. This does not imply so favorable an effect of kainit in seasons when weather conditions are normal, and when rust or blight is less widely prevalent.

OBJECTS AND METHODS OF THE EXPERIMENTS.

The soils of Alabama differ widely. Hence they require different fertilizers. For most profitable results the fertilizer must be suited to the soil. Misfits are frequent and costly, especially in a State spending several millions of dollars for commercial fertilizers. To decrease such losses is the object of the "soil tests," or local fertilizer experiments conducted under the direction of the Alabama Experiment Station by farmers in different soil belts.

To map the State, even roughly, according to the fertilizer requirements of the prevailing soils, must necessarily be the work of years. In locating these experiments the writer has been guided more by the geological map than by county lines.

The number of co-operative fertilizer experiments provided for in 1897 was thirty-six, from which 30 reports were received. Twenty of these reports give definite indications, and are discussed at length in this bulletin. The others, deemed inconclusive, are more briefly tabulated.

Small lots of carefully weighed and mixed fertilizers were supplied to each experimenter. Detailed instructions as to how to conduct the experiments, and blank forms for reporting results, were also furnished.

The following is the list of those who made the fertilizer tests in 1897 and reported results:

Name	Post Office	County	Page
Autrey, A.	Berneys	Talladega	85
Anderson, J. P.	Thomaston	Marengo	83
Blackstock, J. J.	McLendon	Russell	95
Borland, T. M.	Dothan	Henry	68
Ballard, J. L.	Jackson	Clarke	75
Craddock, J. B.	Abbeville	Henry	95
Daffin, E. J.	Tuscaloosa	Tuscaloosa	50
Daugette, Prof. C. W.	Jacksonville	Calhoun	96
Dykes, J. W.	Union Springs	Bullock	69
Funkey, F.	Tuscumbia	Colbert	96
Gordon, Dr. Jno.	Healing Springs	Washington	96
Hightower, W. T.	Perote	Bullock	77
Horn, C. D.	Coatopa	Sumter	71
Jarrett, J. W.	Sterrett	Shelby	52
Jones, T. K.	Greensboro	Hale	79
Logan, J. A.	Clanton	Chilton	54
McGregor, A. A.	Town Creek	Lawrence	56
McDonald, F. C.	Rutledge	Crenshaw	87
McLendon, J. R.	Naftel	Montgomery	73
Meadows, T. T.	Cusseta	Chambers	91
Robertson, J. T.	Legrand	Montgomery	81
Roundtree, F. M.	Evergreen	Conecuh	97
Sellers, Geo. O.	Lumber Mills	Butler	59
Smith, McQueen	Prattville	Autauga	62
Smith, G. W.	Brundidge	Pike	97
Terry, J. W.	Brewton	Escambia	63
Thomason, T. J.	Kaylor	Randolph	93
Valerio, A. M.	Daphne	Baldwln	89
Wilkinson, J. A.	Autaugaville	Autauga	97
Watkins, J. P.	Burnt Corn	Monroe	65

The directions sent required each plot to be one-eighth of an acre in area. Rows were 3½ feet apart, and each experimenter was advised to so thin the cotton as to leave the same number of plants on each plot, preferably at distances of 18 inches between plants.

The directions stated that land employed for this test should be level and uniform, not manured in recent years, and not new-ground, or subject to overflow, and that it should be representative of large soil areas in its vicinity. The need of perfect uniformity of treatment for all plots (except as to kinds of fertilizers used) was emphasized.

Fertilizers were applied in the usual manner—that is, drilled, ridges afterwards being thrown up above the fertilizers.

Notes on the weather show that in most localities the season was abnormally dry, a circumstance which materially lessens the value of the results. A leaf disease, generally spoken of as rust or blight, was very prevalent, especially in the central and southern portions of the State.

THE FERTILIZERS USED.

The fertilizers used in this experiment cost, delivered in Auburn in less than carload lots, as follows:

	Per Ton.
Acid phosphate	$ 11.00
Cottonseed meal	19.00
Kainit	13.75
Slaked lime	5.00

Prices naturally vary in different localities. Anyone can substitute the cost of fertilizers in his locality for the price given above. The above prices for high-grade acid phosphate (dissolved bone) and kainit are several dollars lower than the usual price. The manufacturers of the phosphate used, Edisto Phosphate Company, Charleston, S. C., supplied the Alabama Experiment Station with both phosphate and kainit at an extraordinarily low rate. A part of the kainit was donated by the German Kali Works, New York City.

In each experiment two plots were left unfertilized, these being plots 3 and 8. The following table shows what kinds and amounts of fertilizers were used on certain plots; the number of pounds of nitrogen, phosphoric acid, and potash supplied per acre by each fertilizer mixture; and the percentage composition and cost per ton of each mixture, the latter being given in order that these mixtures may be readily compared with various brands of prepared guanos:

Pounds per acre of fertilizers, nitrogen, phosphoric acid, and potash used and composition of each mixture.

	Fertilizers.		Mixture contains			
Plot No.	Amount per acre.	Kind.	Nitrogen.	†Available phosphoric acid.	Potash.	Cost of mixture, per ton.
	Lbs.		*Lbs.*	*Lbs.*	*Lbs.*	
1	200	Cottonseed meal........	13.58	5.76	3.54	
		*In 100 lbs. c. s. meal.**	6.79	2.88	1.77	$19.00
2	240	Acid phosphate.........	....	36.12	....	
		In 100 lbs. acid phos.	....	15.05	....	11.00
4	200	Kainit..................	....	....	24.60	
		In 100 lbs. kainit.	....	....	12.30	13.75
5	200	Cottonseed meal......	13.58	41.88	3.54	
	240	Acid phosphate.......				
		In 100 lbs. above mixt.	3.09	9.52	.80	14.60
6	200	Cottonseed meal......	13.58	5.76	28.14	
	200	Kainit..................				
		In 100 lbs. above mixt.	3.39	1.44	7.03	16.38
7	240	Acid phosphate.......	....	....	....	
	200	Kainit...............				
		In 100 lbs. above mixt.	....	8.21	5.59	12.26
9	200	Cottonseed meal......	13.58	41.88	28.14	
	240	Acid phosphate.......				
	200	Kainit...............				
		In 100 lbs. above mixt.	2.12	6.54	4.39	14.38
10	200	Cottonseed meal......	13.58	41.88	15.84	
	240	Acid phosphate.......				
	100	Kainit...............				
		In 100 lbs. above mixt.	2.59	7.75	2.93	14.44

* Average of many analyses.

† Counting all of the phosphoric acid in cottonseed meal as available.

Those farmers who are more accustomed to the word ammonia than to the term nitrogen, can change the figures for nitrogen into their ammonia equivalents by multiplying by $1^3/_{14}$.

Unless explained, the term "profit from fertilizers" as used in the following tables, might be misunderstood.

Profit or loss, as there used, is simply the difference between the value of the increase attributed to the fertilizer and the cost of the latter. To make this more exact, the careful reader may subtract from the apparent profit certain small items, which, because variable, could not be incorporated in the table—for example, cost of applying fertilizers and cost of picking and ginning the increase.

Again, the actual profit per acre from cotton culture may be greater or smaller than the "profit from fertilizer." When on the unfertilized plot cotton is produced at a loss of say $3 per acre, and when the tables show, say $10 as the profit from a certain fertilizer mixture, a part of this profit must go towards offsetting the loss that would have occurred without fertilizers, leaving the farmer in this case only $7 in actual profit, although the fertilizer may have been beneficial to the extent of $10 over and above its cost. On the other hand, when cotton is produced at a profit on unfertilized land, and when fertilizers also show a profit, the sum of these two items is very nearly the farmer's actual profit.

In determining the increase over the unfertilized plots, the yield of the fertilized plots, Nos. 4, 5, 6 and 7, is compared with both unfertilized plots lying on either side, giving to each unfertilized plot a weight inversely proportional to its distance from the plot under comparison. This method of comparison tends to compensate for variations in the fertility of the several plots.

It should be remembered that seasons, as well as soils, determine the effects of fertilizers, so that to be absolutely reliable a fertilizer experiment should be repeated for several years on the same kind of soil.

GROUP I. PHOSPHORIC ACID MOST EFFECTIVE.

EXPERIMENT MADE BY E. J. DAFFIN, 2½ MILES EAST OF TUSCALOOSA, TUSCALOOSA COUNTY.

The field had been cleared probably sixty or more years before. The experimenter does not describe the soil, but gives the following list of the trees constituting the original forest growth: Oak, pine, hickory, gum, beech, mulberry, sassafras, persimmon, cherry, poplar and ash.

The preceding crop was oats, which was preceded by two crops of corn.

Rust was present, and there was no difference in this respect between the different plots. The season was very dry, and the crop was made by August 5. The stand was almost perfect. "There were no outside rows."

A spot extending across plots 1, 2 3 and 4 was struck by lightning, but apparently the effect was not very great, for the injured plot that was not fertilized lacked only a few pounds of equaling the yield on the uninjured plot that was not fertilized.

Tuscaloosa experiment with cotton.

Plot No.	FERTILIZER. Amount per acre.	FERTILIZER. Kind.	SEED COTTON Yield per acre	SEED COTTON Increase over unfertilized plots.	FINANCIAL RESULTS Value of increase at 2c per lb.	FINANCIAL RESULTS Cost of fertilizers per acre.	FINANCIAL RESULTS Profit from fertilizers.
	Lbs		*Lbs.*	*Lbs.*			$
1	200	Cottonseed meal	648	56	$1.12	$1.90	—.79
2	240	Acid phosphate	896	304	6.08	1.32	4.76
3	00	No fertilizer	592	......	......	......	......
4	200	Kainit	696	101	2.02	1.38	.64
5	200 240	Cottonseed meal Acid phosphate	1,064	466	9.32	3.22	6.10
6	200 200	Cottonseed meal Kainit	904	303	6.06	3.28	2.78
7	240 200	Acid phosphate Kainit	1,016	413	8.26	2.70	5.56
8	00	No fertilizer	608	......	......	......	......
9	200 240 200	Cottonseed meal Acid phosphate Kainit	1,168	560	11.20	4.60	6.60
10	200 240 100	Cottonseed meal Acid phosphate Kainit	1,168	560	11.20	3.90	7.30

Increase of seed cotton per acre when cottonseed meal was added:

To unfertilized plot........................ 56 lbs.
To acid phosphate plot........................162 "
To kainit plot........................202 "
To acid phosphate and kainit plot........147 "

Average increase with cottonseed meal......142 "

Increase of seed cotton per acre when acid phosphate was added:

To unfertilized plot........................304 lbs.
To cottonseed meal plot........................362 "
To kainit plot........................360 "
To cottonseed meal and kainit plot........257 "

Average increase with acid phosphate ....321 "

Increase of seed cotton per acre when kainit was added:

To unfertilized plot	101 lbs
To Cottonseed meal plot	247 "
To acid phosphate plot	109 "
To cottonseed meal and acid phos. plot	94 "
Average increase with kainit	**138 "**

Phosphoric acid was the fertilizer constituent most urgently needed by this soil. Nitrogen was moderately effective. The most profitable fertilizer was a mixture of 200 pounds per acre of cottonseed meal, 240 pounds of acid phosphate and 100 pounds of kainit. The favorable effect of acid phosphate on the soil in this vicinity was shown in 1889 in an experiment made by Mr. A. V. Albright, of Tuscaloosa county. (See Bul. 12 of this station.)

Experiment Made by J. W. Jarrett, ½ Mile South of Sterrett, Shelby County.

Soil gray; very shallow; slaty subsoil.

This field was fresh land, cleared only three years before, and had produced only corn prior to the time of this experiment. The soil is described as good cotton land, but as not very retentive of either water or fertilizers. There was no rust. The weather was dry.

Sterrett experiment with cotton.

Plot No.	Fertilizers. Amount per acre.	Fertilizers. Kind.	Per cent of crop at first picking	Seed cotton. Yield per acre.	Seed cotton. Increase over unfertilized plots.	Financial results. Value of increase at 2c per lb.	Financial results. Cost of fertilizers per acre.	Financial results. Profit from fertilizers.
	Lbs			*Lbs.*	*Lbs.*			$
1	200	Cottonseed meal......	35	1,080	40	$0.80	$1.90	—1.10
2	240	Acid phosphate........	41	1,448	408	8.16	1.32	6.84
3	00	No fertilizer..........	30	1,040	......	......	......	......
4	200	Kainit................	30	1,216	118	2.36	1.38	.98
5	200 240	Cottonseed meal.... Acid phosphate.....	36	1,688	533	10.66	3.22	7.22
6	200 200	Cottonseed meal.... Kainit..............	25	1,200	—13	—.26	3.28	......
7	240 200	Acid phosphate..... Kainit..............	34	1,520	249	4.98	2.70	2.28
8	00	No fertilizer..........	27	1,328	......	......	......	......
9	200 240 200	Cottonseed meal.... Acid phosphate.... Kainit..............	24	1,720	392	7.84	4.60	3.24
10	200 240 100	Cottonseed meal ... Acid phosphate..... Kainit..............	24	1,512	184	3.68	3.90	—.22

Increase of seed cotton per acre when cottonseed meal was added:

To unfertilized plot	40	lbs.
To acid phosphate plot	125	"
To kainit plot	— 131	"
To acid phosphate and kainit plot	143	"
Average increase with cottonseed meal......	**44**	"

Increase of seed cotton per acre when acid phosphate was added:

To unfertilized plot	408	lbs.
To cottonseed meal plot..................	493	"
To kainit plot	131	"
To cottonseed meal and kainit plot........	405	"
Average increase with acid phosphate.......	**359**	"

Increase of seed cotton per acre when kainit was added:

To unfertilized plot	118 lbs.
To cottonseed meal plot	— 53 "
To acid phosphate plot	—159 "
To cottonseed meal and acid phos. plot	—141 "
Average decrease with kainit	**59 "**

The chief need of this recently cleared land was for acid phosphate. As usual, on fresh land cottonseed meal was not very effective. Kainit was not needed. The most profitable fertilizer was the mixture of acid phosphate and cottonseed meal, which was only a few cents ahead of acid phosphate used alone.

These results accord with those obtained in a two years' test conducted by Mr. J. W. Pitts, Creswell Station, Shelby county, in showing a special need for phosphoric acid and no increase from potash.

EXPERIMENT MADE BY J. A. LOGAN, CLANTON, CHILTON COUNTY.

Gray sandy soil; pale red subsoil.

The field used was cleared of the original growth of pine and oak ten or fifteen years ago. Corn was the crop in 1895 and 1896.

The report does not indicate whether the yields were seriously affected by rust, although this was present on some plots.

Clanton experiment with cotton.

Plot No.	FERTILIZERS. Amount per acre.	FERTILIZERS. KIND.	SEED COTTON Yield per acre.	SEED COTTON Increase over unfertilized plots.	FINANCIAL RESULTS Value of increase at 2c per lb.	FINANCIAL RESULTS Cost of fertilizers per acre.	FINANCIAL RESULTS Profit from fertilizers.
	Lbs.		*Lbs.*	*Lbs.*			
1	200	Cottonseed meal	432	112	$2.24	$1.90	$0.34
2	240	Acid phosphate	584	264	5.28	1.32	3.96
3	00	No fertilizer	320	......	......	......	......
4	200	Kainit	496	169	3.38	1.38	2.00
5	200 240	Cottonseed meal Acid phosphate	912	578	11.56	3.22	8.34
6	200 200	Cottonseed meal Kainit	680	338	6.76	3.28	3.48
7	240 200	Acid phosphate Kainit	1,084	735	14.70	2.70	12.00
8	00	No fertilizer	356	......	......	......	......
9	200 240 200	Cottonseed meal Acid phosphate Kainit	1,032	676	13.52	4.60	8.90
10	200 240 100	Cottonseed meal Acid phosphate Kainit	1,112	756	15.12	3.90	11.20

Increase of seed cotton per acre when cottonseed meal was added:

To unfertilized plot ....112 lbs.
To acid phosphate plot ....314 "
To kainit plot ....169 "
To acid phosphate and kainit plot ......— 59 "

Average increase with cottonseed meal......134 "

Increase of seed cotton per acre when acid phosphate was added:

To unfertilized plot ....264 lbs.
To cottonseed meal plot....................466 "
To kainit plot ....566 "
To cottonseed meal and kainit plot.......338 "

Average increase with acid phosphate.......409 "

Increase of seed cotton per acre when kainit was added:

To unfertilized plot	169	lbs.
To cottonseed meal plot	226	"
To acid phosphate plot	471	"
To cottonseed meal and acid phos. plot	98	"
Average increase with kainit	**241**	"

The chief need of this soil was for phosphoric acid. Potash ranked second in efficiency. To a less extent the yield was increased by nitrogen. The most profitable fertilizers were the mixtures of cottonseed meal, acid phosphate and kainit; apparently 100 pounds per acre of kainit was more profitable than 200 pounds.

Mr. Logan conducted a fertilizer test on cotton in 1891 and again in 1892. All three tests agree in showing that phosporic acid is more urgently needed than any other fertilizing ingredient. They all agree further in showing that the soil of that vicinity responds moderately to nitrogen. They disagree in regard to the effects of potash, muriate of potash in the two earlier experiments proving useless, and kainit in the present experiment proving decidedly beneficial and profitable.

This difference is not strange in view of the fact that the seasons were not alike; that different potash salts were employed, and that almost certainly different fields were used. Apparently the land which in 1897 showed a need of potash was in poorer condition than the field used in the two earlier tests. Apparently a fertilizer for the soils of this locality should consist chiefly of acid phosphate.

Experiment Made by A. A. McGregor, 2½ Miles Southwest of Town Creek, Lawrence County.

Yellowish red soil, 6 inches deep; subsoil red.

This field had been in cultivation at least 70 years. Original forest growth was red oak, post oak, black jack oak and hickory. The preceding crop was cotton, which was immediately preceded by two corn crops. From many valuable notes recorded by the experimenter the following extract is taken as explanatory of the results on plots 7, 9 and 10: "Aug. 4.—No. 10 not fired or matured so much as No. 9 or No. 7. . . . Sept. 20.—All plots containing phosphate have suffered from drought, but plots with phosphate and kainit more than others. There was no rust, but considerable loss from the shedding of forms. Leaves were shed about the middle of September, which was due not to maturity, but to drought and heat."

The number of plants on each eighth-acre plot was as follows: 1131 on plot 1, 1151 on plot 2, 1037 on plot 3, 1042 on plot 4, 1143 on plot 5, 1126 on plot 6, 1105 on plot 7, 1013 on plot 8, 988 on plot 9, and 931 on plot 10.

The actual yields, independent of the number of plants per plot, constitute the basis for the following table. In studying these results to learn whether the yields were greatly affected by variations in the stand, a calculation was made of the theoretical yields on the basis of a perfectly uniform stand. An analysis of these "corrected yields" pointed to the same general conclusions as those drawn from the actual yields. That is to say, the average increase due to acid phosphate was 329 pounds on the basis of actual yields and 332 pounds on the basis of yields corrected to allow for variations in the stand. Likewise the average increase on four plots attributable to cottonseed meal was 168 pounds by actual yields and 177 pounds by "corrected" yields. For kainit the average increase on four plots was 39 pounds, reckoned on actual yields, and 81 pounds on a basis of a uniform stand.

Town Creek experiment with cotton.

Plot No.	Fertilizers: Amount per acre.	Fertilizers: Kind.	Per cent. of crop at first picking, Sept. 4.	Seed cotton: Yield, per acre.	Seed cotton: Increase over unfertilized plots.	Financial results: Value of increase at 2c. per lb.	Financial results: Cost of fertilizing, per acre.	Financial results: Profit from fertilizers.
	Lbs.			Lbs.	Lbs			
1	200	Cottonseed meal	18	756	96	$1.92	$1.90	$0.02
2	240	Acid phosphate	20	1,036	376	7.52	1.32	6.20
3	00	No fertilizer	6	660	......	......	......	......
4	200	Kainit	8	796	168	3.36	1.38	1.98
5	200 240	Cottonseed meal Acid phosphate	27	1,248	652	13.04	3.22	9.82
6	200 200	Cottonseed meal Kainit	17	844	280	5.60	3.28	2.32
7	240 200	Acid phosphate Kainit	23	854	322	6.44	2.70	3.74
8	00	No fertilizer	6	500	......	......	......	......
9	200 240 200	Cottonseed meal Acid phosphate Kainit	26	1,008	508	10.16	4.60	5.56
10	200 240 100	Cottonseed meal Acid phosphate Kainit	26	1,144	644	12.88	3.90	8.98

Increase of seed cotton per acre when cottonseed meal was added:

To unfertilized plot .... 96 lbs.
To acid phosphate plot ....276 "
To kainit plot ....112 "
To acid phosphate and kainit plot ....186 "

Average increase with cottonseed meal ......168 "

Increase of seed cotton per acre when acid phosphate was added:

To unfertilized plot ....376 lbs.
To cottonseed meal plot..................556 "
To kainit plot ....154 "
To cottonseed meal and kainit plot........228 "

Average increase with acid phosphate ....329 "

Increase of seed cotton per acre when kainit was added:

To unfertilized plot	168 lbs.
To cottonseed meal plot	184 "
To acid phosphate plot	— 54 "
To cottonseed meal and acid phos. plot	—144 "
Average increase with kainit	39 "

The chief need of this soil was for phosphoric acid. Nitrogen was decidedly more beneficial than kainit.

These results accord with Mr. McGregor's experiment in 1896.

The greatest profit from fertilizers, $9.82 per acre, was obtained by a mixture of acid phosphate and cottonseed meal.

EXPERIMENT MADE BY GEORGE O. SELLERS, LUMBER MILL, BUTLER COUNTY.

Gray, sandy soil, 10 inches deep; red clay subsoil.

This field, on which the original growth had been yellow pine and blackjack oak, had been cleared eleven years before.

The season was dry until the middle of August, when there occurred ten days of rainy weather, favoring rust, which caused shedding of leaves on all plots where no kainit was used. The stand is reported as uniform.

Lumber Mills experiment with cotton.

Plot No.	Fertilizers. Amount per acre.	Fertilizers. Kind	Per cent. of crop at first picking August 30.	Seed cotton: Yield per acre.	Seed cotton: Increase over unfertilized plots.	Financial results: Value of increase at 2c per lb.	Financial results: Cost of fertilizers per acre.	Financial results: Profit from fertilizers.
	Lbs.			Lbs.	Lbs.			
1	200	Cottonseed meal......	80	520	152	$3.04	$1.90	$1.14
2	240	Acid phosphate.......	85	600	232	4.64	1.32	2.32
3	00	No fertilizer..........	63	368	......	......	......	......
4	200	Kainit	67	568	184	3.68	1.38	2.30
5	200 240	Cottonseed meal.... Acid phosphate.....	95	784	384	7.68	3.22	4.46
6	200 200	Cottonseed meal.... Kainit	69	712	296	5.92	3.28	2.64
7	240 200	Acid phosphate..... Kainit	79	784	352	7.04	2.70	4.34
8	00	No fertilizer..........	61	448	......	......	......	......
9	200 240 200	Cottonseed meal.... Acid phosphate..... Kainit	87	856	408	8.16	4.60	3.56
	200 240 100	Cottonseed meal.... Acid phosphate..... Kainit	87	800	352	7.04	3.90	3.14

Increase of seed cotton per acre when cottonseed meal was added:

To unfertilized plot ....152 lbs.
To acid phosphate plot ....152 "
To kainit plot ....112 "
To acid phosphate and kainit plot .... 56 "

Average increase with cottonseed meal......116 "

Increase of seed cotton per acre when acid phosphate was added:

To unfertilized plot..............................232 lbs.
To cottonseed meal plot.....................232 "
To kainit plot ....168 "
To cottonseed meal and kainit plot........112 "

Average increase with acid phosphate ....186 "

Increase of seed cotton per acre when kainit was added:

To unfertilized plot	184 lbs.
To cottonseed meal plot	144 "
To acid phosphate plot	120 "
To cottonseed meal and acid phos. plot	24 "
Average increase with kainit	**108** "

Acid phosphate was most effective. Both cottonseed meal and kainit, although not equalling acid phosphate, were beneficial. The benefit from kainit in 1897 is not necessarily an indication that this soil is deficient in potash, since at least a large part of this benefit seems due to the rust-restraining tendency of this fertilizer.

Experiment Made by Messrs. McQueen Smith and B. W. Gresham, on the Farm of the Former Near Prattville, Autauga County.

Soil, red clay or loam.

This test was made on nearly level upland which had been in cultivation for perhaps 50 years. The original growth was pine, oak, hickory and chestnut.

Prattville experiment with cotton.

Plot No.	Fertilizers. Amount per acre.	Fertilizers. Kind.	Seed cotton. Yield per acre.	Seed cotton. Increase over unfertilized plots.	Financial results. Value of increase at 2c per lb.	Financial results. Cost of fertilizers per acre.	Financial results. Profit from fertilizers.
	Lbs.		Lbs.	Lbs.	$		$
1	200	Cottonseed meal.......	160	—8	—.16	$1.90	—2.06
2	240	Acid phosphate........	360	192	3.84	1.32	2.52
3	00	No fertilizer..........	168	......	......	......	......
4	200	Kainit	384	197	3.94	1.38	2.56
5	200 240	Cottonseed meal..... Acid phosphate......	520	314	6.28	3.22	3.06
6	200 200	Cottonseed meal..... Kainit	480	155	3.10	3.28	—.18
7	240 200	Acid phosphate...... Kainit	592	348	6.96	2.70	4.26
8	00	No fertilizer..........	264	......	......	......	......
9	200 240 200	Cottonseed meal..... Acid phosphate...... Kainit	616	352	7.04	4.60	2.44
10	200 240 100	Cottonseed meal..... Acid phosphate...... Kainit	664	400	8.00	3 90	4.10

Increase of seed cotton per acre when cottonseed meal was added:

To unfertilized plot ....—8 lbs.
To acid phosphate plot ....122 "
To kainit plot ....—42 "
To acid phosphate and kainit plot .... 4 "

Average increase with cottonseed meal ...... 19 "

Increase of seed cotton per acre when acid phosphate was added:

To unfertilized plot	192 lbs.
To cottonseed meal plot	322 "
To kainit plot	151 "
To cottonseed meal and kainit plot	197 "
Average increase with acid phosphate	**216 "**

Increase of seed cotton per acre when kainit was added:

To unfertilized plot	197 lbs.
To cottonseed meal plot	163 "
To acid phosphate plot	156 "
To cottonseed meal and acid phos. plot	38 "
Average increase with kainit	**139 "**

The chief need of this soil was for acid phosphate. Kainit in this unfavorable season was moderately effective. The cowpeas grown between the rows of corn on this field in 1896 apparently furnished enough nitrogen; at any rate, cottonseed meal was not decidedly beneficial in 1897.

The largest profit, $4.26 per acre, was obtained by the use of a mixture of acid phosphate and kainit, this, with the peavines of the preceding year, forming practically a complete fertilizer.

Experiment Made by J. W. Terry, Brewton, Escambia County.

Gray soil; clay subsoil.

Pine, the original growth, was removed twelve years ago. The preceding crop was oats, followed by cowpeas. Corn occupied the field in 1895, and sugar cane in 1894.

"The very hot and dry weather after the rain in July caused all the fertilized plots to shed bottom leaves. Plots 5, 6, 7, 9 and 10 never recovered from a storm in July."

Brewton experiment with cotton.

Plot No.	FERTILIZERS. Amount per acre.	FERTILIZERS. Kind.	SEED COTTON Yield per acre.	SEED COTTON Increase over unfertilized plots.	FINANCIAL RESULTS Value of increase at 2c per lb.	FINANCIAL RESULTS Cost of fertilizers per acre.	FINANCIAL RESULTS Profit from fertilizers.
	Lbs.		Lbs.	Lbs.			
1	200	Cottonseed meal	808	286	$5.72	$1.90	$3.82
2	240	Acid phosphate	864	352	7.04	1.32	5.72
3	00	No fertilizer	512	......	......	......	......
4	200	Kainit	712	172	3.44	1.38	2.06
5	200 240	Cottonseed meal Acid phosphate	704	157	3.14	3.22	—.08
6	200 200	Cottonseed meal Kainit	792	227	4.54	3.28	1.26
7	240 200	Acid phosphate Kainit	816	234	4.68	2.70	1.98
8	00	No fertilizer	600	......	......	......	......
9	200 240 200	Cottonseed meal Acid phosphate Kainit	864	264	5.28	4.60	.68
10	200 240 100	Cottonseed meal Acid phosphate Kainit	880	280	5.60	3.90	1.70

Increase of seed cotton per acre when cottonseed meal was added:

To unfertilized plot........................286 lbs.
To acid phosphate plot ....—195 ”
To kainit plot .... 55 ”
To acid phosphate and kainit plot .... 30 ”

Average increase with cottonseed meal....... 93 ”

Increase of seed cotton per acre when acid phosphate was added:

To unfertilized plot ....353 lbs.
To cottonseed meal plot..................129 ”
To kainit plot .... 62 ”
To cottonseed meal and kainit plot......... 37 ”

Average increase with acid phosphate ....145 ”

Increase of seed cotton per acre when kainit was added:

To unfertilized plot	172 lbs.
To cottonseed meal plot	—59 "
To acid phosphate plot	—118 "
To cottonseed meal and acid phos. plot	107 "
Average increase with kainit	**26** "

Unfortunately at the date when the report was forwarded to Auburn some cotton still remained unpicked on plots 1, 2, 4 and 5, estimated roughly by the experimenter at about 10 pounds on each of these eighth-acre plots. The table does not include the cotton on these four plots opening at that late date. As recorded, the figures show that the greatest increase in yield is attributed to acid phosphate.

Cottonseed meal increased the yield, in spite of the fact that the preceding crop of cowpeas had already contributed to the supply of nitrogen in the soil. Kainit was unprofitable.

This experiment by no means indicates that under normal weather conditions and on land not recently in cowpeas acid phosphate and cottonseed meal could be used singly to greater advantage than in combination. We should expect a mixed fertilizer to give best results on this pine woods land.

Experiment Made by J. P. and J. C. Watkins, 2 Miles North of Burnt Corn, Monroe County.

Gray, sandy and rocky soil; red clay subsoil.

The field on which this test was made had been in cultivation about thirty years. The original forest growth is reported as pine, oak and sweetgum. No note is made of injury from rust.

Burnt Corn experiment with cotton.

Plot No.	Fertilizers. Amount per acre.	Fertilizers. Kind.	Per cent. of crop at first picking, Sept. 4.	Seed cotton: Yield per acre.	Seed cotton: Increase over unfertilized plots.	Financial results: Value of increase at 2c per lb.	Financial results: Cost of fertilizers per acre.	Financial results: Profit from fertilizers.
	Lbs.			*Lbs.*	*Lbs.*			$
1	200	Cottonseed meal........	12	480	40	$0.80	$1.90	—1.10
2	240	Acid phosphate........	7	648	208	4.16	1.32	2.84
3	00	No fertilizer..........	5	440	......	......	......	......
4	200	Kainit................	5	448	51	1.02	1.38	—.36
5	200 240	Cottonseed meal..... Acid phosphate......	53	656	302	6.04	3.22	2.82
6	200 200	Cottonseed meal..... Kainit..............	18	600	290	5.80	3.28	2.52
7	240 200	Acid phosphate...... Kainit.	6	528	261	5.22	2.70	2.52
8	00	No fertilizer..........	7	224	......	......	......	......
9	200 240 200	Cottonseed meal..... Acid phosphate...... Kainit..............	21	768	434	8.68	4.60	4.08
10	200 240 100	Cottonseed meal..... Acid phosphate...... Kainit..............	31	664	330	6.60	3.90	2.70

Increase of seed cotton per acre when cottonseed meal was added:

To unfertilized plot .... 40 lbs.
To acid phosphate plot .... 94 "
To kainit plot ....239 "
To acid phosphate and kainit plot ....132 "

Average increase with cottonseed meal ......126 "

Increase of seed cotton per acre when acid phosphate was added:

To unfertilized plot ....208 lbs.
To cottonseed meal plot.....................262 "
To kainit plot ....210 "
To cottonseed meal and kainit plot..........144 "

Average increase with acid phosphate........206 "

Increase of seed cotton per acre when kainit was added:

To unfertilized plot	51 lbs.
To cottonseed meal plot	250 "
To acid phosphate plot	53 "
To cottonseed meal and acid phos. plot	132 "
Average increase with kainit	**122 "**

In spite of the wide variation in the yields of the two fertilized plots, there is sufficient evidence to prove that this soil was especially deficient in phosphoric acid, and that nitrogen and potash were also needed. In 1896, when the yield on the unfertilized plots was only about half that of 1897, nitrogen afforded the greatest increase in yield.

GROUP II. POTASH MOST EFFECTIVE.

EXPERIMENT MADE BY T. M. BORLAND, DOTHAN, HENRY COUNTY.

Soil sandy; subsoil clay.

This piney woods field had been in cultivation for eight years, corn and cotton alternating.

Cotton on all plots died prematurely, which the experimenter attributed, not to "rust," but to unusually hot weather in the latter part of July.

Dothan experiment with fertilizers.

Plot No.	Fertilizers. Amount per acre.	Fertilizers. Kind.	Per cent. of crop at first picking.	Seed cotton. Yield per acre.	Seed cotton. Increase over unfertilized plots.	Financial results. Value of increase at 2c per lb.	Financial results. Cost of fertilizers per acre.	Financial results. Profit from fertilizers.
	Lbs.			Lbs.	Lbs.			$
1	200	Cottonseed meal......	59	440	80	$1.60	$1.90	—.30
2	240	Acid phosphate.......	65	512	152	3.04	1.32	1.72
3	00	No fertilizer..........	49	360	......	.....	......	......
4	200	Kainit................	39	592	234	4.64	1.38	3.26
5	200 240	Cottonseed meal.... Acid phosphate.....	75	480	113	2.26	1.23	1.03
6	200 200	Cottonseed meal.... Kainit..............	51	680	325	6.50	3.28	3.22
7	240 200	Acid phosphate. .. Kainit.............	68	720	366	7.32	2.70	4.62
8	00	No fertilizer..........	45	352	......	......	......	......
9	200 240 200	Cottonseed meal.... Acid phosphate..... Kainit.............	72	848	486	9.72	4.60	5.12
10	200 240 100	Cottonseed meal.... Acid phosphate..... Kainit.	81	776	423	8.46	3.90	4.56

Increase of seed cotton per acre when cottonseed meal was added:

To unfertilized plot .... 80 lbs.
To acid phosphate plot ....—39 "
To kainit plot .... 91 "
To acid phosphate and kainit plot ....120 "

Average increase with cottonseed meal...... **63** "

Increase of seed cotton per acre when acid phosphate was added:

To unfertilized plot ....152 lbs.
To cottonseed meal plot.................. 33 "
To kainit plot ....132 "
To cottonseed meal and kainit plot........161 "

Average increase with acid phosphate.........**120** "

Increase of seed cotton per acre when kainit was added:

To unfertilized plot	234 lbs.
To cottonseed meal plot	245 "
To acid phosphate plot	214 "
To cottonseed meal and acid phos. plot	373 "
Average increase with kainit	**267 "**

In this test kainit stands ahead of the other two fertilizers in effectiveness, a large and rather uniform increase in yield occurring on every plot where kainit was used. In a complete fertilizer 200 pounds per acre of kainit proved better than 100 pounds.

The fact that acid phosphate was only moderately effective, and that cottonseed meal was only slightly beneficial, is probably due to the extremely unfavorable season in July and August.

It remains uncertain whether the favorable effects of kainit are here due to (1) a deficiency of potash in the soil; (2) to the tendency of this fertilizer to increase the water-holding power of the soil, or (3) to the rust-restraining tendency of kainit. The experimenter reported no marked difference in amount of rust on kainit plots and those receiving no kainit.

EXPERIMENT MADE BY J. W. DYKES, THREE AND A HALF MILES WEST OF UNION SPRINGS, BULLOCK COUNTY.

Red soil, 5 inches deep; subsoil red clay.

The land had been in cultivation thirteen years, cotton and corn alternating. The crop in 1896 was cotton. The original forest growth was hickory, post oak, sweetgum, etc. This soil is reported as especially liable to "blight and rust," and these leaf diseases were very destructive in 1897, especially on plots 1, 2, 3, 5 and 8, the only plots on which no kainit was used.

Replying to a question relative to the extent of the shedding on the different plots, the experimenter writes: "The extreme heat of the last part of June caused all plots to shed. Plots where no kainit was used shed most, especially plots 1, 2 and 5."

Union Springs experiment with cotton.

Plot No.	Fertilizers. Amount per acre.	Fertilizers. Kind.	Per cent. of crop at first picking.	Seed cotton. Yield per acre.	Seed cotton. Increase over unfertilized plots.	Financial results. Value of increase at 2c per lb.	Financial results. Cost of fertilizers per acre.	Financial results. Profit from fertilizers.
	Lbs			*Lbs.*	*Lbs.*			
1	200	Cottonseed meal.......	78	648	128	$2.56	$1.90	$0.66
2	240	Acid phosphate........	94	664	144	2.88	1.32	1.56
3	00	No fertilizer..........	97	520	......	......	......	......
4	200	Kainit................	77	812	294	5.88	1.38	4.50
5	200 240	Cottonseed meal..... Acid phosphate......	86	704	187	3.74	3.22	.52
6	200 200	Cottonseed meal..... Kainit..............	78	688	173	3.46	3.28	.18
7	240 200	Acid phosphate...... Kainit	85	704	290	5.80	2.70	3.10
8	00	No fertilizer..........	95	512	......	......	......	......
9	200 240 200	Cottonseed meal..... Acid phosphate...... Kainit	81	808	296	5.92	4.60	1.32
10	200 240 100	Cottonseed meal..... Acid phosphate...... Kainit..............	91	784	272	5.44	3.90	1.54

Increase of seed cotton per acre when cottonseed meal was added:

To unfertilized plot ....128 lbs.
To acid phosphate plot .... 43 "
To kainit plot ....—121 "
To acid phosphate and kainit plot .... 6 "

Average increase with cottonseed meal ...... 14 "

Increase of seed cotton per acre when acid phosphate was added:

To unfertilized plot	144 lbs.
To cottonseed meal plot	59 "
To kainit plot	—4 "
To cottonseed meal and kainit plot	123 "
Average increase with acid phosphate	**81 "**

Increase of seed cotton per acre when kainit was added:

To unfertilized plot	294 lbs.
To cottonseed meal plot	45 "
To acid phosphate plot	146 "
To cottonseed meal and acid phos. plot	109 "
Average increase with kainit	**159 "**

The results for 1897 show that the soil needed kainit chiefly as a check on rust.

The largest profit was obtained where kainit alone was used, a mixture of kainit and acid prosphate standing second in this respect. In a complete fertilizer 100 pounds of kainit afforded nearly as large a yield and a slightly greater profit than double that quantity.

EXPERIMENT MADE BY C. D. HORN, COATOPA, SUMTER COUNTY.

Yellowish, sandy soil, with red subsoil at a depth of 3 inches.

This field had been in cultivation for about forty years, almost continually in cotton, except one year, when corn and cowpeas were grown, and in 1896, when cowpeas and sweet potatoes both occupied portions of the field. The original growth was red oak and hickory, with occasionally a post oak.

On August 10th plants on all plots appeared to have died as the result of rust; but new leaves developed on every plot receiving kainit. (Plots 4, 6, 7, 9 and 10.)

The table gives yields based only on the September and

October pickings. Unfortunately the light November picking, which was at the rate of seventy pounds per acre, was mixed by laborers. Apparently the slight yield at the last picking would not have greatly changed the results here recorded.

Coatopa experiment with cotton.

Plot No.	FERTILIZERS. Amount per acre.	FERTILIZERS. Kind.	SEED COTTON. Yield per acre.	SEED COTTON. Increase over unfertilized plots.	FINANCIAL RESULTS. Value of increase at 2c per lb.	FINANCIAL RESULTS. Cost of fertilizers per acre.	FINANCIAL RESULTS. Profit from fertilizers.
	Lbs.		*Lbs.*	*Lbs.*			$
1	200	Cottonseed meal.......	264	32	$0.64	$1.90	—1.26
2	240	Acid phosphate........	400	104	2.08	1.32	.76
3	00	No fertilizer..........	296	......	......	......	......
4	200	Kainit................	496	200	4.00	1.38	2.62
5	200 240	Cottonseed meal..... Acid phosphate......	520	224	4.48	3.22	1.26
6	200 200	Cottonseed meal..... Kainit	648	352	7.04	3.28	3.76
7	240 200	Acid phosphate...... Kainit	640	344	6.88	2.70	4.18
8	00	No fertilizer..........	296	......	......	......	......
9	200 240 200	Cottonseed meal..... Acid phosphate...... Kainit	760	464	9.28	4.60	4.68
10	200 240 100	Cottonseed meal..... Acid phosphate...... Kainit	688	392	7.84	3.90	3.94

Increase of seed cotton per acre when cottonseed meal was added:

To unfertilized plot .... 32 lbs.
To acid phosphate plot ....120 "
To kainit plot ....152 "
To acid phosphate and kainit plot.........120 "

Average increase with cottonseed meal......106 "

Increase of seed cotton per acre when acid phosphate was added:

To unfertilized plot	104	lbs.
To cottonseed meal plot	192	"
To kainit plot	144	"
To cottonseed meal and kainit plot	112	"
Average increase with cottonseed meal	**138**	"

Increase of seed cotton per acre when kainit was added:

To unfertilized plot	200	lbs.
To cottonseed meal plot	220	"
To acid phosphate plot	240	"
To cottonseed meal and acid phos. plot	240	"
Average increase with kainit	**225**	"

All three of the usual fertilizer ingredients were needed. Applied singly there was a financial loss with all except kainit. The mixtures containing kainit were more effective than any other fertilizer. A complete fertilizer was most profitable, and the profit was greater with 200 pounds per acre of kainit than with 100 pounds.

EXPERIMENT MADE BY J. R. MCLENDON, NAFTEL, MONTGOMERY COUNTY.

Light, sandy soil; red clay subsoil.

The land had been cleared about forty years, and had been fertilized but twice during that time, once with commercial fertilizers and once with a crop of cowpea vines. The original growth was pine, red oak and hickory. The preceding crop was cowpeas. The season was extremely dry. The stand was defective.

Naftel experiment with cotton.

Plot No.	Fertilizers: Amount per acre.	Fertilizers: Kind.	Per cent. of crop at first picking, Sept. 22.	Seed cotton: Yield per acre.	Seed cotton: Increase over unfertilized plots.	Financial results: Value of increase at 2c per lb.	Financial results: Cost of fertilizers per acre.	Financial results: Profit from fertilizers.
	Lbs.			*Lbs.*	*Lbs.*			$
1	200	Cottonseed meal.... ..	79	152	8	$0.16	$1.90	—1.74
2	240	Acid phosphate........	76	200	56	1.12	1.32	—.20
3	00	No fertilizer..........	77	144	......	......	......	......
4	200	Kainit................	88	360	215	.30	1.38	—1.08
5	200 240	Cottonseed meal..... Acid phosphate......	88	344	198	3.96	3.22	.74
6	200 200	Cottonseed meal..... Kainit..............	84	456	310	6.20	3.28	2.92
7	240 200	Acid phosphate...... Kainit.....	92	408	261	5.22	2.70	2.52
8	00	No fertilizer..........	79	148	......	......	......	......
9	200 240 200	Cottonseed meal..... Acid phosphate...... Kainit..............	87	616	468	9.36	4 60	4.76
10	200 240 100	Cottonseed meal..... Acid phosphate...... Kainit..............	88	488	340	6.80	3.90	2.90

Increase of seed cotton per acre when cottonseed meal was added:

To unfertilized plot...... .... 8 lbs.
To acid phosphate plot ....142 ”
To kainit plot .... 95 ”
To acid phosphate and kainit plot ....207 ”

Average increase with cottonseed meal.......113 “

Increase of seed cotton per acre when acid phosphate was added:

To unfertilized plot .... 56 lbs.
To cottonseed meal plot..................190 ”
To kainit plot .... 46 ”
To cottonseed meal and kainit plot.......158 ”

Average increase with acid phosphate........113 “

Increase in seed cotton per acre when kainit was added:

To unfertilized plot	215 lbs.
To cottonseed meal plot	302 "
To acid phosphate plot	205 "
To cottonseed meal and acid phos. plot	270 "
Average increase with kainit	**248 "**

The lessons taught by this experiment are plain. The soil was deficient in nitrogen, phosphoric acid and potash. Every fertilizer was unprofitable when applied separately. Every combination of two fertilizers was but slightly profitable; all three used together were necessary for most profitable results. The complete fertilizer containing 200 pounds per acre of kainit (plot 9) was more profitable than the one containing half that quantity (plot 10). While cottonseed meal, acid phosphate and kainit were all necessary, the latter exerted the greatest influence in augmenting the yield during the unfavorable season of 1897.

The experimenter reports that rust prevailed on all plots without kainit, and that it was most destructive on the unfertilized plots.

It is evident from the data given elsewhere in this bulletin, that the favorable effect of kainit was at least largely attributable to its rust-restraining tendency.

Doubtless on any other field than that growing a pea crop the preceding year, cottonseed meal would have afforded a larger increase in yield.

GROUP III. NITROGEN MOST EFFECTIVE.

Experiment Made by J. L. Ballard for Southwest Alabama Agricultural School, Jackson, Clarke County.

Red soil, 5 inches deep; subsoil red clay.

This upland field had been cleared ten years, the original growth having been pine, oak, etc. It was in corn and cowpeas in 1896, in cotton in 1894 and 1895. The weather was almost continually dry during the growing season, and from this cause the crop was greatly injured.

Jackson experiment with cotton.

	Fertilizers.			Seed c'tt'n		Financial results		
Plot No.	Amount per acre.	Kind.	No. plants per plot.	Yield per acre.	Increase over unfertilized plots.	Value of increase at 2c per lb.	Cost of fertilizers per acre.	Profit from fertilizers.
	Lbs.			*Lbs.*	*Lbs.*			
1	200	Cottonseed meal......	777	532	170	$3.40	$1.90	$1.50
2	240	Acid phosphate.......	756	512	150	3.00	1.32	1.68
3	00	No fertilizer..........	714	362	......	......	......	......
4	200	Kainit	735	390	22	44	1.38	—.94
5	200	Cottonseed meal......	777	626	253	5.06	3.22	1.84
	240	Acid phosphate.......						
6	200	Cottonseed meal......	756	808	269	5.38	3.28	2.10
	200	Kainit						
7	240	Acid phosphate.......	735	588	204	4.08	2.70	1.38
	200	Kainit						
8	00	No fertilizer..........	756	390	......	......	......	......
9	200	Cottonseed meal......						
	240	Acid phosphate.......	672	532	140	2.40	4.60	—2.20
	200	Kainit						
10*a*	200	Cottonseed meal......						
	240	Acid phosphate.......	....	512	122	2.44	3.90	—1.46
	100	Kainit						
10*b*	200	Cottonseed meal......						
	240	Acid phosphate.......	....	590	200	4.00	5.40	—1.40
	100	Kainit................						
	600	Lime..................						

Increase of seed cotton per acre when cottonseed meal was added:

To unfertilized plot ....170 lbs.
To acid phosphate plot ....103 ”
To kainit plot ....247 ”
To acid phosphate and kainit plot ....—64 ”

Average increase with cottonseed meal ......114 “

Increase of seed cotton per acre when acid phosphate was added:

To unfertilized plot	150 lbs.
To cottonseed meal plot	83 "
To kainit plot	182 "
To cottonseed meal and kainit plot	—129 "
Average increase with acid phosphate	**72 "**

Increase in seed cotton per acre when kainit was added:

To unfertilized plot	22 lbs.
To cottonseed meal plot	99 "
To acid phosphate plot	54 "
To cottonseed meal and acid phos. plot	—113 "
Average increase with kainit	**16 "**

Both cottonseed meal and acid phosphate increased the yield, cottonseed meal leading in spite of the preceding crop of cowpeas. Kainit was not effective, and the only plots on which any rust was noticed were plots 1 and 3. With lime there was an increase of seventy-eight pounds of seed cotton (compare plots 10a and 10b), or just enough to pay the cost of the lime. Doubtless in a normal season fertilizers would afford results very different from those of 1897, when complete fertilizers made a very poor showing.

EXPERIMENT MADE BY W. T. HIGHTOWER, PEROTE, BULLOCK COUNTY.

Red soil, with clay subsoil at a depth of 8 *inches.*

This field had been in cultivation thirty-seven years. The growth was red oak and post oak. The crop in 1895 and 1896 was corn.

The weather was very hot and dry during the growing season, and there was "no rust or dropping of leaves or fruit except from dry weather."

Perote experiment with cotton.

Plot No.	Fertilizers. Amount per acre.	Fertilizers. Kind.	Per cent. of crop at first picking, Aug. 9.	Seed cotton. Yield per acre.	Seed cotton. Increase over unfertilized plots.	Financial results. Value of increase at 2c per lb.	Financial results. Cost of fertilizers per acre.	Financial results. Profit from fertilizers.
	Lbs.			*Lbs.*	*Lbs.*			
1	200	Cottonseed meal......	13	624	184	$3 68	$1 90	$1 78
2	240	Acid phosphate.......	29	496	56	1 12	1 32	—20
3	00	No fertilizer..........	25	440	......	......	......	......
4	200	Kainit................	28	568	104	2 08	1 38	70
5	200 240	Cottonseed meal...... Acid phosphate.......	23	736	248	4 96	3 22	1 74
6	200 200	Cottonseed meal...... Kainit................	22	744	232	4 64	3 28	1 46
7	240 200	Acid phosphate....... Kainit................	22	688	152	3 04	2 70	34
8	00	No fertilizer..........	17	560	......	......	......	......
9	200 240 200	Cottonseed meal...... Acid phosphate....... Kainit................	18	656	96	1 92	4 60	—2 68
10	200 240 100	Cottonseed meal...... Acid phosphate....... Kainit................	17	512	—48	—96	3 90	—4 86

Increase of seed cotton per acre when cottonseed meal was added:

To unfertilized plot ....184 lbs.
To acid phosphate plot ....192 "
To kainit plot ....128 "
To acid phosphate and kainit plot ......—152 "

Average increase with cottonseed meal.....126 "

Increase of seed cotton per acre when acid phosphate was added:

To unfertilized plot .... 56 lbs.
To cottonseed meal plot................... 64 "
To kainit plot .... 48 "
To cottonseed meal and kainit plot.....–136 "

Average increase with acid phosphate....... 42 "

Increase in seed cotton per acre when kainit was added:

To unfertilized plot	104 lbs.
To cottonseed meal plot	48 "
To acid phosphate plot	96 "
To cottonseed meal and acid phos. plot	—152 "
Average increase with kainit	**62 "**

Cottonseed meal was most effective. It was also most profitable, although at best the profit was slight. There was a large financial loss when a complete fertilizer was used at the rate of 540 and 640 pounds per acre.

EXPERIMENT MADE BY T. K. JONES, 2 MILES SOUTH of GREENSBORO, HALE COUNTY.

Yellowish, sandy soil.

This land has been in cultivation, chiefly in cotton, for more than thirty years. The original growth is reported as hickory, oak and other hard woods. The number of stalks per eighth acre plot was as follows: 1274 on plot 1, 1000 on plot 2, 1016 on plot 3, 1048 on plot 4, 1049 on plot 5, 1126 on plot 6, 1023 on plot 7, 838 on plot 8, 1027 on plot 9, and 1086 on plot 10. In the following table no corrections have been made for a defective stand, for, judging by the fact that the unfertilized plot with 838 plants yielded more than the unfertilized plot with 1016 plants, the plots planted thickly had no advantage over other plots. The land was level and apparently very uniform. There was some rust on all plots, against which kainit was apparently ineffectual.

Greensboro experiment with cotton.

Plot No.	Fertilizers. Amount per acre.	Fertilizers. Kind.	Per cent. of crop at first picking.	Seed cotton. Yield per acre.	Seed cotton. Increase over unfertilized plots.	Financial results. Value of increase at 2c per lb.	Financial results. Cost of fertilizers per acre.	Financial results. Profit from fertilizers.
	Lbs.			*Lbs.*	*Lbs.*			
1	200	Cottonseed meal	38	904	304	$6 08	$1 90	$4 18
2	240	Acid phosphate	50	704	104	2 08	1 32	76
3	00	No fertilizer	24	600	......	......	......	......
4	200	Kainit	35	648	33	66	1 38	—72
5	200 240	Cottonseed meal Acid phosphate	54	944	306	6 12	3 22	2 90
6	200 200	Cottonseed meal Kainit	51	968	310	6 20	3 28	2 92
7	240 200	Acid phosphate Kainit	46	768	91	1 82	2 70	—78
8	00	No fertilizer	21	696	......	......	......	......
9	200 240 200	Cottonseed meal Acid phosphate Kainit	54	928	232	4 64	4 60	04
10	200 240 100	Cottonseed meal Acid phosphate Kainit	62	912	216	4 32	3 90	42

Increase of seed cotton per acre when cottonseed meal was added:

To unfertilized plot ....304 lbs.
To acid phosphate plot ....204 "
To kainit plot ....277 "
To acid phosphate and kainit plot.........141 "

Average increase with cottonseed meal ......232 "

Increase of seed cotton per acre when acid phosphate was added:

To unfertilized plot ....104 lbs.
To cottonseed meal plot.................... 2 "
To kainit plot .... 58 "
To cottonseed meal and kainit plot......... 78 "

Average increase with acid phosphate......... 61 "

Increase in seed cotton per acre when kainit was added:

To unfertilized plot	33 lbs.
To cottonseed meal plot..................	6 "
To acid phosphate plot	—13 "
To cottonseed meal and acid phos. plot...	—74 "
Average decrease with kainit................	**12** "

It is clear that nitrogen was more effective than phosphoric acid. Potash was useless and unprofitable. The most profitable fertilizer was cottonseed meal used alone.

EXPERIMENT MADE BY J. T. ROBERTSON, LEGRAND, MONTGOMERY COUNTY.

Gray soil, with clay subsoil at a depth of 3 inches.

This land had been in cultivation about forty years, and the crop in all recent years had been cotton. The original growth was oak, hickory, pine, etc.

The season was dry until several days of rainy weather about the middle of August, following which rust injured the plants growing on plots where no kainit was used.

Le Grand experiment with fertilizers.

Plot No.	Fertilizers. Amount per acre.	Fertilizers. Kind.	Per cent. of crop at first picking Sept. 8.	Seed cotton. Yield per acre.	Seed cotton. Increase over unfertilized plot.	Financial results. Value of increase at 2c per lb.	Financial results. Cost of fertilizers per acre.	Financial results. Profit from fertilizers.
			Lbs.	*Lbs.*	*Lbs.*			
1	200	Cottonseed meal......	54	648	320	$6 40	$1 90	$4 50
2	240	Acid phosphate........	56	592	264	5 28	1 32	3 96
3	00	No fertilizer..........	51	328	......	......	......	......
4	200	Kainit................	51	608	266	5 32	1 38	3 94
5	200 240	Cottonseed meal...... Acid phosphate.......	59	776	419	8 38	3 22	5 16
6	200 200	Cottonseed meal...... Kainit................	58	824	452	9 14	3 28	5 86
7	240 200	Acid phosphate........ Kainit................	52	736	351	7 12	2 70	4 42
8	00	No fertilizer..........	....	400	......	......	......	......
9	200 240 200	Cottonseed meal...... Acid phosphate....... Kainit................	53	1,000	600	12 00	4 60	7 40
10	200 240 100	Cottonseed meal...... Acid phosphate....... Kainit................	53	944	544	10 88	3 90	6 98

Increase of seed cotton per acre when cottonseed meal was added:

To unfertilized plot ....320 lbs.
To acid phosphate plot ....155 "
To kainit plot ....186 "
To acid phosphate and kainit plot ....249 "

Average increase with cottonseed meal......225 "

Increase of seed cotton per acre when acid phosphate was added:

To unfertilized plot ....264 lbs.
To cottonseed meal plot.................. 99 "
To kainit plot .... 85 "
To cottonseed meal and kainit plot.......148 "

Average increase with acid phosphate.......149 "

Increase in seed cotton per acre when kainit was added:

To unfertilized plot	266 lbs.
To cottonseed meal plot	132 "
To acid phosphate plot	87 "
To cottonseed meal and acid phos. plot	181 "
Average increase with kainit	**167 "**

Plainly the chief need of this soil was for nitrogen. It is equally clear that phosphoric acid was also needed by this soil. Kainit was highly advantageous by reason of its rust-restraining tendency. Whether the latter fertilizer would be profitable in a normal season when rust is less prevalent is an open and interesting question. The complete fertilizers, made up of cottonseed meal, acid phosphate and kainit, were decidedly more profitable in 1897 than any single fertilizer or mixture of two fertilizers. Two hundred pounds per acre of kainit was more profitable than half that quantity.

In 1896, on the same farm, but on a different field, with a poor reddish soil, only fertilizers containing nitrogen were profitable, the increase in yield from the use of acid phosphate and kainit being scarcely appreciable. Both experiments agree in giving pre-eminence to cottonseed meal.

GROUP IV. PHOSPHORIC ACID, POTASH AND NITROGEN ALL EFFECTIVE.

EXPERIMENT MADE BY J. P. ANDERSON ON FARM OF DR. THOMAS, THOMASTON, MARENGO COUNTY.

Gray, sandy soil, 4 inches deep, with red clay subsoil.

This field had been in cultivation for thirty or forty years. All recent crops consisted of cotton. The original growth was oak, hickory, gum and pine. Rust was very injurious, especially on the plots where kainit was not used.

Thomaston experiment with cotton.

Plot No.	Fertilizers. Amount per acre.	Fertilizers. Kind.	Per cent. of crop at first picking Aug. 24.	Seed cotton. Yield per acre.	Seed cotton. Increase over unfertilized plots.	Financial results. Value of increase at 2c per lb.	Financial results. Cost of fertilizers per acre.	Financial results. Profit from fertilizers.
	Lbs.			*Lbs.*	*Lbs.*	$		$
1	200	Cottonseed meal......	50	640	—16	— 32	$1 90	—2 22
2	240	Acid phosphate.......	53	744	88	1 76	1 32	44
3	00	No fertilizer..........	41	656	......	......	......	......
4	200	Kainit................	48	728	118	2 36	1 38	98
5	200	Cottonseed meal......	71	776	211	5 22	3 22	1 00
	240	Acid phosphate.......						
6	200	Cottonseed meal......	59	832	312	6 24	3 28	2 96
	200	Kainit................						
7	240	Acid phosphate.......	57	760	286	5 72	2 70	3 02
	200	Kainit................						
8	00	No fertilizer..........	33	428	......	......	......	......
9	200	Cottonseed meal......	43	1,036	608	12 16	4 60	7 59
	240	Acid phosphate.......						
	200	Kainit						
10	200	Cottonseed meal......	47	984	556	11 12	3 90	7 22
	240	Acid phosphate.......						
	100	Kainit................						

Increase of seed cotton per acre when cottonseed meal was added:

To unfertilized plot ....—16 lbs.
To acid phosphate plot ....123 "
To kainit plot ....194 "
To acid phosphate and kainit plot ....322 "

Average increase with cottonseed meal.......155 "

Increase of seed cotton per acre when acid phosphate was added:

To unfertilized plot .... 88 lbs.
To cottonseed meal plot...................227 "
To kainit plot ....168 "
To cottonseed meal and kainit plot ....296 "

Average increase with acid phosphate........195 "

Increase in seed cotton per acre when kainit was added:

To unfertilized plot	118 lbs.
To cottonseed meal plot	328 "
To acid phosphate plot	198 "
To cottonseed meal and acid phos. plot	397 "
Average increase with kainit	**261 "**

The most effective fertilizer was kainit, the favorable effect of which was due, at least in large part, to its effect in checking rust. Phosphoric acid and nitrogen were also needed by this soil. Every fertilizer was used to greater advantage in combination than alone. The complete fertilizers (plots 9 and 10) were most profitable, the one containing the larger quantity of kainit leading.

Mr. Anderson also conducted a fertilizer test in 1896. Although an accident prevented a statement of the yields, the appearance of the different plots led him to conclude that his soil needed a complete fertilizer and that nitrogen was especially important in 1896.

Experiment Made by A. Autrey, Berneys, Talladega County.

Soil and subsoil red clay; soil 3 or 4 inches deep.

This field had been in cultivation forty or fifty years. The original forest growth was oak, pine and hickory. The preceding crop was oats. There was only about three-fourths of a stand on all plots. The plants on all plots remained free from all leaf diseases.

Berneys experiment with cotton.

Plot No.	FERTILIZERS. Amount per acre.	FERTILIZERS. KIND.	Per cent. of crop at first picking, Sept. 2.	SEED COTTON Yield per acre.	SEED COTTON Increase over unfertilized plot.	FINANCIAL RESULTS Value of increase at 2c per lb.	FINANCIAL RESULTS Cost of fertilizers per acre.	FINANCIAL RESULTS Profit from fertilizers.
	Lbs.			*Lbs.*	*Lbs.*			$
1	200	Cottonseed meal........	11	456	8	$0 16	$1 90	--1 74
2	240	Acid phosphate........	9	512	64	1 28	1 32	—04
3	00	No fertilizer..........	11	448	....	....	....	....
4	200	Kainit................	13	616	157	3 14	1 38	1 76
5	200 240	Cottonseed meal....... Acid phosphate........	20	680	210	4 20	3 22	98
6	200 200	Cottonseed meal....... Kainit................	14	624	142	2 84	3 28	—44
7	240 200	Acid phosphate........ Kainit................	12	656	163	3 26	2 70	56
8	00	No fertilizer..........	13	504	....	....	....	....
9	200 240 200	Cottonseed meal....... Acid phosphate........ Kainit	23	888	384	7 68	4 60	3 08
10	200 240 100	Cottonseed meal....... Acid phosphate........ Kainit................	26	800	296	5 92	3 90	2 02

Increase of seed cotton per acre when cottonseed meal was added:

To unfertilized plot .... 8 lbs.
To acid phosphate plot ....146 ”
To kainit plot ....—15 ”
To acid phosphate and kainit plot ....221 ”

Average increase with cottonseed meal...... 90 ”

Increase of seed cotton per acre when acid phosphate was added:

To unfertilized plot .... 64 lbs.
To cottonseed meal plot..................202 ”
To kainit plot .... 6 ”
To cottonseed meal and kainit plot........242 ”

Average increase with acid phosphate ....129 ”

Increase in seed cotton per acre when kainit was added:

To unfertilized plot	157	lbs.
To cottonseed meal plot	134	"
To acid phosphate plot	99	"
To cottonseed meal and acid phos. plot	274	"
Average increase with kainit	**166**	"

The results, which are not as uniform as desirable, suggest that the land was somewhat deficient in all three of the usual fertilizer constituents. Kainit was slightly in the lead.

The greatest profit was afforded by the plots to which the complete fertilizers were applied.

Experiment Made on Farm of F. C. McDonald, Rutledge, Crenshaw County.

The report does not describe the soil, but the prevailing soil in that locality is gray and sandy.

Rutledge experiment with fertilizers.

Plot No.	Fertilizers. Amount per acre.	Fertilizers. Kind.	Seed cotton. Yield per acre.	Seed cotton. Increase over unfertilized plots.	Financial results. Value of increase at 2c per lb.	Financial results. Cost of fertilizers per acre.	Financial results. Profit from fertilizers.
	Lbs.		*Lbs.*	*Lbs.*			$
1	200	Cottonseed meal	600	48	$0 96	$1 90	— 94
2	240	Acid phosphate	760	208	4 16	1 32	2 84
3	00	No fertilizer	552	......	......	......	......
4	200	Kainit	696	150	3 00	1 38	1 62
5	200 240	Cottonseed meal Acid phosphate	1032	493	9 86	3 22	6 64
6	200 200	Cottonseed meal Kainit	1140	607	12 14	3 28	8 86
7	240 200	Acid phosphate Kainit	808	282	5 64	2 70	2 84
8	00	No fertilizer	520	......	......	......	......
9	200 240 200	Cottonseed meal Acid phosphate Kainit	1216	696	13 92	4 60	9 32
10	200 240 100	Cottonseed meal Acid phosphate Kainit	1304	786	15 72	3 90	11 82

Increase of seed cotton per acre when cottonseed meal was added:

To unfertilized plot .... 48 lbs.
To acid phosphate plot ....285 "
To kainit plot ....457 "
To acid phosphate and kainit plot ....406 "

Average increase with cottonseed meal......299 "

Increase of seed cotton per acre when acid phosphate was added:

To unfertilized plot ....208 lbs.
To cottonseed meal plot..................445 "
To kainit plot ....132 "
To cottonseed meal and kainit plot........ 89 "

Average increase with acid phosphate.......219 "

Increase in seed cotton per acre when kainit was added:

To unfertilized plot	150 lbs.
To cottonseed meal plot	559 "
To acid phosphate plot	74 "
To cottonseed meal and acid phos. plot	203 "
Average increase with kainit	**247 "**

This soil was evidently deficient in all three of the essential elements of plant food, for it responded to every fertilizer or combination of fertilizers. The largest yields and the greatest profits were obtained by the use of the complete fertilizers. In a complete fertilizer 100 pounds of kainit per acre was better than double that quantity.

Likewise in 1896 this soil responded profitably to each of the three usual fertilizer ingredients, the complete fertilizer affording a greater profit than combinations in which any one of these was wanting.

Experiment Made by A. M. Valero, Daphne, Baldwin County.

The experimenter describes the soil as follows: "Poor, pine land; stiff red clay soil, with some humus at the top; pretty well worn out by five years' of corn culture, during which time it was poorly cultivated and fertilized."

"The severe hot weather, which has no precedent in the meteorological records of this county, has proved a drawback to the growth of the plants."

By an oversight, all fertilizers were applied at a rate per acre, which is 25 per cent. greater than the rate for any other experiment in this bulletin.

Daphne experiment with fertilizers.

Plot No.	FERTILIZERS. Amount per acre.	FERTILIZERS. Kind.	SEED COTTON Yield per acre.	SEED COTTON Increase over unfertilized plots.	FINANCIAL RESULTS Value of increase at 2c per lb.	FINANCIAL RESULTS Cost of fertilizers per acre.	FINANCIAL RESULTS Profit from fertilizers.
	Lbs.		*Lbs.*	*Lbs.*			
1	250	Cottonseed meal........	200	120	$2 40	$2 38	$0 02
2	300	Acid phosphate.........	100	20	40	1 65	—1 25
3	00	No fertilizer............	80	......	......	......	......
4	250	Kainit.................	150	70	1 40	1 73	— 33
5	250 300	Cottonseed meal........ Acid phosphate.........	350	270	5 40	4 03	1 37
6	250 250	Cottonseed meal........ Kainit	440	360	7 20	4 10	3 10
7	300 250	Acid phosphate......... Kainit	520	440	8 80	3 38	5 42
8	00	No fertilizer............	80	......	......	......	......
9	250 300 250	Cottonseed meal........ Acid phosphate......... Kainit.................	560	480	9 60	5 75	3 85
10	250 300 125 375	Cottonseed meal........ Acid phosphate......... Kainit................. Lime..................	600	520	10 40	5 81	4 59

Increase of seed cotton per acre when cottonseed meal was added:

To unfertilized plot ....120 lbs.
To acid phosphate plot ....250 ”
To kainit plot ....290 ”
To acid phosphate and kainit plot .... 40 ”

Average increase with cottonseed meal......175 ”

Increase of seed cotton per acre when acid phosphate was added:

To unfertilized plot .... 20 lbs.
To cottonseed meal plot..................150 ”
To kainit plot ....370 ”
To cottonseed meal and kainit plot........120 ”

Average increase with acid phosphate.......165 ”

Increase in seed cotton per acre when kainit was added:

To unfertilized plot	70 lbs.
To cottonseed meal plot	240 "
To acid phosphate plot	420 "
To cottonseed meal and acid phos. plot	210 "
Average increase with kainit	**235 "**

Applied singly, every fertilizer entailed a financial loss. In combination, each of the three fertilizing material was effective, indicating that the soil was deficient in nitrogen, phosphoric acid and potash. Kainit was most effective. The most profitable fertilizer consisted of a mixture of kainit and acid phosphate.

GROUP V. PHOSPHORIC ACID AND NITROGEN ABOUT EQUALLY EFFECTIVE, AND POTASH NOT VERY EFFECTIVE.

Experiment Made by T. T. Meadows, Cusseta, Chambers County.

Red soil, with clay foundation at a depth of 3 *inches.*

This field had been in cultivation forty or fifty years. It was very poor. The season was "very dry until July 9; then rain was too late to benefit the plants, as they had stopped growing and made no second growth." There was some rust. There were no outside rows.

Cusseta experiment with cotton.

Plot No.	Fertilizers. Amount per acre.	Fertilizers. Kind.	Seed cotton. Yield per acre.	Seed cotton. Increase over unfertilized plots.	Financial results. Value of increase at 2c per lb.	Financial results. Cost of fertilizers per acre.	Financial results. Profit from fertilizers.
	Lbs.		*Lbs.*	*Lbs.*			
1	200	Cottonseed meal	200	104	$2 08	$1 80	$0 18
2	240	Acid phosphate	256	160	3 20	1 32	1 88
3	00	No fertilizer	96	......	......	......	......
4	200	Kainit	120	29	58	1 38	— 80
5	200 240	Cottonseed meal Acid phosphate	448	362	7 24	3 22	4 02
6	200 200	Cottonseed meal Kainit	336	254	5 08	3 28	1 80
7	240 200	Acid phosphate Kainit	192	115	2 30	2 70	— 40
8	00	No fertilizer	72	......	......	......	......
9	200 240 200	Cottonseed meal Acid phosphate Kainit	440	368	7 36	4 60	2 76
10	200 240 100	Cottonseed meal Acid phosphate Kainit	504	432	8 64	3 90	4 74

Increase of seed cotton per acre when cottonseed meal was added:

To unfertilized plot ....104 lbs.
To acid phosphate plot ....202 "
To kainit plot ....235 "
To acid phosphate and kainit plot ....253 "

Average increase with cottonseed meal......199 "

Increase of seed cotton per acre when acid phosphate was added:

To unfertilized plot ....160 lbs.
To cottonseed meal plot....................258 "
To kainit plot .... 84 "
To cottonseed meal and kainit plot.......114 "

Average increase with acid phosphate.......156 "

Increase in seed cotton per acre when kainit was added:

To unfertilized plot	29 lbs.
To cottonseed meal plot....................	150 "
To acid phosphate plant	—45 "
To cottonseed meal and acid phos. plot....	6 "
Average increase with kainit................	**36 "**

Cottonseed meal and acid phosphate were both fairly effective.

The most profitable fertilizer was a complete fertilizer containing 200 pounds per acre of cottonseed meal, 240 pounds of acid phosphate, and only 100 pounds of kainit. A close second to this in point of profit was a mixture of cottonseed meal and kainit.

Of the three separate fertilizer materials kainit was least effective and practically worthless except when combined with cottonseed meal.

Experiment Made by T. J. Thomason, Kaylor, Randolph County.

Gray soil 5 *or* 6 *inches deep; yellow subsoil.*

This field was supposed to have been cleared for about fifty years. The preceding crop was cotton. Nothing is said about fertilizers used in previous years, but the good yields obtained on the unfertilized plots—888 and 1000 pounds of seed cotton per acre—suggest that the land had been highly fertilized in recent years. Rust did not do any special damage.

Kaylor experiment with cotton.

Plot No.	Fertilizers. Amount per acre.	Fertilizers. Kind.	Per cent. of crop at first picking, Sept. 15.	Seed cotton. Yield per acre.	Seed cotton. Increase over unfertilized plot.	Financial results. Value of increase at 2c per lb.	Financial results. Cost of fertilizers per acre.	Financial results. Profit from fertilizers.
	Lbs.			*Lbs.*	*Lbs.*			
1	200	Cottonseed meal	37	1116	228	$4 56	$1 90	$3 36
2	240	Acid phosphate	32	1240	352	7 04	1 32	5 72
3	00	No fertilizer	18	888	......	......	......	......
4	200	Kainit	21	1024	114	2 28	1 38	90
5	200 240	Cottonseed meal Acid phosphate	34	1320	387	7 74	3 22	4 52
6	200 200	Cottonseed meal Kainit	32	1200	245	4 90	3 28	1 62
7	240 200	Acid phosphate Kainit	31	1120	142	2 84	2 70	14
8	00	No fertilizer	25	1000	......	......	......	......
9	200 240 200	Cottonseed meal Acid phosphate Kainit	30	1312	312	6 24	4 60	1 64
10	200 240 100	Cottonseed meal Acid phosphate Kainit	31	1360	360	7 20	3 90	3 30

Increase of seed cotton per acre when cottonseed meal was added:

To unfertilized plot ....228 lbs.
To acid phosphate plot .... 35 "
To kainit plot ....131 "
To acid phosphate and kainit plot ....170 "

Average increase with cottonseed meal......141 "

Increase of seed cotton per acre when acid phosphate was added:

To unfertilized plot .... 352 lbs.
To cottonseed meal plot..................159 "
To kainit plot .... 28 "
To cottonseed meal and kainit plot........ 67 "

Average increase with acid phosphate.......152 "

Increase in seed cotton per acre when kainit was added:

To unfertilized plot	114 lbs.
To cottonseed meal plot	17 "
To acid phosphate plot	—210 "
To cottonseed meal and acid phos. plot	—75 "
Average decrease with kainit	**39** "

Acid phosphate and cottonseed meal were about equally effective, both giving moderately profitable returns. Kainit was used at a loss. The plot which yielded most profit was the one to which acid phosphate alone was applied.

Neither in 1896 nor in 1897 was the complete fertilizer the most profitable fertilizer for land capable of producing 800 to 1000 pounds of seed cotton per acre.

INCONCLUSIVE EXPERIMENTS.

The experiment near McLendon, Russell county, was made by J. J. Blackstock on the farm of Hirsch Brothers.

The field was level and the soil loamy. It had been cleared about sixty years before. The original growth was gum and short leaf pine. The stand was reported good.

The variable effect of fertilizer in the several mixtures renders conclusions impossible, but raises the suspicion that the soil, by reason either of a sufficiency of all three of the usual forms of commercial plant food, or because of defective physical condition, was unable to profit by any of the ordinary commercial fertilizers. In 1896 also the results were negative or inconclusive.

An experiment was made by J. B. Craddock on farm of Southeast Alabama Agricultural School, Abbeville, Ala.:

The land had been in cultivation for about fifty years. The original growth was oak and hickory.

The experiment is incomplete, having no unfertilized plot, but by comparing the yield obtained by use of the mixture containing all three fertilizers with the yields afforded by the plots to which fertilizers were applied singly and two by two, we find that the results in 1897 agree substantially with those of 1890, 1891, 1892 and 1896 in showing that all three of the usual fertilizer constituents increase the yield of cotton on this soil.

The experiment at Jacksonville was conducted by Prof. C. W. Daugette. The figures afford no suggestions as to the needs of this soil. Probably previous applications of manure, or previous methods of treatment, have rendered the field unfit for experimental purposes.

Experiment Made by Dr. John T. Gordon, Healing Springs Washington County.

Gray, sandy soil, 12 inches deep ; sandy clay subsoil.

The field is described as a gently rolling ridge between two branches, on which the original growth was long leaf pine. It was in cotton in 1896, and for the three years preceding that time it was continuously in corn and cowpeas. "There was no rust or other leaf disease. Leaves remained green until the dry, hot winds came, about the last of August and first of September, when the leaves seemed to wither, at first in spots, afterwards pretty generally."

Although the yields of the unfertilized plots point to uniformity in natural fertility, the results are perplexing. Apparently some undiscovered cause was more influential than the fertilizers. This is the fifth test of fertilizers on this soil. Previous results were either inconclusive or suggestive of a deficiency of all three of the usual fertilizer ingredients.

Experiment Made by F. Funkey, 1½ Miles South of Tuscumbia, Colbert County.

Reddish soil and subsoil.

This field had been in cultivation about fifty years. The original forest growth was oak, blackjack oak and hickory. Oats was the crop in 1894, corn in 1895 and 1896. The stand was reported as good. The season was dry after July 1. The land was not sufficiently uniform to permit of conclusions.

The experiment at Evergreen was made by F. M. Roundtree on the farm of the South Alabama Agricultural School, on red sandy soil. The test is not conclusive.

The figures suggest in 1897, as also in 1896, a need of nitrogen in spite of the fair yields obtained on the unfertilized plots. It is evident that the variations in the fertility of the soil are so great and so abrupt as to render impossible the drawing of any definite conclusions from these experiments.

Experiment Made by J. A. Wilkinson, 4 Miles West of Autaugaville, Autauga County.

Soil, chocolate sandy, or red; subsoil red, with some gravel.

This land, cultivated for fifty or sixty years, had been in cotton for many years without fertilizers of any kind. The stand was uniform. Rust, present on some plots, was apparently not destructive. The weather was dry during most of the growing season, which probably explains the slight influence of fertilizers on the yield.

The wide variation in the yields of the two unfertilized plots introduces an element of uncertainty which is, perhaps, not entirely overcome by the method of computing the increase.

Bearing this in mind, we can regard the experiment as only suggestive, and not as indicative, of a moderate increase from cottonseed meal and kainit, and of a slight effect from acid phosphate.

An experiment was made by Mr. G. W. Smith one mile southeast of Brundidge. It was made on gray soil, underlaid by clay at a depth of two feet. The field had been cleared 44 years. The original growth was oak, hickory, gum and dogwood. Preceding crops were cotton in 1895 and 1896, and corn in 1894.

The great difference in the yields of the two unfertilized plots prohibits drawing any definite conclusions as to the relative values of the three fertilizing materials, all of which, under some conditions, were apparently beneficial.

Inconclusive experiments with cotton.

Plot No.	Amount per acre.	Fertilizers. Kind.	McLendon. Seed cotton per acre.	McLendon. Inc. over unfertilized plots.	Abbeville. Seed cotton per acre.	Jacksonville. Seed cotton per acre.	Healing Springs. Seed cotton per acre.	Healing Springs. Inc. over unfertilized plots.	Evergreen. Seed cotton per acre	Evergreen. Inc. over unfertilized plots.	Tuscumbia. Seed cotton per acre.	Tuscumbia. Inc. over unfertilized plots.	Autaugaville. Seed cotton per acre.	Autaugaville. Inc. over unfertilized plots.	Brundidge. Seed cotton per acre.	Brundidge. Inc. over unfertilized plots.
			Lbs.	*Lbs.*	*Lbs.*	*Lbs*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
1	200	Cottonseed meal	680	......	624	672	864	608	1616	328	736	280	470	30	800	330
2	240	Acid phosphate	592	—88	408	1200	864	608	1144	—144	768	312	510	70	680	210
3	00	No fertilizer	680	..	..	972	256	......	1288	......	456	......	440	......	470	......
4	200	Kainit	912	213	408	1456	832	579	1296	51	640	104	560	84	704	165
5	200 240	Cottonseed meal Acid phosphate	1000	282	824	1256	672	423	1776	590	984	368	670	158	992	384
6	200 200	Cottonseed meal Kainit	872	134	736	1136	720	474	1512	380	816	120	840	292	1136	458
7	200 200	Acid phosphate Kainit	728	—29	824	904	736	493	1280	97	880	104	690	106	1152	405
8	00	No fertilizer	776	......	.....	1264	240	......	1032	......	856	......	620	......	816	.....
9	200 240 200	Cottonseed meal Acid phosphate Kainit	744	—32	976	1184	776	536	1304	272	976	120	680	60	1216	410
10a	200 240 100	Cottonseed meal Acid phosphate Kainit	728	—48	816	1024	880	640	890	—142	1032	176	600	—20	920	104
10b	200 240 100 600	Cottonseed meal Acid phosphate Kainit Slacked lime	......	.....	......	......	656	416	992	—40	......	......	......	......	......	......

EFFECT OF KAINIT ON RUST.

In Bulletin No. 89 were published the results of a fertilizer experiment made in 1897 on the station farm, in which kainit exerted a decided effect in reducing the injury due to "rust," or "blight." Early in the summer every one conducting a fertilizer test for this station was requested to keep a record of the amount of rust or other leaf disease on the plots differently fertilized.

The records bearing on this subject are summarized here:

Number of experiments in which kainit was decidedly effective in checking leaf disease.................. 8

Number of experiments where rust was present, and where kainit did not check it....................... 5

Number of experiments where the rust-restraining effects of kainit were slight............................... 3

Number of experimenters reporting no difference between different plots, but failing to note the presence or absence of leaf diseases.................................. 3

Number of experiments entirely free from rust.......... 9

The other reports contained no data relative to this question.

At Lumber Mills, after the rainy weather beginning August 14, "all plots that had no kainit began to throw off leaves. The leaves would have dark spots come on them, and then they would rot and drop off. Plot 5 shed worse than the others. Plot 4 did not shed any."

At Cusseta there was some rust on plot 5 (cottonseed meal and acid phosphate), but none on plot 9 (complete fertilizer). No notes were recorded relative to the presence or absence of rust on the other plots. The experimenter writes: "Kainit helps to keep off rust."

Mr. J. M. King, who conducted a test at Wilson, Escambia county, but whose numerical results were not sent in, writes as follows:

"During July plots 1 and 5 were the best, but as the weather became dryer and hotter these plants began to blight, the leaves and forms began to shed, and by the last of August both plots were dead. Plot 4 (kainit) remained green the longest."

From Coatopa the experimenter writes: "August 10 I thought the plants on all plots were dead—rusted. They afterwards put out some leaves on the following plots: 4, 6, 7, 9 and 10." These were the plots which received kainit.

Kainit in this experiment afforded a larger increase in yield than acid phosphate or cottonseed meal, which result is probably attributable rather to this renewed growth on the kainit plots than to a special deficiency of potash in the soil.

The report from Thomaston contains the following notes: "Rust was bad on all plots relatively in order named: 5, 8, 3, 2, 7, 4, 10 and 9. Kainit does not prevent, but only alleviates, rust."

At Union Springs, on a field especially subject to rust, "the extreme heat of the last of June caused all plots to shed, where no kainit was used, especially plots 1, 2 and 5. July 8 I noticed that rust appeared on the unfertilized plots. July 15 rust appeared on plots 1, 2 and 5," those receiving no kainit. No mention is made of rust in connection with plots fertilized with kainit.

From LeGrand, Mr. Robertson writes: "There was comparatively no shedding of leaves or rust except on plots where there was no kainit used. Plot 4 did not shed a leaf, and remained green until frost. Plots 9 and 10 did almost as well."

At Naftel "Nos. 1, 2, 3 and 8 suffered more with rust than the others; Nos. 3 and 8 (unfertilized) more than any other." The report contains the following estimate of the percentage of leaves which were shed prematurely as a result of rust:

Plot 1 (cottonseed meal)........................50%
Plot 2 (acid phosphate).........................33%
Plot 3 (no fertilizer)..........................75%
Plot 4 (kainit).................................00%
Plot 5 (meal and phosphate).....................20%
Plot 6 (meal and kainit)........................00%
Plot 7 (phosphate and kainit)...................00%
Plot 8 (no fertilizer)..........................60%
Plot 9 (meal, phosphate and kainit).............00%
Plot 10 (meal, phosphate and kainit)............ 1%

Here both 100 and 200 pounds per acre of kainit effectually checked rust.

Above we have the reports which show a decided rust-restraining effect of kainit.

Five experiments, as follows, show that kainit, under their prevailing local conditions, failed to reduce the injury from leaf diseases. At Tuskaloosa the amount of rust was as great on the kainit plots as on any others. This field had been subsoiled by following the turn plow with a scooter. At Abbeville there was apparently no uniform effect on rust due to kainit. At Prattville "plot 1 was worse affected, and commenced to drop the leaves about five or six days sooner than the others. All the rest dropped the leaves about the same time."

At Jackson rust was detected only on plot 1 (cottonseed meal) and plot 3 (unfertilized). At Greensboro there was some rust on all plots, but no marked difference.

It is evident from the preceding paragraphs that kainit did check leaf diseases in eight of the thirteen experiments affording definite data. This is equal to 61 per cent. of favorable results.

It is not strange that the effect of kainit on rust was widely different under different conditions of soil and weather.

For that little word "rust" is used to include almost all of the leaf diseases, of which Prof. G. F. Atkinson has described several in the earlier bulletins of this station. The one which, in his experiments, was influenced by kainit, was what is generally known as black rust, but which he designated as "mosaic disease," or "yellow leaf blight."

Leaf diseases were widely prevalent and destructive in 1897, and until late summer dry weather was general. Remembering these abnormal conditions, we should not expect kainit to exert so favorable an effect in normal seasons and in years when leaf diseases are less injurious.

BULLETIN No. 92. APRIL 1898.

ALABAMA Agricultural Experiment Station

OF THE

AGRICULTURAL AND MECHANICAL COLLEGE,

AUBURN.

EXPERIMENTS WITH LIME ON ACID SOILS.

F. S. EARLE and A. W. ORR.

BIRMINGHAM
ROBERTS & SON.
1898

☞ The Bulletins of this Station will be sent free to any citizen of the State on application to the Agricultural Experiment Station, Auburn, Alabama.

Experiments with Lime on Acid Soils.

The very interesting results obtained with lime on sandy, upland soils in Rhode Island* suggested to the writer, that a similar acid condition might exist in our sandy Gulf coast soils, and be the cause of the peculiar behavior of some vegetable crops in that region.† Through the cooperation of Mr. A. W. Orr of Deer Park, Washington County, Ala., the Station has been able to make some preliminary investigations on the effect of lime on these soils, the results of which are herewith presented. They are in no sense final, but they seem suggestive and interesting enough to warrant publication at this time. The work so far done includes some experiments in the greenhouse here with soils shipped from Deer Park, and field experiments conducted at Deer Park by Mr. Orr, whose report forms a part of this bulletin.

EXPERIMENTS AT AUBURN.

The samples of soil were received here on December 2, 1896. No. 1 was the ordinary upland soil of the coast region, quite sandy, and rather deficient in humus. No. 2, the so called "Savannah Land" was a light gray sandy loam These "Savannahs" are low lying, level, treeless expanses, usually too wet for cultivation without drainage. They are characteristic of the coast region, and are only considered fit for cultivation to rice or sugar cane. No. 3 was a stiff black soil from a swampy "hammock"—the low lying timbered lands along small streams. The three samples represent the prevailing types of coast soils. All of them gave a prompt and decided acid reaction with litmus paper. A portion of each lot was fertilized with cottonseed meal and placed in a shallow box, 20x36 inches, having a partition dividing it into two equal parts. On one side of the partition in each box a quantity of slacked lime was dug into the soil, the other side being left without lime. The boxes were watered and left on the green

* See Bull. 46 of the Rhode Island Experiment Station, and Annual Reports for 1894, 1895 and 1896

† See Bull. 37 of the Mississippi Experiment Station, "Fruits and Vegetables on the Gulf Coast."

house bench till January 1. On again testing with litmus paper the limed ends of the boxes now gave a strong alkaline reaction. The boxes were planted to American Wonder peas. It soon became evident that too much lime had been used, for after coming up, the peas in the limed ends of the boxes all died. They did not seem able to strike root in the soil. The boxes were replanted at intervals, but without success, until about the middle of March, when they were planted to lettuce and radishes. On April 2 it was noted that at last a good stand had been secured in two of the limed boxes. The one containing the upland soil was still a complete failure. In box No. 3. with the hammock soil the lettuce was decidedly best in the limed end, no difference could be noted in the radishes. In box No. 2., the Savannah soil, the lettuce was at least three times as large in the limed end, while the radishes seemed hardly so good with the lime. The radishes continued to grow luxuriantly in both ends of both boxes, but at maturity they were slightly better in each case in the limed ends. With the lettuce the difference was very marked. In the unlimed ends of both boxes it was stunted and sickly, with leaves less than two inches long, but in the limed ends it grew rank and luxuriant. The result was as striking a one as the experimentor could desire, and it is well illustrated by the

accompanying reproduction of a photograph of one of the boxes taken at the close of the experiment. In the limed end (to the right in the cut) the luxuriant lettuce fills the box, almost hiding the radish tops from view, while in the unlimed end the lettuce leaves are so small as to be almost hidden by the sides of the box, and it was necessary to press aside the radish leaves to show them at all.

The results obtained by Mr. Orr are somewhst contradictory, and in interpreting them it should be borne in mind that the lime was applied quite late in the Spring (March 2), and that the greenhouse experiments show that it had not had time to lose its injurious caustic effects by Aprll 1, when most of the planting was done. Then, too, the date of planting was too late for the best success with a number of the crops planted. The strikingly good results with corn, tomatoes, lettuce, and tobacco indicate the advisability of continued experiments with lime in this region, or at any other points in the State where the soil gives an acid reaction. At Auburn our soils seem to be almost or quite neutral, and so far, field experiments with lime have given no striking results. The reaction of the soil can be easily and quickly tested by any one, by pressing into its moistened surface slips of litmus paper such as can be found at most drug stores. If the soil is acid the blue paper will be turned red, if it is alkaline the red paper will be turned blue, and if it is neutral or nearly neutral neither color will be changed.

The freedom of the tomatoes on the heavily limed plot from Blight, or Bacteriosis, a disease that is very prevalent and destructive in our southern counties, is especially noteworthy, since it goes to corroborate the result of some experiments with this disease conducted by the writer at the Ocean Springs branch of the Mississippi Experiment Station.* In all cases where it has been tried, heavy applications of lime seem to have had a decidedly beneficial effect in preventing this dreaded disease.

F. S. EARLE.

AUBURN, ALA., Feb. 18, 1898.

*See 6th Annual Report of the Mississippi Experiment Station, pp. 53-61.

Field Experiments with Lime at Deer Park.

A piece of ordinary upland soil measureing 6x7 rods was selected for the experiment. It was divided into four plots each 6 rods long and $1\frac{3}{4}$ rods wide. On March 2, freshly slacked lime was applied to these plots as follows:—

Plot 1.—3 bbls. or about 45 bbls. per acre.

Plot 2.—2 bbls. or about 30 bbls. per acre.

Plot 3.—1 bbl. or about 15 bbls. per acre.

Plot 4.—No lime.

On March 3 a very heavy rain fell so that it was necessary to replow the land before planting. On March 20 furrows were opened crossing these four plots, and fertilizer consisting of equal parts cottonseed meal, acid phosphate and kainit was dropped in the furrow at the rate of 8 lbs. per row (about 800 lbs. per acre), and bedded on. On April 1 the tops of the beds were leveled down nnd planting was begun. The following is a list of the crops planted and the results noted with each.

Row 1.—Abundance pea. Seeds did not come as quickly on the limed as on the unlimed land. The plants on plots 3 and 4 had dark green foliage and made a good half crop. On plot 2 the foliage was lighter, and it made about one third of a crop. On plot 1 the plants were scattering and very pale and sickly; crop a failure. In this case the lime did no good. Small applications did no harm, but the heavier ones were very harmful.

Row 2.—White dent corn from Northern Alabama planted in hills two and one half feet apart, and thinned to two plants in the hill. Plot 1 fine, foliage dark green, ears well filled out and of fair size, a good crop. Plot 2, a little lighter color but nearly as good. Plot 3 almost a failure. Plot 4 a complete failure; it burned out with the drouth. [This corn was evidently planted too thick for good results on thin land, which makes the success with the heavy liming the more gratifying. F. S. E.]

Row 3.—German millet. Plot 4, good stand, fine crop, four feet high. Plot 3, good stand, fair crop, three feet high. Plot 2, poor stand, almost a failure, two feet high. Plot 1, very scattering, a failure, one foot high. [Here, as with the peas, the caustic effect of the freshly applied lime was markedly injurious.]

Row 4.—Mayflower tomato. The plants were transplanted from a seed bed. All grew well at first, but as the plants became older, plot 4 all blighted so badly that no fruit was obtained. Plot 3 was a little better, but two-thirds blighted. Plot 2 was much better; no blight was seen, the crop was fair, but the foliage was a little off color. Plot 1, plants extra fine, good color, and no signs of blight or other disease. The boll-worm did not seem to trouble this plot as badly as the others. A noticeable point in connection with this plot was that the vines remained green till frost, and still carried flowers and fruit, while on the other plots all were dead and dried up.

Row 5.—Early Valentine beans. No difference could be noted with this crop. After the dry weather came on all the plots were a failure.

Row 6.—Ruta Bagas. They did nothing; a failure on all the plots. [Entirely too late for success with this crop.]

Row 7.—Scarlet button radish. Crop good on all plots. The lime seemed to make no difference.

Row 8.—Lettuce; Black-Seeded Simpson. Plot 4, crop fair. Plot 3, good crop. Plot 2, still better. Plot 1, much the best. It was extra good, and the plants remained green all summer.

Row 9.—Egg Plant. Set with transplanted plants. All plots grew much alike till the first fruits set, when the plants on the limed plots blighted badly. The unlimed plot made a fair crop. [It is hard to reconcile this result with that obtained with tomatoes. It is possible that the death of the plants on the limed plots was due to some other cause than the bacterial blight.]

Row 10.—Abundance pea, fertilized and planted ten days later. A failure. [Entirely too late for this crop.]

Row 11.—Brazilian corn and Florida butter beans. The corn grew fairly well, but had the best ears and the best color on plot 2. The beans were all about alike. They stayed green and bore fruits and blossoms till frost.

Rows 12, 13 and 14.—Amber Sorghum, Northern seed. No difference on the different plots; all small.

Rows 15, 16 and 17.—Stowels Evergreen sweet corn. All failed.

Rows 18 and 19.—Spanish peanuts. The limed land had the largest vines and the most nuts. On the no-lime plot the vines were light and had less fruit.

Row 20.—Seed-leaf tobacco, home-grown seed. Plants set May 12. The limed plots all a good crop, the no-lime plot almost a failure.

Row 21.—Livingston Favorite tomato. Plants transplanted May 12, but owing to the drouth the crop was a failure.

Row 22.—Okra, planted May 12. No difference—a fair crop on all plots.

Rows 24 and 25.—Irish potatoes, planted July 8. The seed seemed immature and came up poorly. No difference in growth of top, but the tubers were largest on plot 1.

Row 26.—Early Valentine beans, planted July 22. Plot 3 gave the best results, better vines and more fruit.

Row 27.—Flax, Northern seed. Complete failure; the seed would not germinate.

Rows 28, 29 and 30.—Kaffer corn, planted August 1. All grew and fruited splendidly, a little the tallest on the limed land.

Rows 31 and 32.—White Spine cucumber, planted July 22. No difference in vine or fruit. All badly injured by insects.

A. W. ORR.

DEER PARK, ALA., February 14, 1898.

BULLETIN No. 93. APRIL 1898.

ALABAMA

Agricultural Experiment Station

OF THE

AGRICULTURAL AND MECHANICAL COLLEGE,

AUBURN.

PEANUTS, COWPEAS AND SWEET POTATOES AS FOOD FOR PIGS.

J. F. DUGGAR, Agriculturist.

BIRMINGHAM
ROBERTS & SON.
1898

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Peanuts, Cowpeas and Sweet Potatoes as Food for Pigs.

BY J. F. DUGGAR.

SUMMARY.

Spanish peanuts, when harvested by young pigs, were converted into pork, worth, at 3 cents per pound, $18.34 per acre of peanuts, when all conditions were favorable.

In another field, with only half a stand of plants, the value of the pork from an acre of Spanish peanuts was $10.94 and $7.83 in two experiments.

Under favorable conditions pork (live weight) was produced at the rate of 1,426 pounds per acre of peanuts, supplemeted by 37.8 bushels of corn.

With half a stand of plants an acre of Spanish peanuts produced, unaided, pork at the rate of 261 pounds per acre, and at the rate of 840 pounds per acre when the acre of peanuts was supplemented with 35.6 bushels of corn.

When fed to pigs in pens only 2.8 pounds of unhulled Spanish peanuts were required to produce each pound of increase in live weight. This is equal to 9 pounds of increase, worth 27 cents, as a return for each bushel of peanuts eaten.

Shoats pastured on nearly mature cowpeas and supplied with corn made almost three times the gain in live weight made by similar shoats fed exclusively on corn.

The cowpea crop was above the average, and its value in 3-cent pork, after subtracting the cost of the corn fed, was $10.65 per acre.

Shoats fed in pens gained more rapidly in weight on a

ration of ground cowpeas and corn than on ground corn alone. In effect 5.28 pounds of this mixed food was equal to 8.06 pounds of ground corn.*

Three pounds of sweet potatoes proved decidedly inferior to one pound of cornmeal.

Cowpeas fed with corn did not injuriously affect the quality of pork or lard. Peanuts, when fed with corn, greatly softened the pork and lard.

The softening effect of peanuts was still greater when they constituted the sole food.

This softening effect of peanuts was not corrected by feeding exclusively on corn for a month before the date of slaughtering.

THE PIGS FED.

The experiments recorded in this bulletin were begun Sept. 8, 1897, and concluded Feb. 16, 1898. All the animals used were growing pigs, varying in size at the beginning of the different experiments from pigs just weaned to half-grown shoats. The results obtained apply to the class of animals here used, and not necessarily to nearly mature fattening hogs.

In every experiment an abundance of ash material was insured by a daily supply of hardwood ashes, unleached, and salt. The weighing of pigs and of food, of which more than 2,500 were made during the course of these experiments, and other details, were attended to by Mr. T. U. Culver, Farm Superintendent.

FEEDING EXPERIMENTS WITH PEANUTS.

PASTURING PEANUTS.

A lot of 6 Poland China pigs immediately after weaning were enclosed with a portable fence in a field of Spanish peanuts. The aim was to ascertain the amount of pork that could be produced by a given area of this crop.

The pigs were not allowed to range over the entire field but were kept on a small area until all the peanuts were eaten, the inclosure being moved as often as necessary. Shelled corn was fed daily, so as to make growth more rapid.

From the first day, the nuts were eaten with great relish, and as long as the vines remained green and tender a large proportion of the leaves were also eaten. The pigs were placed on the peanuts September 8, when the crop of nuts was not yet fully matured. The peanuts had been planted May 5.

Before beginning to weigh the pigs, a week was allowed for them to become thoroughly accustomed to their food. Afterwards weekly weighings were made.

At the beginning of the experiment the 6 pigs weighed 184.3 pounds; at the end of the experiment six weeks later, they weighed 380.7 lbs., having more than doubled their weight in six weeks.

The gain was 196.4 pounds. To produce this growth there were eaten 373 pounds of shelled corn, and all of the peanuts and some of the leaflets on an area of 7,673 square feet, which is a little more than one-sixth of an acre.

The following is the financial statement of the above result, valuing pork at 3 cents per pound gross and corn at 40 cents per bushel:

	DR.	CR.
By 196.4 lbs. pork at 3c..................		$5.89
To 373 lbs. corn at 40c per bu............	$2.66	
To balance; value of 7,673 sq. ft. in peanuts	3.23	
	$7.53	$7.53

A profit of $3.23 on 7,673 square feet is at the rate of

$18.34 per acre. If corn were valued at 50 cents per bushel the net returns for an acre of peanuts would be reduced to $14.86 after subtracting the value of the corn.

Here we have over $18 per acre as the return for peanuts converted into pork. It should also be remembered that the land was enriched not only by the manure but by the peanut vines, for the peanut is a soil-improving plant, drawing a part of its nitrogen, like the cowpea, from the air. The nuts on a part of the patch were dug, and the yield was at the rate of 1,565 lbs. (62.6 bushels) of dry nuts per acre.

Thus we have as the total food required to produce 1 lb. of gain 1.4 lbs. of peanuts and 1.9 lbs. of corn, or a total of 3.3 lbs. of concentrated food and an indefinite amount of leaflets.

To put the matter in another way, one acre of peanuts, supplemented by 2,117 lbs. of corn or 37.8 bushels, afforded 1,115 pounds of pork.

This piece of poor sandy upland which gave a return of over $18 per acre in peanut pork, would not have produced with same fertilizers, over 200 pounds of lint cotton per acre worth $10 to $12. The expense of cultivating these peanuts was much less than the cost of a similar area in cotton.

PEANUT PASTURAGE VS. CORNMEAL.

On another field of fertility about equal to the preceding, Spanish peanuts were planted June 24, following wheat, which had been harvested about a month before. An exceptionally dry summer was the cause of a very poor stand. The plants on a number of rows were counted, and instead of the usual average of one plant for every 18 or 20 inches of drill, the average distance between plants was nearly four feet.

In this field another experiment was made in pasturing peanuts. Nine Essex pigs, of similar breeding, and from two litters differing in age by only three days, were used. They had been recently weaned and were decidedly inferior in feeding qualities to the Poland Chinas used in the preceding experiment. They were divided into three lots of three pigs each.

Lot V was hurdled on the above mentioned peanuts, and in addition was given daily what corn meal the pigs would eat. Lot VI was also hurdled as before, but received no grain. Lot VII was confined in a dry lot and given all the ground corn they would eat, and nothing else.

The experiment proper began November 4 after a week of preliminary feeding. During the next four weeks the gains made were as follows:

The lot pastured on peanuts and given corn gained 38.6 lbs.
The lot pastured on peanuts gained 21.1 lbs.
The lot receiving only corn lost 5.1 lbs.

Lot V ate 2.06 pounds of corn, for every pound of growth made, and during four weeks grazed on an area of 2,025 square feet planted in peanuts.

This is at the rate of 840 pounds of growth from one acre of peanuts (with less than half a stand) and 1710 pounds (35.6 bushels) of cornmeal. With pork at three cents per pound and cornmeal at 40 cents per bushel of 48 pounds, this is a gross return of $25.20 and a net return (after subtracting the value of the meal) of $10.94 per acre of peanuts.

Lot VI, on peanuts without grain, pastured an area of 3,517 square feet, and the gain made was 21.1 pounds, which is at the rate of 261 pounds of pork per acre. At three cents per pound gross for pork, this gives a value of $7.83 to the acre of peanuts on which there was only half a stand of plants.

Bearing in mind the defective stand in this field, it is safe to conclude that pigs under 100 pounds should convert an acre of peanuts into pork worth from at least $12 to $20, the higher net value of an acre of peanuts being obtainable when the pigs receive in addition a moderate allowance of corn or cornmeal.

The peanut is certainly worthy of a foremost place in the list of hog crops. The Spanish variety can be used for the early crop, and also for planting after oats, the common running variety for the late fall crop. It is highly desirable to arrange a succession of peanut crops rather than to have large areas ripen at the same time, for in wet weather Spanish peanuts will not remain long in the ground after maturity without sprouting.

PEANUTS VERSUS CORNMEAL.

A more accurate measure of the nutritive value of the nuts was desired than could be obtained in grazing experiments.

Hence for a further period of six weeks all three lots were fed in pens on weighed quantities of food.

Lot V. received equal weight of cornmeal and unhulled Spanish peanuts; Lot VI., peanuts alone; and Lot VII., now reduced to two pigs by the removal of the most unthrifty at the end of the pasturage experiment, continued to receive only cornmeal.

During the period of six weeks ending Jan. 13, 1898, the results were as follows:

Peanuts and cornmeal vs. peanuts alone and cornmeal alone.

	Gain.	Lbs. of food per lb. of gain.
	Lbs.	*Lbs.*
Lot V.—One-half peanuts, one-half cornmeal...	84.0	3.7
Lot VI.—Peanuts..............................	59.5	2.8
Lot VII.—Cornmeal............................	8.6	10.7

In this experiment a pound of peanuts, including hulls, was worth more for young pigs than a pound of cornmeal. These young pigs were able to make a growth of 9 pounds per bushel of Spanish peanuts when no other food was allowed. This gives a food value of 27 cents to a bushel of

Spanish peanuts when pork is worth 3 cents per pound, gross, and 31½ cents when pork is worth 3½ cents per pound.

The unfavorable effects of long continued feeding of an exclusive corn ration to young pigs is shown in the above table. The unthrifty appearance of the pigs eating nothing but corn was a startling commentary on the financial loss following such a course.

The addition of corn to the peanut ration increased the total gain, but it required more of the mixed food than of peanuts to produce a pound of increase.

FEEDING EXPERIMENTS WITH COWPEAS.

COWPEA PASTURAGE FOR SHOATS.

September 8, 1897, six Essex shoats, all of the same litter and averaging 50.1 pounds each, were divided into two lots, one lot weighing 152.7 pounds, the other 148.2. Lot I, which was slightly the heavier, was confined to a dry lot and fed as much shelled corn as the shoats would eat. Lot II was confined by hurdles to a field of cowpeas of the variety Wonderful or Unknown.

The soil of this field was sandy upland of a better grade than the ordinary upland soils of this locality. The stand of cowpeas was thin and the rows were about four feet apart. Nevertheless the yield of dry peas on the portion of the field from which peas were picked, was at the rate of 13.2 bushels per acre, which is considerably above the ordinary yield.

When the pigs were placed in the field the leaves were all green and only about one-half of the peas had taken on the color of maturity. The other pods were all green, but most of them had attained full size. As long as the leaflets continued succulent and green, they were readily eaten. In the latter half of the experiment only the seed was eaten.

Before the beginning of the experiment proper, the usual preliminary period of a week was allowed for the pigs to get accustomed to their rations. Both lots received hardwood ashes and salt regularly.

During the 6 weeks covered by this portion of the experiment, the results were as follows:

Corn vs. cowpea pasturage and corn.

	Gain.	Lbs. corn eaten.	Lbs corn per lb. gain.
	Lbs.		
Lot I.—Corn alone................	45.2	263.8	5.86
Lot II.—Cowpea pasturage and corn	122.0	374.0	3.07

When corn was fed alone it took nearly twice as much corn to make a pound of growth as when the pigs had access to both corn and cowpeas. The pigs on pasture had a better appetite, ate more corn, made nearly three times as much growth as the pigs on an exclusive corn diet, and made that gain at less cost per pound.

Assuming that the whole field was similar to the area on which the peas were weighed, yielding at the rate of 13.2 bushels per acre, the area of 7,280 square feet, on which the pigs were pastured during six weeks, yielded 132 pounds of shelled cowpeas. This is equal to 1.1 pounds of cowpeas, together with 3.07 pounds of corn, for every pound of growth made by the pigs. Thus we have 4.17 lbs. as the total amount of mixed grain required to produce one pound of growth, against 5.86 pounds of corn, when corn was fed alone. The better effects of the mixed ration may be due to one or all of the following causes:

(1.) To the undetermined amount of leaflets eaten;

(2.) To the more nitrogenous character (or better quality) of the mixed ration;

(3.) To the better appetites of the pigs on a mixed diet, resulting in the consumption of a larger quantity of corn and in more rapid fattening than occurred with the lot on an exclusive corn diet. It is a well established principle that rapid fattening of pigs is effected with less food per pound of growth than is slow fattening.

The financial statement for Lot II is as follows—based on pork at 3 cents per pound and corn at 40 cents per bushel:.

	DR.	CR.
By 122 lbs. of live pork at 3c. per lb.		$3 66
To 263.8 lbs. of corn at 40c. per bu.	$1 88	
To balance: Value of 7,280 sq. ft. in cowpens	1 78	
	$3 66	$3 66

This is at the rate of $10.65 per acre. This is certainly not a large return for an acre, but to this value of pork produced by an acre of cowpeas should be added the fertilizer value of the vines, which is considerable, as every farmer knows. There is reason to believe that vines and excrement on a field where pigs have grazed are worth practically as much for fertilizing purposes as the vines on a similar area not grazed.

A return of $10.65 per acre, a figure which was obtained from an acre capable of yielding 13.2 bushels of peas, is not to be expected from land poorer than that used in this experiment.

It was planned to duplicate the experiment just detailed, using two Essex sows and their litters, both of the same age and breeding. A few days after farrowing, one sow and her litter were placed in hurdles on the cowpea field referred to above; as much shelled corn was fed as this lot would eat. The other sow, with her litter, received only corn. The experiment was brought to a premature close by the sudden death (from hog cholera and swine plague) of the sow receiving only corn. During three weeks, when both sows were in health, the sow and six pigs on cowpea pasture and supplied with corn made a total gain of 29.9 pounds. The other lot, a sow and seven pigs, receiving only corn, lost during this period 9 pounds. As usual just after farrowing, both sows lost weight—the one on corn alone 42 pounds, the other 9.1

pounds. The seven pigs suckling the corn-fed sow gained 33 pounds; the other lot gained 39 pounds.

GROUND COWPEAS AND CORN VERSUS GROUND CORN ALONE.

At the conclusion of the grazing experiment just noted, the same pigs were used in another experiment closely related in aim to the preceding.

Lot I. was continued on an exclusive corn ration. Lot II. received equal weights of corn and shelled cowpeas. The food for both lots was ground, and both lots were kept in covered pens, with small yards adjoining.

After the usual preliminary period of one week, the experiment proper was begun Nov. 4, 1897, and continued until Jan. 3, 1898.

During this period of 70 days the results were as follows:

Ground corn versus ground cowpeas and corn.

	Gain.	Food eaten.	Lbs. food per lb. of gain.	* Nutritive ratio of food.
	Lbs.	*Lbs.*	*Lbs.*	
Lot I.—Ground corn alone.................	68.0	548.2	8.06	1 to 9.7
Lot II.—½ corn, ½ cowpeas (ground).......	108.0	569.9	5.28	1 to 6 2

* The nutritive ratio of a food is the ratio of the digestible nitrogenous matter contained in it to the sum of the digestible fats, sugars, starch and other non-nitrogenous organic matter. The digestibility of cowpeas was assumed to be the same as that of Canada field peas.

The above table shows that the gain made was much greater with the mixed ration of corn and cowpeas than with corn alone. It required to make one pound of growth more than 8 pounds of ground corn fed alone; less than 5⅓ pounds of the mixed grain produced the same result.

SWEET POTATOES VERSUS CORNMEAL.

The 6 Poland China pigs employed in the first experiment described in this bulletin were divided at the conclusion of that test, into 2 lots of three each, one lot weighing 191.5 pounds, the other lot 189.2 pounds.

After a week in which to accustom the pigs to their new food the experiment proper, which consisted of two periods of 28 days each, was begun November 4.

During the first period Lot III received a ration consisting of three parts by weight of sweet potatoes and one part ground cowpeas. During this period Lot IV was fed on a ratio made up of equal weights of ground corn and ground cowpeas.

Since more than two-thirds of the weight of sweet potatoes is water, more than half of the ration of sweet potatoes and cowpeas was water. The other ration contained but little moisture, probably 10 or 12 per cent.

The effort was at first made to feed equal weights of dry matter to each lot. This required that each lot should consume equal weights of peas and that for every pound of corn eaten by Lot IV three pounds of sweet potatoes should be eaten by Lot III. Lot III could not be induced to eat the desired quantity of sweet potatoes. Hence each lot was fed all it would eat of its special ration.

At the end of 28 days, the rations were reversed, the pigs which had formerly eaten sweet potatoes and cowpeas being now given corn and cowpeas, and *vice versa*. More than a week was allowed for both lots to become accustomed to their changed rations. Then the second period of the experiment, consisting of 28 days was begun December 16.

The results for both periods are plainly stated in the following table:

Sweet potatoes vs. ground corn.

	Gain.	Food eaten.	Lbs. food per ℔ of gain.	*Dry matter per pound of gain.
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*
First period.				
Lot III. { ¾ sweet potatoes / ¼ cowpeas (ground)	36.7	431 0	11.74	5.28
Lot IV. { ½ corn / ½ cowpeas } (ground)	78.5	255.8	3.42	3.08
Second period.				
Lot VI. { ¾ sweet potatoes / ¼ cowpeas, (ground)	29.1	446.7	15.35	7.00
Lot III. { ½ corn / ½ cowpeas } (ground)	51.7	265.	5.11	4.60
Totals for 8 *weeks* (1*st and* 2*nd periods*)				
Ration of { ¾ sweet potatoes / ¼ cowpeas, (ground)	65.8	877.7	13.34	6.00
Ration of { ½ corn / ½ cowpeas } (ground)	130.2	520.8	4.00	3.60

*Assuming 90 per cent. of dry matter in corn and peas and 30 per cent. dry matter in sweet potatoes.

In both periods of the experiment the ration containing sweet potatoes was decidedly inferior to that containing corn.

Taking the results for the entire eight weeks covered by the two periods of the experiment, the increase in live weight was nearly twice as great with the ration containing corn as with the other. In order to produce a pound of increase in live weight there was required 13⅓ pounds of the ration made up of sweet potatoes and cowpeas, or 4 pounds of the ration of corn and cowpeas.

Making allowance for 70 per cent. of water in the potatoes and 10 per cent. in each of the grains, there was required to make a pound of increase 3.6 pounds of dry matter in the grain ration and 6 pounds of dry matter in the sweet potato ration.

This result, so disadvantageous to sweet potatoes, was probably due in part to the fact that the pigs would not eat a sufficient quantity of the bulky ration to obtain the same amount of dry matter as was furnished by full rations of the more concentrated mixture.

By feeding a ration made up of equal weights of sweet potatoes and cowpeas, the daily consumption of nutritive materials would doubtless be increased, and on such a ration we might expect results more favorable to sweet potatoes. Again, hogs rooting in potato fields might eat larger quantities of sweet potatoes.

But the difference is apparently too wide to be ascribed wholly to the amount of food eaten. The figures suggest that the dry matter of sweet potatoes is inferior in composition or in digestibility to that of corn.

The results show that under the conditions of this experiment one pound of corn was worth much more than three pounds of sweet potatoes. These figures do not enable us to place an exact value on potatoes, but indicate that pricing corn at 40 cents per bushel, sweet potatoes were worth less than 13 cents per bushel of 56 pounds. (The legal weight of a bushel of sweet potatoes varies in different states.)

If corn were worth 50 cents per bushel, these results would give to sweet potatoes a value considerably below 17 cents. Probably 10 and 12 cents per bushel would be a closer estimate of the nutritive value of a bushel of potatoes fed with cowpeas in the proportions employed in this experiment.

It is plain that sweet potatoes could not profitably be grown, stored, and fed to hogs, even if each bushel could be converted into pork worth 10 to 15 cents. This does not imply that sweet potatoes cannot be profitably employed as food for hogs. But a profit is possible only by saving the expense of harvesting, the heaviest single item of expense in sweet potato culture. If the hogs do the rooting, the sweet potato is doubtless a cheaper food than corn on some sandy soils that yield ten to fifteen times as many bushels of sweet potatoes as of corn. The vines are also valuable as food for hogs.

The value of sweet potatoes will be enhanced by feeding with them a liberal allowance of cowpeas or peanuts, which supply the nitrogenous material in which the sweet potato is deficient.

EFFECT OF COWPEAS AND PEANUTS ON QUALITY OF PORK.

The feeding experiments with pigs conducted by the Agricultural Department of this Station during the last two years have been chiefly concerned with a comparison of the nutritive values of cowpeas, peanuts, sweet potatoes, corn and other products of Southern farms. The great aim has been to accumulate information which might make plain the methods of producing pork at the least possible cost and with greatest profit.

Attention has also been given to the effects of various foods on the quality of pork. Certain packing houses paid during the past winter extra prices for hogs that afforded the best quality of pork, that is pork with the largest proportion of lean meat. Whether such pork would bring an advanced price or not, it is certainly important that pork for the family table should be of the best quality. While pork from a thin mature hog is not desirable, lean pork from well nourished animals is more nutritious, or contains more of the very valuable nitrogenous material, than does pork that has an excessive proportion of fat.

Both in these experiments and in those recorded in Alabama Bulletin No. 82 the proportion of lean meat was greater in a ration made up of equal weights of cowpeas and corn than with an exclusive corn diet.

One of the corn fed pigs was very thin throughout the latter half of the experiment and yet when the carcass was examined a marked deficiency in muscular development was noted.

Two pigs from each of Lots I, II, V, VI, and VII were carefully examined with reference to the weight of internal organs and amount of fat on stomach, intestines and kidneys. The results showed that the fat on stomach, and intestines constituted 4.20 per cent of the net weight of the pigs fed on corn alone and only 2.43 per cent. of the net weight of those fed on a mixture of cowpeas and corn. There was also a slightly greater percentage of kidney fat on the lot fed on corn.

The pork resulting from feeding a mixture of corn and cowpeas was scarcely distinguishable in appearance from that produced by exclusive corn feeding.

EFFECT OF FOODS ON QUALITY OF LARD.

Fat of pigs from Lots I., II., V., VI. and VII. was rendered into lard. It was evident that the firmness of this lard was greatly effected by the kind of food. Samples of lard were sent to the chemist of the Experiment Station, Prof. B. B. Ross, with a request that he determine the melting points of each sample. His report is given below:

Effects of food on melting point of lard.

Lot. No.	Pig. No.	FOOD.	Lard from body fat, or kidney fat, or both	Melting point of lard.	
				Degrees Fahrenheit.	*Degrees Centigrade.*
II.	48	½ cowpeas, ½ corn.	Leaf lard.	114.8	46.0
II.	48	do do	Body lard.	112.1	44.5
I.	47	Corn (large, fat shoat)	Leaf lard.	113.0	45.0
I.	47	do do	Body lard.	109.4	43.0
VII.	63	Corn (small, poor pig)	Leaf and body lard.	109.4	43.0
VI.	61	½ peanuts, ½ corn.	Leaf and body lard.	104.1	40.5
V.	58	Peanuts.	Leaf and body lard.	76.1	24.5

As pig No. 47 was in good condition when killed, and as No. 63 was not, the lard from the former may be safely taken as the more correct standard for lard from hogs fed exclusively on corn. The average of the melting points of leaf lard and body lard from this pig gives 111.2 degrees Fahrenheit as a standard. The average melting point of lard from the pig fed on cowpeas and corn was 113.4 degrees, or 2.2 degrees higher than that of corn lard. When equal weights of peanuts and corn were fed, the melting point of the lard was reduced 7.1 degrees Fahrenheit below the standard. When peanuts constituted the entire ration the melting point was lowered by 35.1 degrees.

Lard from exclusive peanut feeding solidified only during the coldest weather of February, at other times in February and March becoming almost a semi-liquid.

The low melting point, or want of firmness of lard, made from peanuts, injures its sale. However, cooking tests fail to reveal any real inferiority.

As shown by the above table, leaf lard was slightly firmer than body lard.

It is a common practice among farmers whose hogs depend largely on peanuts, sweet potatoes and acorns, to feed corn exclusively in the two or four weeks immediately preceding the date of butchering. The aim is to harden the meat.

With the aim of learning to what extent pork can be hardened by this process, one pig from each of the pens receiving peanuts or cowpeas, was placed on an exclusive corn diet after the conclusion of the experiments described above. This corn ration was continued for one month. Then the pigs were slaughtered, the fat rendered into lard, and the melting points again determined by Professor Ross, with the following results:

Melting point of lard from pigs, fed on various ration, but on corn alone during the last month of life.

Lot No.	Pig No.	Food up to 1 mo. before killing.	Food for 1 mo. before killing.	Melting point of lard.	
				Degrees Fahrenhe't	*Degrees Centigrade*
II.	45	½ cowpeas. ½ corn.	Corn.	109.4	43.0
V.	56	½ peanuts. ½ corn.	Corn.	98.6	37.0
VI.	59	Peanuts.	Corn.	101.3	38.5

The month of corn feeding had a marked effect in raising the melting point from 76.1 degrees (No. 58) up to 101.3 degrees, a temperature which was still considerably below that of corn lard.

The month of corn feeding did not raise the melting point of the two samples of lard from pigs which prior to that period had received for several months a ration consisting of half corn and half peanuts. In fact, the melting points at the end of the month of exclusive corn feeding were several degrees lower than at the beginning, a variation which was probably due to individual peculiarities of the different animals from which the samples of lard were made.

Even after the month of exclusive corn feeding, the lard and pork from pigs formerly receiving peanuts were conspicuosly more oily and softer than ordinary lard and pork.

After one month of corn feeding, cooking tests of small sections of pork from Nos. 45, 56 and 59 were made by two families. One report was as follows :

"The corn and cowpea sample [Lot 2] looked and cooked like all corn-fed pork; very little shrinkage; flavor very fine and delicate. The all-peanut sample [Lot VII] was rather soft.

It shrank more than the other in cooking, but the flavor was peculiarly sweet and rich. It was preferred to either of the others by some of the family. The corn and peanut sample was intermediate in character. All were pronounced very good, much better than the average pork of the market."

The other report was substantially the same except that the samples from the lots fed on peanuts alone, and peanuts and corn, were not distinguishable in flavor. Even after cooking, the samples from the lots fed partially or exclusively on peanuts were more oily and less firm than ordinary pork.

In brief, one month of exclusive corn feeding increased the firmness of pork made from animals previously fed on peanuts alone, but the improvement was not sufficient to make the flesh or the lard as firm as the same articles afforded by animals fed entirely on corn. Further experiments in this direction are planned.

APPENDIX.

Lungs, heart, spleen, liver, kidnegs, fat on stomach and intestines, and fat around kidneys in percentages of dressed weight (dressed weight=100); also actual dressed weight in pounds:

Lot.	Pig—Number.	Lungs.	Heart.	Spleen.	Liver.	Kidneys.	Fat on stomach and intestines.	Fat around kidneys.	Dressed weight.
		%	%	%	%	%	%	%	*Lbs.*
I........................	44	.81	.20	.099	2.91	.240	4.85	6.75	50.4
I........................	47	.62	.27	.140	3.03	.250	3.55	4.85	124.4
I........................	Av	.72	.24	.120	2.97	.245	4.20	5.80	87.4
II........................	46	.52	.20	.090	2.10	.280	2.17	5.90	123.9
II........................	48	.61	.31	.180	1.98	.310	2.69	5.11	93.8
II........................	Av	.57	.26	.135	2.04	.295	2.43	5.50	108.9
V........................	60	1.13	.30	.090	4.34	.540	3.08	7.00	33.4
V........................	61	.64	.34	.230	2.84	.350	4.32	5.53	68.5
V........................	Av	.89	.32	.160	3.59	.445	3.70	6.27	51.0
VI........................	57	1.32	.42	.170	4.77	.310	4.80	6.40	28.9
VI........................	58	1.01	.39	.160	3.95	.440	4.52	6.94	38.5
VI........................	Av	1.17	.41	.165	4.36	.375	4.66	6.67	33.7
VII........................	62	1.29	.36	.140	8.63	.360	1.08	2.52	13.9
VII........................	63	1.98	.48	.190	3.09	.430	4.20	4.37	20.7
VII........................	Av	1.64	.42	.175	5.86	.395	2.64	3.45	17.3

BULLETIN NO. 94. JUNE 1898.

ALABAMA

Agricultural Experiment Station

OF THE

AGRICULTURAL AND MECHANICAL COLLEGE,

AUBURN.

STRAWBERRIES.

F. S. EARLE.

BIRMINGHAM
ROBERTS & SON.
1898

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☞ The Bulletins of this Station will be sent free to any citizen of the State on application to the Agricultural Experiment Station, Auburn, Alabama.

Strawberries.

BY F. S. EARLE.

No fruit is of easier culture and none succeeds under more widely varying conditions of soil and climate than the strawberry. Ripening as it does with the first warm days of spring, its acid juice is particularly refreshing and seems to have been fitted by nature to the needs of the system at this season. There can be no doubt that the free use of strawberries adds not only a pleasant and agreeable, but a very healthful feature to the spring bill of fare. This fact is appreciated by the people of the northern cities as is shown by the immense and annually increasing quantities of this fruit that find sale in these markets. Growing the berries to supply this enormous northern demand, now furnishes one of the principal and most remunerative industries for a large number of southern communities; and it is recognized as one of the most important of horticultural money crops. As has been previously pointed out, (see Bull. 79:85) the people of this state have so far paid but little attention to commercial horticulture, although we possess a climate and soils as well adapted to the growing of fruits and vegetables as any of our neighbors. There are but few points in Alabama where strawberries are grown in sufficient quantity for shipment. Cullman, in Cullman county, on the Louisville and Nashville Railroad, is the largest shipping point.

In the opinion of the writer the strawberry acreage of the state could be largely increased with profit, and with less chance of loss than with most other horticultural crops. This is a point however that must be left to the individual judgment of planters. I wish however to again call attention to the necessity of carefully studying the requirements of the business, and of its adaptability to local conditions; and especially to the necessity of providing refrigerator transportation facilities before embarking heavily in the business. This, of course, where shipment to the great northern markets is the object. This necessary requirement of the best possible transportation facilities will confine the large planting of berries to a few shipping centers. For this reason, persons coming to the state for the purpose of growing berries are earnestly advised to locate at some point where the business is already established.

There is, however, a considerable home market that is now very inadequately supplied, and that might well repay the attention of a great number of scattered growers. Every family in Alabama ought to have this healthful and delicious fruit on the table every day for six or eight weeks; but not one in ten—no, not one in fifty—is thus liberally supplied. There are few families in the state outside of some of the larger cities who could not command the small amount of land and labor to raise an abundant home supply, and thus enjoy the luxury of having them fully ripened and freshly gathered as needed. Many people will, however, buy berries if offered in attractive shape and at a reasonable price, who would not take the small amount of trouble necessary to grow them. There is not a town of any size in the state where one or more farmers could not make a substantial addition to their income by planting an acre or so of strawberries and marketing them regularly. At first the demand might be small but it would grow rapidly if stimulated by a constant supply, for people soon learn to eat much more fruit if it is constantly at hand in tempting condition. If even a small per cent. of the people of the state can be induced to plant more berries for home consumption, this Bulletin will have accomplished its purpose. The larger commercial growers are mostly in possession of the information it contains.

Soils and Fertilizers.

Any fairly good, well drained soil will answer for growing strawberries for home use or for local markets. A soil that holds moisture well is preferable to one that is too dry, but on the other hand, hill land is preferable to bottom land on account of its greater freedom from spring frosts. For growing berries for distant shipping a strong, rather stiff clay soil is greatly to be preferred to one that is sandy, because berries grown on such clay soils are firmer and carry to market in much better condition. This is a point of great practical importance to the distant shipper.

Land that is full of foul weed seed or that is set to Burmuda, coco or Johnson grass should not be selected for strawberries on account of the greatly increased labor and expense of cultivation. All but very rich land should be liberally fertilized to secure the best results, though some fruit may be expected without fertilizers even on quite thin soil. Stable manure is not advised under most circumstances on account of the danger of introducing grass and weed seeds. The proper mechanical condition and ability to resist drouth can best be secured by plowing under a crop of cow-peas well in advance of planting. This green manuring should be supplemented by applications of acid phosphate and potash under the row. Too large a proportion of nitrogen is not desirable, since it sometimes causes a rank growth of vines at the expense of fruit, and renders the plant more liable to suffer from rust. A light top dressing of nitrate of soda applied in the spring just before blooming is often useful in increasing the size of the fruit.

Preparation of Soil and Planting.

The land for strawberries should be deeply plowed, and the plow should be quickly followed by the harrow, not once, but three or four times in a place so as to pulverize all lumps before they harden into clods, and to cover the entire surface with a coating of fine mellow soil to prevent undue evaporation. This quick harrowing of the soil immediately after breaking is of the utmost importance for all crops, especially on stiff lands, and it is a point that many farmers overlook. In only too many cases the rough furrows are allowed to lie and bake into clods that it may require weeks of labor to pulverize, while the moisture that should be sealed up and preserved in the ground by the harrow for the use of the coming crop is allowed to evaporate and waste.

About ten days before planting lay off the ground with a shovel plow, running the rows three to three and a half feet apart. Scatter the fertilizer in the furrow, mix by running once or twice with a scooter, and then bed as if for cotton. Just before planting drag the beds down with the back of the harrow, or with a heavy plank drag so that the top of the bed will not be more than two or three inches higher than the water furrow. This will drag all trash or clods to the middles, and will leave a bed of moist, mellow, but slightly compacted soil to receive the plants.

When the plants are taken up, the old leaves and runners should be pulled off and the plants should be bunched with the roots all lying one way. It is not necessary to tie the bundles except where they are to be sold by count. Pack them closely side by side, if in a box with the roots down, or if in a barrel with the roots to the center. Always keep plants covered with dampened sacks to prevent drying. When ready to begin planting, put an inch or two of water in an ordinary wooden bucket and pack in a layer of plants with their roots in the water, this keeps them fresh and also causes the soil to adhere more closely to the roots when planted. The planting crew consists of a man with a bright, sharp spade, and a small boy with the bucket of plants. The man sets the spade in front of him, with the corner of the blade at the spot where the plant is to stand, throws his weight on it, driving the sharp blade full length in the mellow soil, and then pushes it from him so as to open a wedge shaped hole behind the spade. The boy has a plant ready, holding it by the top, and with a slight swinging motion, brings the plant to its place in the corner of the hole, with its roots extending full length, and the crown held just at the surface of the ground. The man withdraws the spade, setting it forward ready for the next plant, and as the dirt falls back about the plant he puts his foot on it, pressing it closely about the roots. With a little practice, plants can be set in this way very rapidly and satisfactorily. There are just two points to keep in mind. First, the plant must be left at the right depth—not so deep as to cover the bud, nor so shallow as to expose the roots—and, second, the dirt must be packed closely about the roots. This last can be easily tested by taking hold of the plant by one leaf and trying to pull it up; if properly set, the leaf will break without loosening the roots. Directions are often seen in print for "spreading the roots out like a fan," or for making a hole with "a mound in the middle, round which the roots can be placed in a natural position;" but time spent in such pastimes is simply wasted. New roots as they grow will quickly spread out in all directions. The office of the bundle of old roots is simply to hold the plant firmly in place and to supply it with moisture till the new roots are formed.

This same method of planting with a spade can be used equally well for cabbage, tobacco, sweet potato slips, or any other small plants, and it will be found more rapid and satisfactory than the more laborious method of planting with a dibber or a trowel.

The subsequent cultivation of the plants will be facilitated by having them in perfectly straight rows. This can be done by stretching a line against which to set the spade in planting; or a mark can be made by dragging a chain or rolling a light wheelbarrow along the row. A serviceable wheel marker can be made from an old buggy wheel by attaching handles wheelbarrow fashion and nailing short bits of lath to the rim at the right distance apart for the plants with the ends slightly projecting so as to leave a slight indentation in the soil. This will not only secure accurate alignment but accurate spacing as well. Plants should be set from twelve to thirty inches apart in the row, according as the variety is a good runner or not, and according to the richness of the soil and the season of planting.

At the north strawberries are usually planted in the spring, while in Florida the usual practice is to plant in late summer or fall. In this state we do not need to be confined strictly to either practice, but can plant with some prospect of success at any time from August to March when the soil is in a suitable condition of moisture. The greatest drawback to fall planting is the drouth that so often prevails at that season. It is always more difficult to get plants to live then than in the winter or spring. In Southern Alabama strawberries planted in the late fall or early winter will, on rich soil, make sufficient growth during the mild winter to produce a fair crop in the spring, though not nearly so large a one as if planted in August or September. In Middle and North Alabama the plants will grow very little during winter, and planting should be made as early as August to secure a crop the following spring. It is always difficult to secure a supply of strong, well rooted plants as early as August, and unless the weather is unusually favorable it is difficult to get plants to live at this season when taken up and handled in the usual way. This difficulty can be avoided by striking the runners in small pots plunged in the soil along the row. Such potted plants with the ball of earth adhereing to the roots can be safely planted at any time when the soil is in proper tilth. This method is often employed by market gardeners where land is scarce and valuable, for it enables them to take some early crop from the land before planting the strawberries. The greatest objection to adopting this method on a large scale is the expense of the pots. The labor of growing a field in this way would be less than that of planting in the spring and cultivating throughout our long summers. True the pots can be used over again year after year, but the initial expense would be heavy when many acres are grown. A modification of this system that does away with the expense of the pots consists in allowing the runners to strike in the open ground and then taking them up with a ball of earth by means of some of the various transplanters now on the market. This system has not been much practiced in this state, but it seems well adapted to the conditions in South Alabama, where the labor and difficulty of properly cultivating spring-set plants through the period of midsummer rains is very great, and where the fall drouths often prevent planting in the ordinary way until too late for the best results. In Middle and North

Alabama the average planter will usually get the best results by planting in February or early March. Plants set at this time will attempt to bear a few berries, but there will not be enough to be of value, and it is better for the vigor of the plants to cut off the flower stems and thus prevent fruiting entirely for the first season. The ripening of even a few fruits is a heavy tax on the vitality of a newly set plant that is not yet well rooted.

Cultivation and Mulching.

The cultivation required for strawberries is very simple and may be made much like cotton, except that more hand work will be required after the runners begin to grow and take root. The main requirements are, first, that it be shallow so as not to disturb the short fiberous roots; and, second, that it be frequent enough to keep down all weeds and grass, and to prevent undue evaporation by a mulch of loose surface soil. Some five-toothed cultivator like the Planet Jr. is usually used for working between the rows, though good work can be done with the ordinary cotton sweep by setting the wings flat to throw as little dirt as possible. The big eye hoe used for chopping cotton is not adapted to hoeing strawberries. A light garden hoe should be provided and it should be used with a shuffling motion, cutting out any small grass and weeds with the forward stroke, and leveling and fining the earth with the back stroke. In working around the plant the hoe should always be tilted a little so that the corner next the plant does not penetrate more than a fourth of an inch. Deep hoeing that disturbs the roots in hot dry weather is almost surely fatal. Such careless, improper work kills more plants than any other one cause. For the same reason big weeds should not be pulled up from among the plants in a dry time. Either wait for a rain or cut them out with a knife or chisel.

Some growers follow the plan of stopping regular cultivation about mid-summer and allowing the crab grass to grow up between the plants, only going over occasionally to chop out any big weeds that appear. If the grass does not come up too thick it does not seem to seriously check the growth of the plants, and as it dies down in the fall it leaves a slight protecting mulch that prevents the baking of the soil and helps to keep the berries clean in the spring. This is, of course, a cheap method and it seems to succeed fairly well on some soils. It is doubtful, however, if it ever gives the largest crops, and there is always danger that the grass will grow thick and heavy enough to entirely smother the plants. Clean culture throughout the season is in most cases much more desirable.

At the north, berries are usually mulched heavily with wheat straw or some similar material when freezing weather sets in, to protect the plants from injury from severe cold, or from the bad effects of frequent freezing and thawing. This mulch is left between the rows in the spring to help hold moisture and to keep the fruit clean. No winter or spring cultivation is given. Here no such mulch is necessary to protect the plants during the winter, and two or three hoeings are necessary to keep down the numerous winter growing weeds that would otherwise choke the plants before the end of the fruiting season. The last hoeing should be given just as the plants begin to bloom, and a light mulch should now be scattered about the plants to prevent the fruit from being spattered by dirt when it rains. Pine straw is often used for this purpose, where it is available, and it answers fairly well, though it is open to the objection of harboring crickets and other fruit eating insects. Probably cotton seed or cotton seed hulls furnishes the best mulch to use in this state. Only a comparatively small quantity is required to cover the exposed ground immediately about the plants.

If the field is to be kept over for another crop, advantage should be taken of the first rain after the picking season is over, to bar off the rows, leaving them ten or twelve inches wide and throwing the dirt to the middles. An abundant application of fertilizer should be made in the furrows and the dirt be worked back with the cultivator before the row has time to get dried through. Subsequent cultivation is much as with new set plants. The number of crops that it will pay to take from a field will depend on various circumstances. Sometimes plantings will continue to yield well for three or four years. Usually it will be found best to plow them up after the second crop. At the south where fall planting is successful, the tendency will be to take only one crop, thus occupying the land only half the year, except so far as necessary to grow plants for the fall setting.

The advisability of keeping strawberries strictly in hills, or of allowing them to make runners and form matted rows is a question that has been widely discussed, and on which opinions and practice still differ. The bulk of the testimony seems to favor a narrow matted row, with the plants set somewhat thinly, to either a wide row or hill culture. It is safe to say that nine-tenths of the berries marketed in this country, are grown in matted rows, and this method is recommended for all spring set plants. When planted in the fall, most kinds make very few runners till after the fruiting season, so that fall planting, practically means hill culture, so far at least as the first crop is concerned. For this reason, plants should be set closer in fall than in spring planting.

Insects and Diseases.

Strawberries are the favorite food plant of a long list of noxious insects. Some attack the leaves, others the roots, some bore into the crowns, while still others eat holes in the fruit or injure it by sucking the juice, thus causing it to "button" or dry down into hard unsightly knots. When berries are grown continuously in large quantity in any neighborhood, many of these pests are sure to become troublesome. So far, there has been very little complaint of damage in this state, and no detailed account of strawberry insects will be attempted here. The best preventive measure is a quick rotation of crops. The plan of plowing up fields when the crop is gathered, and replanting in the fall, where this can be successfully done, will prove very effective in controlling many of these pests. For a full account of strawberry insects, the reader is referred to Bull. 42, of the Florida station. The only fungus disease that need be mentioned here, is the so-called rust or leaf spot. This causes white, red-bordered spots on the leaves; if sufficiently abundant, it finally kills the foliage, bnt its greatest damage is done by attacking the fruit stems and calyx, causing them to become brown and brittle. Such fruit is always inferior in flavor and appearance. Serious damage is often done in this way, when the foliage is but little injured· This disease occurs in all parts of the country. Some varieties are much more injured by it than others, and probably our best means of combating it is by selecting resistant varieties. It was at one time held that dusting the fields with air slacked lime in the spring, helped to hold the disease in check. It will often be noticed that mulched plants are less injured than those that are unmulched. At the north many growers practice setting fire to the mulching after the crop is picked, thus burning off the leaves entirely. This plan is very effective in destroying leaf diseases and insects. It should, however, be tried with great caution, if at all, on our light soils, and only when the ground is thoroughly moistened by recent rains. The remedy now universally recommended for rust is to spray with Bordeaux mixture (6 lbs. copper sulphate, and 6 lbs. quick lime, to 50 gallons of water.) There can be no question that this is often useful, though spraying strawberries at this station, has so far yielded only negative results. More experimentation is needed to determine when and how often to spray under our conditions.

Marketing.

Little need be said here under this heading further than to call attention to the general remarks on this subject in Bull. 79, pp. 103–110. No fruit requires greater care in handling than the strawberry. It is necessary to pick the fields all over carefully every day, or every other day at fartherest, in order to prevent getting over-ripe fruit in the boxes. For the same reason the pickers must be carefully watched to see that no ripe berries are left on the vines and that no over-ripe ones go in the boxes. When many hands are used an overseer should be placed in charge of each gang of thirty or forty hands, whose duty it should be to pass back and forth among them constantly, inspecting the work, examining the fruit in the boxes, assigning rows, and keeping order. The berries for distant shipment should be picked as soon as they are colored all over but before they begin to soften. Some varieties will color up nicely in transit if picked a little green. This is a very desirable point in a market berry, for it is often difficult to prevent pickers from taking the fruit as soon as it is colored on the upper side. Kinds that do not color after picking will go into market showing so many green sides as to seriously affect prices. In picking the berry should be seized by the stem, pinching it off about half an inch below the fruit, which is then laid in the box with as little handling as possible. This is a point of vital importance. Berries that are seized in the fingers and pulled off are ruined for distant shipment, and are made so soft and mussy as to become quickly unfit even for home use or the nearest market. The only berries exposed for sale on the streets of Auburn this season were so damaged by this careless "pulling" that they were unfit for use before noon, though brought from a neighboring town only six or seven miles away.

Berry pickers are usually paid by the quart, the price ranging from one to two cents in different localities. Accounts are often kept by means of printed pasteboard checks ranging in value from one to fifty quarts, that are handed to the picker as the berries are brought into the packing shed. These tickets are cashed at the end of the week or of the season.

Packing strawberries neatly and rapidly requires skill and nimble fingers. All imperfect berries that are in sight are removed, and, if many are found, the box is emptied so that those in the bottom may be picked out also. The berries on the top of the box are then arranged closely side and side so that the box will be evenly and closely filled. If this is not carefully done the fruit will be either too high so as to be crushed by the cover, or not full enough so that the berries will shake about and the box will not seem over half full when it reaches the market. This packing does not imply "facing" where all the big berries are put on top, a practice that it is needless to condemn; but if honestly and skillfully done it adds materially to the market value of the fruit.

Strawberries are now universally shipped in cheap quart boxes or baskets that are given away with the fruit. The old system of return packages has been abandoned in nearly all markets. Numerous styles of packages are on the market. The one should be selected that is the most popular in the cities it is proposed to supply.

Strawberries that are properly handled can be usually shipped safely for twenty-four hours by express. That is, berries picked today can be shipped to markets where they can be sold tomorrow. If the weather is cool and dry they may be saleable on the second day, but there is always considerable risk in shipping for forty-eight hours by express. In properly managed refrigerator cars good berries will carry safely for four or five days. Planting strawberries for distant shipment is recommended only at points where such refrigerator service can be secured.

VARIETIES.

The proper selection of varieties for a given locality is an important question with any fruit. It is especially important with strawberries since many kinds are quite local in range, doing well in one locality and perhaps failing utterly only a few miles away on a different soil or under different cultural conditions. The following thirty-five kinds were planted on the Station grounds during the fall of 1896. They have, therefore, been under observation during two fruiting seasons. They were planted on a dry sandy ridge. Very little fertilizer has been used and the cultivation and treatment has purposely been made poorer than would be given by the average market grower. The object has been to give the different kinds as severe a test as possible, believing that any kinds giving satisfactory results under such conditions can safely be recommended for general planting. It is thought that the kinds here recommended can be safely planted in all parts of the state. It is not intended to imply that other kinds may not do equally well or better under some of the varied conditions included in our territory. On stronger soils and under better cultural conditions many of the northern favorites would doubtless make a more satisfactory showing. No attempt has been made to measure the exact yield from each plot as it is not believed that estimates from such limited data are reliable. The following notes are not intended as descriptions of the varieties, but merely to indicate their behavior here. Those characterized as worthless are for the most part those that lack vigor under our rather trying conditions. It is not implied that they are not valuable kinds in regions to which they are adapted.

Planters should remember that some kinds are pistillate and will not bear unless planted near some perfect flowered varieties. The nursery catalogues always state whether flowers are perfect or not.

ANNIE LAURIE—Worthless.

BELMONT—Worthless.

BOUNCER—This is evidently a large fruitful berry where it is at home, probably worthless here.

BRANDYWINE—As a rule the very large berries lack vigor here. This one seems to be an exception, and it is strongly recommended as the best of the large late kinds.

BRUNETTE—Probably worthless.

BUBACH—This universal favorite has done poorly under the trying conditions of the test. Under better culture in a private garden it has done better and yielded some fine fruit, but it is much less vigorous than Brandywine and cannot be recommended for general cultivation in middle and south Alabama. It will probably do well in the northern portion.

CLYDE—Lacks vigor, worthless.

CRESCENT—This old standby is comparatively worthless here.

ELEANOR—Of considerable promise, and with better care would be valuable; worthy of farther trial.

ENHANCE—Like the last this is worthy of farther trial. It is very productive, but may prove lacking in vigor.

ENORMOUS—Large and fruitful, but foliage too weak, worthless.

GANDY—Not suited here; worthless.

GARDNER—This plant is more vigorous and seems better adapted to our conditions than any we have tested. It runs very freely, and the foliage is very resistant to rust. It is fairly productive, begins ripening early and continues in bearing a long time. Unfortunately the fruit seems a little soft to stand distant shipment, and the color is too light to suit all markets. It is heartily recommended for local use, but its shipping qualities should be carefully tested before planting it largely for market.

GIANT—Perfectly worthless here.

GLENN MARY—Unfortunately we failed to get a good stand of this valuable new berry. The few plants that lived have proved vigorous and very fruitful. The fruit is of the largest size, firm and of fine color. It is worthy of extended trial.

GREENVILLE—Worthless here.

HAVALAND—Vigorous and productive, but the fruit ripens so unevenly as to be practically worthless.

HOFFMAN—This favorite southern market berry has been very disappointing, and has scored a failure under conditions where it was expected to be a leader. It is considered a standard market variety for light soils.

JESSIE—Vigorous and fairly productive, but never seems fully satisfactory. It has some good points as a family berry but is not suited for market.

LADY THOMPSON—Undoubtedly the best one kind for general planting here. It is vigorous, early and productive. The fruit, while not the largest, is all good sized and of regular, handsome shape. It is remarkably uniform and free from small and imperfect berries, and holds its size to the end of the season.

MARSHALL—A promising variety, worthy of farther trial.

MARY—Complete failure, worthless.

MEEKS—Next to Gardner, the most vigorous plant on our grounds. The fruit is a dark rich red and the best in flavor of the entire lot. It begins ripening very early and continues throwing up fruit stems as late as the latest. The first berries are large but the later ones run small for market. It would doubtless ship well, but unfortunately the total yield seems too small, and shy bearing must be set down as its greatest fault.

MICHEL—This well known early berry does well here and is recommended with Lady Thompson for general planting. Some of the Northern Experiment Stations report this as a shy bearer, but here it is the most productive kind we have, though it needs rather better conditions than the severe ones of this test. It is our earliest berry, beginning slightly in advance of Lady Thompson and continuing considerably longer in bearing. While this is a good point for home use, a long bearing season is a doubtful advantage in a market berry for the South. Some complaint has reached the Station from different parts of the state that this berry rusts badly. Here we have had no trouble with it, but the foliage is certainly more delicate than that of some of the other kinds.

PARKER EARLE—This variety is always a failure on poor thin soils, worthless here.

RIO—Seems to be worthless.

SHARPLESS—This old favorite is worthless here.

SPLENDID—Worthless.

SUNNYSIDE—Worthless.

SUNRISE—Also worthless.

TUBBS—Seems fairly promising and worthy of farther trial.

WARFIELD—This standard market berry is out of its element and worthless.

WILLIAM BELT—This has merit, deserves farther trial.

WILSON—This old standby, the first variety to make commercial strawberry growing possible, has held its own wonderfully under the trying conditions of this test. Judged by this trial alone, it could not be graded lower than third or fourth on the list as a general purpose berry.

WOLVERTON—Worthless.

The opinions formed of these different kinds may be summarized as follows:—

Earliest berry—Michel.

Best early kinds for general planting—Lady Thompson, Michel.

Best large late kinds—Brandywine, Glenn Mary.

Most vigorous vine and hardiest foliage—Gardner, Meeks.

Promising, worthy of farther trial—Eleanor, Enhance, Marshall, Tubbs, William Belt.

Of doubtful value—Bouncer, Bubach, Hoffman, Jessie, Wilson.

Worthless here—Annie Laurie, Belmont, Brunette, Clyde, Crescent, Enormous, Gandy, Giant, Greenville, Havaland, Mary, Parker Earle, Rio, Sharpless, Sunnyside, Sunrise, Warfield, Wolverton.

BULLETIN No. 95. AUGUST 1898.

ALABAMA

Agricultural Experiment Station

OF THE

AGRICULTURAL AND MECHANICAL COLLEGE,

AUBURN.

EXPERIMENTS WITH OATS.

J. F. DUGGAR.

BIRMINGHAM
ROBERTS & SON.
1898

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Experiments With Oats.

BY J. F. DUGGAR.

SUMMARY.

Among a number of varieties of oats tested none was found superior in yield to the common Red Rust Proof oat.

Varieties which produced moderate yields of grains and relatively large amounts of tall fine straw were Myer's Turf and Hatchett's Black. These and related varieties are hardy, and are valuable for grazing and for forage.

In three different experiments Red Rust Proof oats sown in November yielded 7.9, 11.8, and 9.7 bushels per acre more than the same kind of seed sown from February 9 to March 1. The average increase in these three experiments due to fall sowing was 9.8 bushels.

The period between October 1 and November 15 is suggested as the best time for sowing the bulk of the crop of Red Rust Proof oats in central Alabama.

A comparison of cotton seed and cotton seed meal applied both in fall and spring was rendered inconclusive by reason of unfavorable weather.

Cowpea vines, plowed under, increased the yield of oats sown in February to the extent of 10.4 bushels per acre. The yield of fall-sown oats on land where cowpea vines had been plowed under (after 11 bushels of peas per acre had been picked) was 28.6 bushels per acre against 7.1 bushels on a plot previously abandoned to weeds and crab grass, a gain of 21.5 bushels of oats.

The plot on which only the roots and stubble of cowpea vines were plowed under yielded 34.4 bushels of oats per acre

against 9.7 bushels where German millet stubble had been plowed under, an increase of 24.7 bushels of oats per acre. Considering yield of peas and of hay and yield of the succeeding oat crop, it was more profitable to cut cowpeas for hay than to pick the peas and plow under the vines.

Nitrate of soda applied as a top dressing on both fall-sown and spring-sown oats, was most profitable when applied not later than the last of March, or at least 55 days before the grain was mature.

Eighty pounds of nitrate of soda per acre afforded a profit when applied in March. In one experiment this amount of nitrate of soda afforded a yield of 29.3 bushels of oats per acre, while 160 lbs. of nitrate of soda per acre resulted in a yield of 34.1 bushels. This was an increase over the plot receiving no nitrate of soda of 12.9 bushels with the smaller quantity of fertilizer and 17.7 bushels with the larger amount; there was a greater profit on the investment when 80 pounds was employed.

On soil well supplied with vegetable matter, plots receiving 660 lbs. of slaked lime per acre at time of planting yielded more than plots not limed. But slaked lime applied as a top dressing in March on oats growing on sandy land deficient in vegetable matter failed to increase the yield.

In a co-operative fertilizer experiment conducted near Auburn with oats sown in February, drought caused the crop to fail on all plots. The greatest resistance to drought and the largest yields were obtained on the plots receiving kainit.

Scalding seed oats for 10 to 15 minutes in water kept at a temperature of 130 to 135 degrees Fahrenheit effectually prevented smut here. This is a standard, cheap, and effective method of preventing smut, and the saving resulting from this treatment of seed oats is usually 5 to 20 per cent. of the crop, and sometimes more.

VARIETIES.

Several varieties of oats were imported from France, and these were compared in the season of 1896-97 with varieties obtained from T. W. Wood & Sons, Richmond, Va., and with home grown oats of the Red Rust Proof variety. Nearly all of the varieties from France were evidently spring oats and these proved too tender for fall sowing in this latitude. Winter killing of from one-third to two-thirds of the plants on these plots was the cause of the low yields. One foreign variety, Gray Winter, proved hardy, and for two years it has kept a rather high rank among the varieties tested. All varieties, except the Naked or Hull-less, were sown at the rate of 44 pounds of seed per acre.

The eleventh-acre plots were arranged in two series, side by side, Plot 10 being opposite and near Plot 1, Plot 18 opposite Plot 9, and so on. The field, which embraced a hill-top on which there was a deep sandy, poor soil, produced a crop of cotton in 1896. The plots seemed to be of the same fertility, but the yields of the check plots of Red Rust Proof oats suggest that there was a gradual decline in the fertility from Plot 1 to 9 and from Plot 10 to 18.

Varieties of oats sown November 16, 1896.

Plot No.	VARIETY	SEED FROM	YIELD PER ACRE		Percent. Grain
			Straw	Grain	
			Lbs.	*Bus.*	
1	Red Rust Proof......	Ala. Expt. Station......	888	23.6	46
*3	Red Rust Proof......	Ala. Expt. Station......	901	19.7	41
*6	Red Rust Proof......	Ala. Expt. Station.....	744	16.1	41
7	Hull-less Oats.........	France	653	4.4	18
8	Giant White Abundance	T.W.Wood & Sons, Va.	321	3.1	26
9	White Hungarian...	France	603	2.8	14
10	Yellow Giant	France	1,019	5.4	14
11	Hatchett's Black....	T.W.Wood & Sons, Va.	1,219	17.7	32
12	Red Rust Proof....	Ala Expt. Station.......	1,074	29.7	47
13	Gray Winter..........	France	1,354	18.4	30
14	Beardless...... ...	T.W.Wood & Sons, Va	802	14.9	38
15	Red Rust Proof......	Ala. Expt. Station.. ...	892	23.5	46
16	Red Rust Proof.... .	T.W.Wood & Sons, Va	879	20.3	43
17	Early Siberian........	France	939	9.9	24
18	Virginia Gray........	T.W.Wood & Sons, Va.	1,317	28.8	40

In this test Virginia Gray and Red Rust Proof stand first in yield of grain.

* The plots not represented in the above table formed part of another experiment.

Seed of some of the above mentioned varieties was saved and sown November 6, 1897, together with a few additional varieties. In the same field was also a test of productiveness of a "spring strain" against a "fall strain" of Red Rust Proof oats. Both strains were originally from the same source, the only difference being that the seed for Plots 10 and 13 were from a crop sown in February, 1897, the "fall strain" from a crop sown in November, 1896.

Varieties of oats sown November 6, 1897.

Plot No.	VARIETY	SEED FROM	YIELD PER ACRE Straw	Grain	Per Ct. Grain
			Lbs.	*Bus.*	
1	Delaware Winter...	Delaware, crop of '96..	783	10.6	30.4
2	Virginia Gray.......	T.W.Wood & Sons, Va.	924	13.9	31.5
3	Virginia Gray.......	* Ala. Expt. Station....	1,071	15.7	32.
4	Red Rust Proof.....	Ala. Expt. Station.......	1,800	30.8	41.3
5	Myer's Turf..........	Miss. Expt. Station......	1,456	15.4	25.3
6	Gray Winter.........	† Ala. Expt. Station...	1,476	19.5	29.7
7	Hatchett's Black...	* Ala. Expt. Station...	1,057	20.8	38.7
8	Beardless	* Ala. Expt. Station...	1,155	27.1	42 9
9	Early Siberian......	* Ala. Expt. Station...	1,129	13.9	28.5
10	Red Rust Proof (spring strain)	Ala. Expt. Station......	936	27 0	48.
11	Red Rust Proof (fall strain)	Ala. Expt. Station.....	1,122	21.7	38.1
12.	Red Rust Proof (fall strain)	Ala. Expt. Station ...	978	28.8	48.5
13	Red Rust Proof (spring strain)	Ala. Expt. Station......	1,055	30.3	47.9

In this test the Red Rust Proof variety leads in the production of grain, closely followed by Beardless; Hatchett's Black and Gray Winter rank next. If we omit Plot 11, the figures for which are shown by the low percentage of grain to be abnormal or erroneous, there is no material difference between the "spring strain" and "fall strain" of Red Rust Proof oats. This practical equality occurred in a mild winter, during which no oats of this variety were at all injured by cold on the farm of this experiment station. Possibly in a severe winter the results would be different.

* Originally from T. W. Wood & Sons, Richmond, Va.; seed grown in Alabama only one year.

† Originally from France; seed grown in Alabama only one year.

February 17, seven varieties of oats named in the table below were sown on "branch bottom land." On account of inequalities in the soil, causing poor and irregular growth over nearly all plots, except on a small strip at the east end of each, only this small measured portion of each plot was harvested. This vitiates the experiment somewhat, the yields in the following tables representing only the best portions of each plot:

Varieties of oats sown February 17, 1898.

Plot No.	VARIETY.	SEED FROM	YIELD PER ACRE Straw	YIELD PER ACRE Grain	Percent Grain.
			Lbs.	*Bus.*	
1	May...................	Opelika, Ala.	1790	35.9	39.9
2	Red Rust Proof.....	Ala. Expt. Sta....... ...	1149	23.4	39.6
3	Burt....................	Miss. Expt. Sta..........	1658	41.4	41.7
4	Virginia Gray......	*Ala. Expt. Sta..........	472	5.2	26.4
5	Red Rust Proof....	Ala. Expt. Sta..........	1403	37.8	46.3
6	Myer's Turf.........	Miss. Expt. Sta	907	5.7	16.6
7	Blk.BelgianWinter	France	.....	**......	.....
8	Black Mesdag	France	1046	6.2	15.9

In this test of "spring-sown" oats Burt was most productive, followed by May and Red Rust Proof. The winter varieties failed, one winter variety maturing no grain at all.

WHAT IS THE BEST VARIETY OF OATS?

It seems that there is no one variety best for all conditions. The Red Rust Proof is the only one in the list tested by us which is worthy of the name of a "general purpose" oat in this locality. It can be sown both in fall and in late winter in this latitude. It is generally not greatly injured by rust, but is rust resistant rather than rust proof. The straw is short, an objection on very poor or stony land, since short straw means loss in harvesting. The height of straw can be increased by the liberal use of nitrogenous fertilizers, such as cotton seed, cotton seed meal, and nitrate of soda.

*Originally from T. W. Wood & Sons, Richmond Va.; seed grown in Alabama only one year.

**Failed to produce seed when sown in February.

In hardiness or resistance to winter killing Red Rust Proof is surpassed by the group of varieties embracing Myer's Turf, Virginia Gray, Delaware Winter, and Gray Winter. All these "grazing oats" are nearly or quite identical in most qualities, though apparently differing among themselves in productiveness. All are hardy, have tall fine straw, a low percentage of grain and a long season of growth. Two varieties of this group have proved totally unfit for sowing in February. Varieties of this type are preferred for grazing or forage.

For sowing after Christmas the choice is between Red Rust Proof and Burt or May, the last two as grown here appearing to be identical.

The Red Rust Proof is in most general repute, but some farmers prefer the Burt.

As to the relative productiveness of Red Rust Proof and Burt, the latter stood first in the experiment noted above, and in a test of the two varieties made in the spring of 1896; in that test unfavorable weather and late sowing caused both varieties to fail, Burt yielding 9.4 bushels per acre and Red Rust Proof only 7.8 bushels. Additional evidence is needed before we can be sure that there is any material difference in the productiveness of these two varieties sown after Christmas.

In time of ripening Burt and its equivalent (May) are earlier than the Red Rust Proof. Here Burt matured one to two weeks before Red Rust Proof sown at the same date in spring and only one to three days later than fall sown Red Rust Proof oats. The latter variety matured 12 to 19 days earlier when sown in November than when sown in February. Myer's Turf, Virginia Gray, and Gray Winter were ten to twelve days later in maturing than Red Rust Proof sown at the same date in the fall. Hatchett's Black, a hardy and moderately productive variety, matures between Red Rust Proof and Myer's Turf.

Where a large oat crop is grown it is advantageous to avoid having the entire crop ripen at once. This is an argument in favor of sowing several varieties.

TIME OF SOWING.

November 16, 1896, Red Rust Proof oats were sown on two plots on very poor, sandy soil, which had produced a crop of cotton in 1896. Lying between these two plots was another which was not sown until the first of the following March. In each case Red Rust Proof oats, at the rate of 44 pounds per acre, were sown broadcast on the plowed ground and covered with a cultivator. The fertilizer was applied at the time of planting in each case, and was worked into the soil with a smoothing harrow. The fertilizer was applied at the same rate on each of the three plots, viz:

33 lbs. muriate of potash per acre.
110 lbs. cottonseed meal per acre.
198 lbs. acid phosphate per acre.

Total, 341 lbs. per acre.

Although the November sowing occurred later than was desirable, the plants of the Red Rust Proof variety sown at this time were not appreciably damaged by cold. The fall-sown oats were ripe May 31, the spring-sown oats June 12, a difference of 12 days in time of harvesting.

Fall-sown vs. spring-sown oats.

Plot.	DATE OF SOWING	YIELD PER ACRE Straw	YIELD PER ACRE Grain
		Lbs.	*Bu.*
1	November 16, 1896	888	23.6
2	March 1, 1897	587	13.8
3	November 16, 1896	901	19.7
Av. 1 & 3	November 16, 1896	895	21.7
Gain from fall sowing		308	7.9

In this case there was a gain of 7.9 bushels per acre, or 57% in favor of fall-sowing, even when the date of sowing was delayed until the middle of November to allow time for gathering the preceding cotton crop.

November 23, 1897, on soil somewhat similar to that on which the preceding experiment was made, Red Rust Proof oats were sown on one plot and an adjoining plot was left to be sown late in the winter.

February 9, 1898, this second plot was sown, all conditions of preparation, amount of seed, and fertilizer, being identical on the two plots. On each plot the fertilizer was applied at the same time as the seed, in November and February respectively.

The fertilizer consisted of;

	160 lbs.	acid phosphate per acre.
	160 lbs.	cotton seed meal "
	40 lbs.	muriate of potash "
Total,	360 lbs.	

The yield was 18.2 bushels per acre on the fall-sown plots, and 6.4 bushels per acre on the plot sown in February.

The extremely dry weather of the latter part of the spring injured the crop on both plots, but its effects were most severely felt by spring sown oats, which being 19 days later in maturing were cut short by the continuous drought. In ordinary seasons, or on soil better supplied with moisture, there would doubtless have been less difference in yield.

Another test bearing on this subject was made in 1897-98. This was made on better land than that used in the preceding experiment.

As before, all conditions on both plots were made equal except that one plot was sown November 26, and the other February 9.

The yield was 23.8 bushels per acre with the fall sown oats and 14.1 bushels with Red Rust Proof oats sown in February, a gain of 9.7 bushels per acre as the result of sowing in the fall.

The results for all three experiments just mentioned are brought together in the following table:

Average results of fall-sown vs. spring-sown oats.

DATE OF SOWING	Percent. grain in sheaf oats	Yield of grain per acre	Yield of straw per acre	Increase of grain from fall sowing
Experiment No. 1.	*Percent.*	*Bus.*	*Lbs.*	*Bus.*
November 18, 1896	45	21.7	895	**7.9**
March 1, 1897	43	13.8	587	
Experiment No. 2.				
November 23, 1897	38	18.2	958	**11.8**
February 9, 1898	47	6.4	228	
Experiment No. 3.				
November 26, 1897	43	23.8	994	**9.7**
February 9, 1898	51	14.1	440	
Averages.				
Sown in November	42	21.2	949	**9.8**
Sown in February and March	47	11.4	418	

The averages in the above table show that oats sown in November were more productive than those sown February 9–March 1 to the extent of 9.8 bushels of grain and 531 pounds of straw per acre.

In 100 pounds of unthreshed oats there was 47 pounds of grain with spring sowing, and only 42 with fall sowing, a difference due to the extra height of straw of fall-sown oats.

The average date of harvesting the Red Rust Proof variety was May 26 when sown in November, and June 11 when sown in February or early March. This difference of 16 days in time of maturing renders fall oats less liable to suffer from drought or other unfavorable weather conditions.

It is almost universally admitted that throughout the greater part of Alabama oats sown in the fall afford larger yields than do "spring-sown oats"—by which term is meant oats sown any time in the latter half of winter or in early spring.

And yet the proportion of fall-sown oats is unfortunately small. The chief causes for the failure of farmers to sow large areas of fall oats are two; (1) depredations of live stock which are so generally allowed to run at large in winter, and (2) the fear that fall oats may be winter killed.

The remedy for the depredations of stock is obvious, although its discussion is not in place here. Moreover, on many farms there are enclosed fields from which all stock can be easily excluded.

The danger of winter killing is usually overestimated and the losses from this cause can be reduced by choosing the best date for sowing. Moreover, oats sown in January or February also run some degree of the same risk, though less frequently killed than oats sown from Nov. 15 to Dec. 15.

Several instances are in mind where in this vicinity both spring-sown and fall-sown oats were killed on the same field during the same winter, the latter having been planted in January or February, after the fall oats had been destroyed.

As intimated above, winter killing of oats is sometimes due to sowing at the wrong time in the fall. The farmer who, in this latitude, is just beginning to sow oats when Thanksgiving Day comes, a case not uncommon, is inviting this danger.

To withstand the alternate freezes and thawings of winter, oats should be sown early enough to develop a strong root system before cold weather. On the other hand, it occasionally happens that Red Rust Proof oats are sown so early in the fall that on rich land they throw up seed heads before the cold weather of early spring has passed, and in this "booting" stage they are very susceptible to injury from cold. It is impossible to name any date as absolutely the best for sowing, since this varies with different localities, with different soils in the same locality, and even with different seasons.

Observation indicates that in the central part of Alabama it is advisable to sow the bulk of the crop of Red Rust Proof oats between October 1 and November 15. These dates are not set as extreme limits even for the Red Rust Proof variety. Hardier varieties, as Turf, Virginia Gray, etc., may be sown earlier. The attempt to grow spring-sown oats on poor land has brought frequent failure and has done much to discourage the culture of oats in the South. If spring-sown oats are to be produced at a profit, they must have good land, and especially they need low lying fields that are comparatively drought proof. Of course fall-sown oats succeed best also on rich land, but these can often be produced at a profit on land too poor to afford a profitable crop of spring oats.

Even if fall oats should be completely winter killed one year in three, the two remaining crops of fall oats, according to our experiments and observations, would afford more profit than three crops of spring oats. Another consideration in favor of fall oats is the fact that the winter growiug vegetation tends to prevent injurious leaching of the valuable nitrates from the soil. This is especially important on rich soils.

That spring sowing is more convenient in some respects is a fact not to be ignored. For example, it permits oats to follow cotton, a crop which is not usually removed in time for oats to be sown at the favorable period in the fall. This objection to fall sowing may be overcome by adopting a rotation in which oats follow corn, thus:

First year, cotton;
Second year, corn;
Third year, fall-sown oats, followed by cowpeas;
Fourth year, cotton again.

Or where a larger proportion of cotton and a smaller proportion of the other crops is desired, cotton might be the crop during the first and second years of the rotation, followed by corn, which in the fourth year is followed by oats (or other small grain) and cowpeas.

Both the above named rotations allow the oats to be sown in the fall, the corn crop being easily removed in time for this.

Cotton Seed and Cotton Seed Meal as Fertilizers for Oats.

In order to compare cotton seed with cotton seed meal, and to note the effects of each when applied in fall and in spring, the following experiment was made. November 17, 1897, on poor sandy land, five plots of Red Rust Proof oats were sown. All plots on that date were fertilized with 200 lbs. of acid phosphate and 30 lbs. of muriate of potash per acre, a combination which for brevity may be designated "mixed minerals." In addition two plots received 472 lbs.

per acre of cotton seed, and another plot received 200 lbs. per acre of cotton seed meal. The cotton seed, as well as the meal and mineral fertilizers were harrowed in.

March 4, a top dressing of 472 pounds of cotton seed per acre was applied to another plot and 200 pounds per acre of cotton seed meal was sown broadcast on yet another plot. Fertilizers applied in spring were not harrowed in.

The oats were cut May 23.

Results of applying cottonseed and cottonseed meal to oats in fall and spring.

NITROGENOUS FERTILIZER PER ACRE	When applied	YIELD PER ACRE	
		Grain	Straw
		Bus.	*Lbs.*
472 lbs. cottonseed (av. 2 plots)	Nov. 17	15.7	834
200 lbs. cottonseed meal	Nov. 17	17.8	969
472 lbs. cottonseed	March 4	14.5	730
200 lbs. cottonseed meal	March 4	14.2	775

Positive conclusions are not warranted because all plots in this sandy field were so severely injured by drought.

It can scarcely be doubted that under normal conditions cottonseed can be more profitably applied to oats in fall than as a top dressing in spring.

Observation, not however founded upon exact experiment, leads to the belief that the same is true for cottonseed meal.

An experiment comparing cottonseed, cottonseed meal, and nitrate of soda as fertilizers for spring oats was begun in 1896, but the general failure of spring-sown oats rendered valueless the data obtained in this test, as also that of experiments relative to thickness of seeding and to effects of different phosphates on oats.

COWPEAS AND VELVET BEANS AS FERTILIZERS FOR OATS.

On sandy soil in 1896 several plots were sown broadcast with the Wonderful variety of cowpeas, and an adjacent plot was sown broadcast with German millet. The German millet was plowed under, as was also the peavines, the peas having been previously picked.

February 18, 1897, Red Rust Proof oats were sown after the above mentioned crops, using in both cases 100 pounds of acid phosphate and 80 pounds of nitrate of soda per acre.

After cowpeas the oat straw grew to be three to four inches taller than on the plot preceded by German millet· The yields were as follows:

Oats following cowpeas and German millet, 1897.

	YIELD PER ACRE	
	Grain	Straw
	Bus.	*Lbs.*
Oats after cowpeas, vines plowed under	22.8	788
Oats after German millet, plowed under	12.4	559
Difference per acre	10.4	229

In this case cowpeas were more valuable than German millet as fertilizer for the following oat crop, the difference in favor of cowpeas being 10.4 bushels of oats per acre and 229 pounds of straw.

An experiment to ascertain the manurial values of cowpeas and velvet beans, and to compare the relative fertilizer value of the entire vines with that of the roots and stubble of both plants, was begun in 1897. May 14, 1897, on poor sandy soil Wonderful cowpeas were sown on two plots, velvet beans (a leguminous plant closely related to cowpeas), on two plots, and German millet on a fifth plot. A sixth plot was prepared and fertilized but left without seed, to grow up in crab grass, poverty weed, etc. Cowpeas and velvet beans were sown in drills two feet apart, German millet broadcast. The millet was cut for hay July 16, yielding 994 pounds per acre. The cowpeas on one plot were picked September 10, yielding 11 bushels per acre.

The velvet beans did not mature seed.

In September, 1897, cowpeas on one plot and velvet beans on one plot were cut for hay and the stubble plowed under. The vines of cowpeas on one plot and of velvet beans on another were also plowed under on the above mentioned date. Then oats were sown at a uniform rate on all four plots, also on the plot where German millet stubble had been plowed under and on the one where crab grass and various weeds had just been buried by the plow.

On all plots oats were fertilized with 220 pounds per acre of acid phosphate and 44 pounds of muriate of potash, no nitrogen being supplied except that contained in the remains of preceding crops of cowpeas, velvet beans, etc.

Yield per acre of oats grown after stubble or vines of cowpeas, velvet beans, etc.

Plot No.		YIELD PER ACRE Grain	Straw
		Bus.	*Lbs.*
1	Oats after velvet bean vines	28.6	1206
6	Oats after velvet bean stubble	38.7	1672
	Average after velvet bean vines and stubble	**33.6**	**1439**
4	Oats after cowpea vines	28.8	1463
3	Oats after cowpea stubble	34.4	2013
	Average after cowpea vines and stubble	**31.6**	**1738**
2	Oats after crab grass and weeds	7.1	231
5	Oats after German millet	9.7	361
	Average, after non-leguminous plants	**8.4**	**296**

From early spring there was a marked difference in the appearance of the several plots, the plants being much greener and taller where either the stubble or vines of cowpeas had been plowed under.

When the oats began to tiller, or branch, the difference increased, the plants supplied with nitrogen, through the decay of the stubble or vines of cowpeas and velvet beans, tillering freely and growing much taller than the plants following German millet or crab grass.

May 18, 1898, oats on all plots were cut.

In this experiment the average yield of oats was 33.6 bushels after velvet beans, 31.6 bushels after cowpeas, and only 8.4 bushels after non-leguminous plants (crab-grass, weeds and German millet).

Here is a gain of 24.2 bushels of oats and nearly three-fourths of a ton of straw as a result of growing leguminous or soil-improving plants, instead of non-leguminous plants, during the preceding season.

Undoubtedly this is an extreme, and not an average, case. If cottonseed meal, or other nitrogenous fertilizer, had been used on all the plots of oats, the plants on plots 2 and 5 would have made much better growth, and the difference in favor of the leguminous plants would have been reduced.

A gain of five to fifteen bushels of oats per acre as a result of plowing under cowpea stubble or vines would make the growing of cowpeas for fertilizer a profitable operation, and it is far safer to count on such an increase as that obtained in our first experiment, (10.4 bushels), rather than to expect such an exceptional increase as that obtained in this last experiment.

An unexpected result of this experiment is the larger crop on the plots where only the stubble was left than on those where the vines of cowpeas and velvet beans were plowed under. The plots were of nearly uniform fertility, as judged by the location and by the uniform growth of cotton on all plots in 1896. While admitting the possibility that the two west plots (plots 3 and 6) were slightly richer than the two on the east (plots 1 and 4), the writer thinks that the difference in yield was almost wholly due (1) to the fact that the vines (especially those of the velvet beans) were not properly buried by the small plow employed, and (2) that the seed bed for oats was more compact where only stubble was plowed under, a point of advantage, doubtless, in such a dry winter as that of 1897–98. It does not follow that the land will be permanently benefited by a cowpea stubble to a greater extent than by cowpea vines. The reverse is probably true. The effect of both stubble and vines on late corn, following oats, is now being determined. It is usually more profitable, where many head of live stock are kept, to save the cowpea hay and plow under only the stubble than to pick the peas and plow under the vines.

Time of Applying Nitrate of Soda.

Nitrate of soda is valuable for its nitrogen, of which it contains about 16 per cent. Nitrogen in this form usually costs somewhat more per pound than in the form of cottonseed meal. Nitrate of soda is more quickly available than cottonseed meal, and hence finds its most appropiate use on vegetable or other crops in which quick growth is desired. In Europe it is also extensively used on field crops, especially as a top dressing in spring for small grain. Scattered over growing grain in the spring it does not need to be worked into the soil, but if the soil is damp a top dressing of nitrate of soda is quickly diffused. Its favorable effect may often be seen in a week in the deeper green and accelerated growth of the plants.

Three series of experiments, two with fall sown oats, and one with spring oats, were made here to determine the best time of applying nitrate of soda.

On Red Rust Proof oats sown in the fall on sandy upland nitrate of soda, at the rate of 80 lbs. per acre was applied, broadcast at several different dates in the spring of 1896. In addition to the nitrate of soda, a complete fertilizer containing cotton seed meal had been used at time of sowing.

The dates of application and condition of soil and plants at the several dates follow:

March 28.—Oats well branched, some leaves 6 inches long, soil rather moist, rain a few days after fertilizer was applied.

April 21.—Plants beginning to throw up seed stems, land very dry and no rain fell until eight days after fertilizer was used.

April 30.—Plants beginning to head, soil moist, rain on preceding night and also on the second day after the application of the nitrate of soda.

May 12.—Heads open on all plants, soil very dry; a shower fell two days later.

The grain on all plots, which were one-tenth acre in size, was harvested May 27.

The results are given in the following table:

Time of applying nitrate of soda on fall sown oats, 1896.

80 LBS. NITRATE OF SODA PER ACRE APPLIED	No. of days before harvest	YIELD PER ACRE		Increase per acre from nitrate
		Grain	Straw	
		Bus.	*Lbs.*	*Bus.*
No nitrate of soda (av. 2 plots)......		16.4	590	
March 28 (av. 2 plots)..................	60	29.3	923	12.9
April 21 (av. 2 plots).................	35	19.1	680	2.7
April 30 (av. 2 plots)	27	21	886	4.6
May 12 (1 plot)........................	15	20.7	747	4.3
One-half on March 28................... One-half on April 30.....................	60 27	23.5	939	7.1

The largest average yield, 29.3 bushels per acre, was obtained by applying 80 pounds per acre of nitrate of soda March 28.

Here the increase per acre attributed to $2 worth of nitrate of soda was 12.9 bushels, worth at 40 cents per bushel $5.16, leaving a net profit of $3.16 per acre from the use of this fertilizer at this date. A profit was also obtained by applying 40 pounds of nitrate of soda March 28 and an equal quantity April 30. The yield was less, however, than when the entire amount was applied March 28.

Nitrate of soda applied under very unfavorable conditions April 21 brought financial loss. Later applications, although under rather favorable soil conditions, were unprofitable.

The preceding experiment was in its essential points repeated in 1897–98. Red Rust Proof oats were sown on four plots on a reddish loam soil November 17, 1897. The fertilizer used on each plot at the time of sowing consisted of 200 pounds of acid phosphate and 472 pounds of cotton seed per acre. In addition nitrate of soda at the rate of 80 pounds per acre was employed as a dressing in the spring, two plots being thus treated March 4, 1898, a third plot on March 29, and a fourth plot on April 27. The soil was damp when the two earlier applications were made and barely dry on the surface at the time of making the last one.

The crop was harvested May 23.

The results follow:

Time of applying nitrate of soda to fall-sown oats, 1898.

80 LBS. NITRATE OF SODA APPLIED	No. of days before harvest	YIELD PER ACRE	
		Grain	Straw
		Bus.	*Lbs.*
March 4 (av. 2 plots).....	80	35.0	1801
March 29...	55	34.3	1901
April 27..	26	18.8	878

In this, as in the preceding experiment, nitrate of soda was more effective when applied in March than when used in the latter part of April.

Comparing the yields obtained from the application in March with the yield from the last top dressing, which was apparently ineffective, we are justified in concluding that both of the earlier applications of nitrate of soda returned a profit.

An experiment in applying a top dressing of nitrate of soda on spring oats was made in 1896 on reddish loam soil. Red Rust Proof were sown January 27, 1896, all plots receiving equal quanities of a fertilizer containing phosphoric acid and potash, but no nitrogen. Nitrate of soda at the rate of 120 lbs. per acre was applied as a top dressing at several dates, namely:

March 28, when the plants had leaves 3 to 4 inches long;

April 28, when the plants were beginning to throw up seed stems;

And May 6, when many of the panicles (heads) were showing.

On lot of nitrate of soda was divided, half being applied March 28 and the balance April 28. On all these dates there was sufficient moisture in the soil to dissolve the nitrate of soda.

The oats were cut May 29.

Time of applying nitrate of soda to spring-sown oats, 1896.

120 LBS. NITRATE OF SODA APPLIED	No. of days before harvest	YIELD PER ACRE Grain	Straw	Increase per acre from nitrate
		Bus.	*Lbs.*	*Lbs.*
No nitrate of soda	...	10.4	376	.....
March 28	62	20.3	.....	9.9
April 28 (av. 2 plots)	31	13.1	414	2.7
May 6	23	10.8	357	.4
One-half March 28 / One-half April 28	62 / 31	13.5	433	3.1

The results with spring oats confirm the teachings of the experiments with fall-sown oats. From these experiments it appears that the earlier top dressing of nitrate of soda returned a profit. It is evident that nitrate of soda when used as a top dressing on oats should be applied not later than the last of March and at least 55 days before the grain is mature.

In regard to the amount of nitrate of soda which can be profitably used in spring as a top dressing for oats, extensive experiments have not been made here. A single test in 1896 on fall sown oats gave a yield of

34.1 bushels with 160 lbs. nitrate of soda,
29.3 bushels with 80 lbs. of nitrate of soda,
16.4 bushels with no nitrate of soda.

The larger and smaller amounts were applied as a top dressing on the same day, March 29. The use of 80 pounds per acre resulted in a profit; the increase due to the additional 80 pounds just about covered the cost of the additional fertilizer. Eighty pounds per acre is certainly safer than a larger quantity, although a heavier application sometimes proves best.

Effect of Lime.

February 1, 1896, Red Rust Proof oats were sown on four plots of land previously used for truck crops. The soil was rich and more abundantly supplied with vegetable matter than most of the upland in this locality. All plots were fertilized alike with a complete fertilizer, except that two plots received in addition slaked lime at the rate of 660 pounds per acre.

In spite of the unfavorable season the yields were satisfactory, the two limed plots averaging 38.5 bushels per acre, the two plots not limed 25.6 bushels. There was on comparatively rich land a difference of 12.9 bushels of oats per acre in favor of the limed plots.

March 11, 1898, quick lime from the Anniston Lime and Stone Company, was weighed out at the rate of 1,000 pounds per acre, and after being slaked, was applied as a top dressing on oats sown in the fall.

The soil was poor and sandy and the yields correspondingly small, 12.1 bushels per acre on the limed plot and 13.7 bushels on the plot not limed and used as a check. Here there was no gain effected by liming; it should be noted, however, that poor, sandy soil and late application are conditions very unfavorable for lime.

January 29, oats were sown on poor, reddish land, with and without lime, the rate when lime was used being 640 pounds of slaked lime per acre. Stock broke into the field and injured the crop when the oats were ripening, hence the plots were not separately harvested. There was no difference in the growth on the limed and not limed plots, so far as could be judged by the eye.

Lime hastens the rotting of vegetable matter in the soil and can be most advantageously used when the soil is abundantly supplied with organic matter.

It is also highly beneficial on acid soils. To determine whether a soil is acid, buy at a drug store a piece of blue litmus paper, keep this in a stoppered bottle until convenient to use it. Then bring it in contact with the moist soil to be tested. If the blue color of the litmus paper changes to reddish the soil is acid and will probably be helped by an application of lime.

It should not be understood that the favorable effect of lime is confined to soils which show this acid reaction with litmus paper. The Agricultural Department of this station will supply litmus paper free of charge to anyone agreeing to make this test and to report results.

Co-operative Fertilizer Experiments.

This experiment was conducted according to directions by Mr. H. C. Crayton, on his farm about seven miles south of Auburn.

Twelve plots, each one-eighth acre, were used. The land was gray sandy upland. Red Rust Proof oats were sown February 10, and the fertilizers were harrowed in after the grain was sown. After the date of sowing there was only an insignificant rainfall. The long continued dry weather caused the failure of the oats sown in February.

On account of the extremely unfavorable conditions, resulting in a yield of only about one-half or one-third the usual crop on that soil, the yields given below fail to show the normal effects of fertilizers.

A fertilizer test reveals the manurial needs of a given soil only when the supply of moisture is sufficient to dissolve the fertilizer and cause a normal growth. The yields are here given for what they are worth.

Yields of oats in co-operative fertilizer test.

Plot No.	Fertilizer		Yield per acre	
	Amount per acre	Kind	Straw	Grain
	Lbs.		*Lbs.*	*Bus.*
A	436	Cottonseed	192	2.8
B	240	Florida soft phosphate	168	2.6
1	200	Cottonseed meal	200	3.0
2	240	Acid phosphate	200	3.0
3	.....	No fertilizer	232	3.4
4	200	Kainit	328	5.1
5	200 240	Cottonseed meal Acid phosphate	300	4.4
6	200 200	Cottonseed meal Kainit	372	7.3
7	240 200	Acid Phosphate Kainit	248	4.2
8	.....	No fertilizer	232	3.4
9	200 240 200	Cottonseed meal Acid phosphate Kainit	712	10.0
10	200 240 100	Cottonseed meal Acid phosphate Kainit	472	5.6

The only fertilizer that showed any tendency to increase the yield was kainit. This does not necessarily indidate that the soil was more deficient in potash than in nitrogen and phosphoric acid. The favorable result is probably due to the effect of kainit on the moisture supply of the soil, a result which would not necessarily be so noticeable in seasons of normal rainfall.

Prevention of Smut.

Smut is the cause of much loss to those who grow oats in all parts of the United States. We have seldom noticed in Alabama a field of oats not treated for smut in which the injury due to smut could be estimated at less than five per cent. of the crop. In one locality visited just before the last crop was harvested no field was seen in which the loss could be estimated at less than twenty per cent. and in some fields it was evidently more than forty per cent.

There are several methods for treating smut. The one which is used on the Station Farm with entire success and which is believed to be the cheapest and the best for our conditions is the Jensen treatment. This consists in keeping the seed oats in hot water at a temperature of from 130 to 135 degrees Fahrenheit for 10 to 15 minutes. The temperature kills the spores (so-called "seed") of the fungus which produces smut but does not interfere with the germination of the oats.

An experiment to determine the amount of injury from smut was made on two plots of oats sown on poor sandy land February 12, 1896. Equal quantities of seed oats were weighed out for the two plots. The seed for one plot was then placed in water at a temperature of 130 to 135 degrees Fahrenheit for ten minutes. The yield of oats was 13.1 bushels per acre with seed not treated, and 14.2 bushels with scalded seed. This is a gain of 1.1 bushels per acre or about eight per cent., obtaind at the cost of only a few minutes labor.

A careful count was made of the sound and smutted heads growing on measured and equal areas on each plot. The average results showed that on the plot with seed not scalded 5 9 per cent. of the heads were destroyed by smut. Not a single head of smut could be found on the plots sown with treated seed. The gain in yield was even greater than the number of diseased stalks would indicate. This represents a general truth, namely, that the average farmer is apt to underrate the amount of injury done by smut, failing to notice many of the diseased stems, which remain dwarfed and inconspicuous, or to allow for grain which, though apparently sound, is light, as the result of smut. As estimated above, the loss in Alabama oat fields due to smut is generally greater than that noted in this experiment, where comparatively clean seed was used.

By treating all the seeds for a few years in succession, and sowing grain only on fields where smut has not recently developed, the seed grown on the farm will become so free from smut spores that scalding will in time become unnecessary. The value of the treatment given above has been conclusively proven in many experiments in a number of states. The treatment is rendered easier by the following arrangement for heating the grain:

Have a vessel for heating water and three tubs or barrels. In tub No. 1 maintain the water at a temperature of 110 to 120 degrees Fahrenheit, in No. 2 keep the water at 130 to 135 degrees, adding cold or hot water as required, and in No. 3 keep cold water. Dip the sacks of oats for a few minutes in tub No. 1, the sole purpose of which is to prevent the cold oats from going immediately into tub No. 2, and thereby reducing the temperature too low.

From tub No. 1 carry the sacks of warm oats to tub No. 2, keeping the oats submerged there and occasionaly stirred for ten or fifteen minutes. Then dip the hot oats into cold water or immediately spread them to cool. Only the one vessel having water kept continuously at 130 to 135 degrees is absolutely necessary. The other two are simply conveniences to hasten the work. An accurate thermometer is absolutely necessary. No guess work is admissible. A good "floating dairy thermometer" can be obtained from large drug stores or from dealers in dairy goods at a cost not exceeding 50 cents.

This cheap thermometer should be compared with a more expensive one to see that it is accurate. If the floating thermometer varies by a degree or two from the standard, due allowance can be made for this when using the former.

Two men in an hour can treat several bushels, usually 3 to 4 bushels where grain is handled in one bushel sacks, or larger quantities in proportion as the sacks and hot water vessels are larger. The cost for labor should not, at current rates, exceed three cents per bushel or not over five cents per acre. In return a gain of from 1 to 8 bushels of oats per acre may be expected. The scalded oats may be sown as soon as cooled or they may be dried for later sowing, by being spread out in a thin layer and stirred, or by adding any drying material, as sand, dust, etc.

BULLETIN No. 96. AUGUST, 1898.

ALABAMA

Agricultural Experiment Station

OF THE

AGRICULTURAL AND MECHANICAL COLLEGE,

AUBURN.

Experiments with Crimson Clover and Hairy Vetch.

J. F. DUGGAR.

BIRMINGHAM
ROBERTS & SON.
1898

Experiments With Crimson Clover and Hairy Vetch.

BY J. F. DUGGAR.

SUMMARY.

Clover, vetch and similar leguminous plants are able to draw much of their nitrogen from the air when enlargements called tubercules or nodules are found on their roots. They are unable to do this, or to store up fertility, when tubercules are absent.

In order for tubercules to develop, specific germs or bacteria must be present in the soil or seed, or come in contact with the young rootlets. In the regions where the clovers, vetch, alfalfa, etc., are extensively grown, these germs become generally distributed in the soil of the entire region. In a number of localities in Alabama, where these legumes are not grown to any great extent, these germs are absent from some soils or present in insufficient numbers.

Inoculation is the process of supplying these germs, either by scattering on a field some of the germ-laden soil from a field where these rarely grown legumes have borne tubercles, or by the use of the prepared material called Nitragin.

Nitragin is a concentrated germ fertilizer containing myriads of germs which are able to cause the growth of tubercles on the roots of certain leguminous or soil improving plants. Both Nitragin and germ-laden earth were very profitably used in our experinents.

Crimson clover inoculated with clover Nitragin afforded a crop of 4,057 pounds of hay per acre, while ordinary or untreated seed gave (including many accidently inoculated

plants) only 761 pounds of hay. This is a gain of at least 3,296 pounds of hay per acre as the result of inoculation.

Seed of hairy vetch inoculated with vetch Nitragen produced hay at the rate of 3,270 pounds per acre, against 564 pounds with ordinary or untreated seed. This is an increase of 2,706 pounds of hay per acre as the result of inoculation.

The cost of inoculation, using Nitragin as above, was at the rate of $2.25 per acre, leaving a large profit.

In an earlier experiment here hairy vetch was inoculated with soil from an old vetch field, wihout expense except a small item for labor. This home grown inoculating material effected an increase of 2,308 pounds of hay per acre.

A field once inoculated, whether naturally or artificially, remains inoculated for years.

As a general rule, each division or genus of leguminous plant has its own specific or adapted germ.

Nitragin is very perishable especially in warm weather and this may cause frequent failure in using it.

Natural agencies are constantly at work spreading root tubercle bacteria and inoculating soils. If given sufficient time (several years) most legumes will probably develop tubercles without help from man. Artificial inoculation brings quicker success in the culture of rarely grown legumes.

Inoculated hairy vetch yielded slightly less dry material in the above-ground portion and a considerably smaller weight of roots than nearly mature rye.

However the inoculated vetch contained in both tops and roots a much higher percentage of the valuable element, nitrogen, than did rye, and also more than did non-inoculated vetch plants.

The crop on one acre contained in tops, stubble and roots 105.5 pounds of nitrogen in the case of inoculated hairy vetch, only 26 pounds in the case of rye, and still less in non-inoculated vetch plants. This excess of 79.5 pounds of nitrogen stored up by vetch explains the superior fertilizer and food value of hairy vetch over rye.

Of the total nitrogen in healthy plants of crimson clover and hairy vetch, less than one-fifth was contained in the roots and short stubble. The roots and stubble alone of hairy vetch contained about four-fifths as much nitrogen as the entire rye plant.

Both heavy and light applications of non-nitrogenous fertilizers were profitably applied to hairy vetch.

Soil Improving Plants and Root Tubercles.

In several experiments described in Bulletin No. 95 of this station the land was left in a much more fertile condition by plowing under a crop of cowpea vines than by turning under a growth of crabgrass and weeds. The cowpeas had stored up fertility, the other plants had not.

Examination of the roots of the plants shows that cowpea roots have many roundish enlargements, while roots of crab grass, most weeds, cotton, corn, etc., are free from swellings of this character.

The name tubercle or nodule is applied to these enlargements, which may be found on all thrifty cowpea plants, clover plants, etc. If these tubercles are present the plant bearing them is a renovating or soil-improving plant. All plants on which these nodules can grow belong to the class of leguminous plants or legumes.

Leguminous plants, unlike others, are able to obtain from the air a large proportion of the nitrogen required for growth. This power to collect or "fix" atmospheric nitrogen resides, not in the flowering plant itself, but in the tubercles attached to its roots.

Each of these enlargements, nodules, or tubercles, is filled with myriads of miscroscopic germs or bacteria, which feed on the gaseous nitrogen found in limitless amounts in the atmosphere. Air, and consequently free or gaseous nitrogen, circulates in all cultivated soils and comes in contact with root tubercles. The germs within these nodules seize this nitrogen, which flowering plants cannot directly utilize, and change it into a form suitable for nourishing these higher plants. The nitrogenous food thus prepared in the tubercle enters into the circulation in the root to which the nodule is attached, and thence is carried in the sap to build up all parts of the leguminous plant.

Inoculation of Soil or Seed.

Every plant suitable for the growth of root tubercles ought to have an abundant supply of them. The writer has never found a cowpea plant of suitable age and grown under normal conditions which was free from tubercles.

Yet some plants that can form tubercles are sometimes found to have none. The writer has examined hundreds of individual clover and vetch plants on which there were no tubercles. For such plants the farmer has no use. They are no more doing the work they should do than is a barren stalk of corn.

Why do leguminous plants under some conditions fail to form tubercles? It is because the proper germ ("seed," so to speak) is absent from the particular soil in which legumes grow without root nodules. In order for tubercles to form on a given leguminous plants a specific germ must be present. For clover this must be a germ or bacterium of that particular strain or stock which is accustomed to grow in clover tubercles; for vetch it should be the kind of germ which is accustomed to grow in vetch tubercles; and so for other plants.

Inoculation consists in placing a supply of these germs in such position that the young roots of the leguminous plants will come in contact with them. We may inoculate either the soil or the seed.

Individual tubercles are short-lived, and when one decays it distributes in the surrounding soil a great multitude of germs or root-tubercle bacteria which serve the purpose of seed for the next crop of tubercles. Thus in an old clover field are myriads of clover germs, in an old vetch field multitudes of vetch germs, and so for other legumes. Hence when clover follows clover or when it is sown in a locality where the growth of clover is general and clover germs generally distributed, artificial inoculation is unnecessary.

It was not suspected until recent years that any soils stood in need of being artificially supplied with root-nodule bacteria. Salfeld and others found that "moor soils," a small and peculiar class of peaty soils found in Europe, were benefited by artificial inoculation for certain legumes. No account of large areas of American soils needing inoculation had been published so far as could be learned prior to Bulletin 87 of this station. That bulletin pointed out the fact that in many portions of Alabama the frequent failure of clover, alfalfa, and other rarely grown legumes was due to the absence or insufficiency of the corresponding root-nodule bacteria in the soil.

Since soil of an old clover field contains abundant clover germs, since these are necessary to the abundant growth of clover, and since they are wholly or in part absent from some soils, it follows that soil from an old clover field should be added to soils thus deficient and hence unsuitable for clover.

Quite recently a German firm whose American agents are Victor Koechl & Co., 79 Murray St., New York, have placed on the market a preparation called Nitragin. The several brands of Nitragin contain in concentrated form the same kinds of germs that are found in old fields of clover, vetch, alfalfa, etc.

Either this prepared material or the soils containing the requisite root-nodule bacteria may be used as an inoculating material. Both have been separately used in our experiments and both have been highly beneficial.

Crimson Clover and Hairy Vetch.

Before describing in detail our experiments in which there was an enormous increase in the yield of crimson clover and hairy vetch, brief notes regarding these two plants are in order.

Crimson clover is an annual leguminous plant making its growth between October and May. Making all of its growth in the cooler, moister portion of the year, it escapes with less injury than does red clover from dry weather in summer. It has a head which is two or three times as long as that of red clover and which is of a crimson or scarlet color. The plant grows 16 to 28 inches high, makes good pasturage, and excellent hay if cut in time. Its chief value in the South will doubtless be as a green manure for improving the soil of old cotton and corn fields.

It can be sown among the standing cotton stalks in October and covered with a V-harrow or cultivator, and can be plowed under the following April in time for summer crops. Sown here as late as November 6 among cotton stalks it attained a height of 14 to 26 inches. The amount of cleaned seed required to seed an acre is 15 to 20 pounds, and the cost is usually 5 cents per pound, the seed for an acre costing 75 cents to $1.00.

Hairy vetch is also an annual leguminous plant, making its growth during the same period as crimson clover and useful for the same purposes. It is a vine-like growth, and for support should be sown with some erect plant, as one of the grains. For sowing with vetch Myer's turf oat has been highly recommended by the Mississippi Experiment Station. Here this mixture, one to two pecks of vetch seed per acre and one to one and one-half bushels of oats, has been successful on rich spots, but on poor land an earlier ripening variety of oats is needed.

Europeans recommend rye as an excellent plant to sow with hairy vetch, but in our experiments common Southern rye ripened too early.

If vetch is sown alone for hay one bushel per acre is required. With the small grains vetch can be combined in any proportion desired. The cost of seed is about three dollars per bushel.

Both crimson clover and hairy vetch should be sown in the period between September 1 and November 1, usually October 1. Earlier sowing is permissible on land not very subject to drought.

Inoculation Experiments with Crimson Clover.

It is almost certain that crimson clover has failed more frequently and more completely than any other plant ever tested in Alabama. The cause is now revealed, and the cure for such failures in indicated by the results recently obtained in experiments conducted at this Station.

Four plots, each one-twentieth acre in area, were used for an inoculation experiment with crimson clover in November, 1897. The soil was a clay loam, by no means fertile. The four plots used were all in the same terrace, and all were prepared alike and at the same time. So far as could be learned no clover had previously been grown in this field nor in adjoining fields. Each plot was fertilized with 15 pounds acid phosphate and 2 pounds of muriate of potash. This is at the uniform rate of 300 pounds of acid phosphate and 40 pounds of muriate of potash per acre on all plots. No nitrogenous fertilizer was used on any plot.

One pint of seed of crimson clover was sown on each plot; this is at the rate of ten quarts of seeds per acre. On account of dry weather seed was not sown until November 5, 1897, which was a month later than the preferred season.

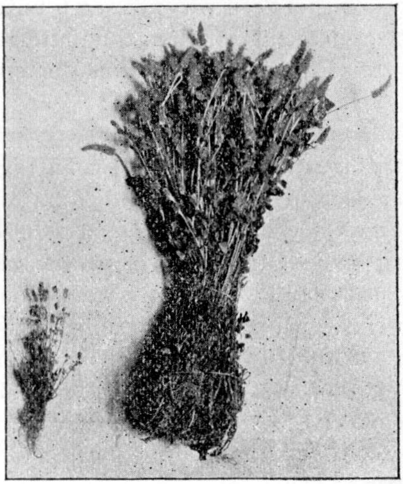
The seed for Plots 1 and 3 was inoculated, that is supplied with clover germs, as follows:

The seed was moistened with water to which had been added about two teaspoonsful of clover Nitragin. This is a material imported from Germany, and containing myriads of the germs such as are found on the little enlargements or tubercles that grow on thrifty clover plants. By this means the individual seeds for Plots 1 and 3 were brought in contact with clover germs, or just such germs as the seed would come in contact with if sown on a field where clover had previously grown successfully. The seed of Plots 2 and 4 was not moistened, but sown in the usual way.

As soon as seed was sown on all four plots, a harrow was run over all plots to cover seed.

On account of late sowing, crimson clover plants on all plots made very little growth and all plots appeared alike until March, 1898. By this time the plots sown with inoculated seed presented a greener appearance, and on examination of the plants on the inoculated plots, enlargements or tubercles could be found on the roots. These tubercles were not present on the plots sown in the ordinary way, except on plants growing along a depression or water-furrow and in other spots near the edges of the plots and adjacent to the inoculated plots. These spots were greener than the other portions of the non-inoculated plots, and their location (in depression and along the border of the non-inoculated plots adjacent to the inoculated plots) indicated that the plants in these green spots had become inoculated by seed dragged from adjacent plots, or by the drainage water from the inoculated plots. This accidental inoculation of a part of the plots to which no clover germs were intentionally applied must be kept in mind when noting the yields.

During all of March and April the plants on Plots 1 and 3 grew luxuriantly. The plots not inoculated made almost no growth in March (except on the spots accidently inoculated



CRIMSON CLOVER.
18 Non-inoculated plants. 18 Inoculated plants.

as above) and acquired a decided yellowish color. In April some of the non-inoculated plants, then not over two inches high, died, apparently from nitrogen starvation. Others had barely sufficient vitality to throw up seed stems 4 to 7 inches high, capped by a very small bloom. Still others did not bloom, but remained stationary at a height of 2 to 4 inches. Late in April and during the first few days in May the contrast between the inoculated and non-inoculated plants drew forth expressions of astonishment from numerous visitors to whom the field was shown.

Plots 1 and 3 were ready to be cut May 1, but for the benefit of visitors harvesting was postponed for more than a week. When cut the plants on the inoculated plots were 22 to 26 inches high and well branched. The deep green foliage was surmounted by the brilliant crimson of the blooms, the whole presenting a very attractive appearance.

On plots 2 and 4 there were spots covering one-fifth to one-eighth of their area on which spots the plants presented the same luxuriant appearance as on the inoculated plots. Elsewhere on the non-inoculated plots the plants were yellowish, the blooms few, small, and near the ground, and the plants too small to be cut with either mower or scythe. These small plants were carefully cut with a small sickle to avoid any possible waste.

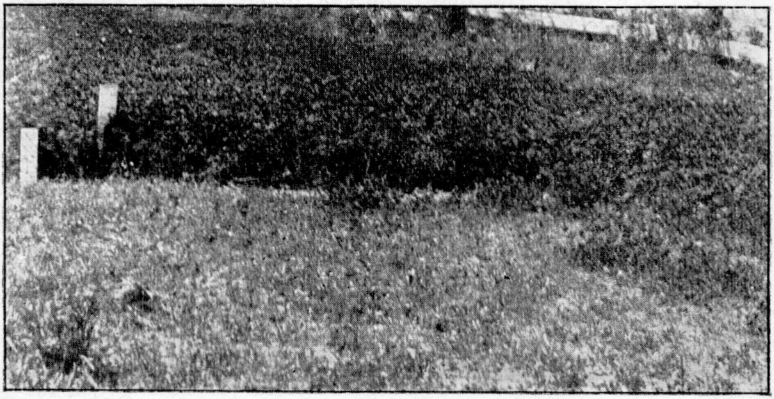
In the table below are given the yields of both green forage and hay. These figures, however, fail to do justice to the increase effected by inoculation, for most of the material on the non-inoculated plots consisted of the luxuriant plants growing on accidentally inoculated spots, as before explained.

Yields of crimson clover from inoculated and non-inoculated seed.

Plot No.	SEED	YIELD PER ACRE	
		Green forage	Cured hay
		Lbs.	*Lbs.*
1	Inoculated	16746	4781
2	Not inoculated	1277	464
3	Inoculated	11333	3333
4	Not inoculated	3310	1059
Av.	Inoculated	**14039**	**4057**
Av	Not inoculated	**2293**	**761**

In this experiment the average yield of green clover was 14,039 pounds per acre with inoculation, and only 2,292 pounds without inoculation. Of cured hay the average was 4,057 pounds per acre with inoculation, and only 761 pounds without, an increase of 3,296 pounds per acre.

In regard to the cost of this beneficial treatment, Nitragin is quoted at 62 cents per bottle in Germany, but costs us $1.25, plus express from New York. One bottle is sufficient



CRIMSON CLOVER.
Inoculated plants shown in upper part of picture, non-inoculated plants in foreground.

for five-eighths of an acre, so that, including express from New York, the cost of inoculation with Nitragin is about $2.25 per acre.

But material obtained at home without cost can be used instead of costly Nitragin. The soil from a field where any true clover (red, crimson, white or creeping clover, etc.) has made a luxuriant growth and formed tubercles can be used to inoculate clover seed, or soil from an old vetch field may be used as inoculation material for vetch. In the following experiment, first published in Alabama Station Bulletin No. 87, such inexpensive inoculating material was used.

Hairy Vetch Inoculated with Vetch Earth.

Seed of hairy vetch was sown October 17, 1896, all plots being fertilized alike with acid phosphate and sulphate of potash. Before sowing, one lot of seed was dipped into water, into which there had been stirred and allowed to settle earth from a lawn, once a garden spot, where common vetch (*Vicia sativa*) had for several years in succession made a luxuriant growth and formed tubercles.

The plants from inoculated seed formed numerous branches, most of which were about three feet long; those from ordinary untreated seed made but few branches, and these were only about eight inches long. The inoculated plants had large clusters of tubercles on the roots; the others had no tubercles.

The weight of cured hay was 2,540 pounds per acre from inoculated seed, and only 232 pounds from non-inoculated seed, a gain of 2,308 pounds, obtained at no other expense than that of the labor necessary to obtain the soil from the lawn where vetch had grown.

Inoculation Experiment with Hairy Vetch.

An experiment similar to the above was begun November 4, 1897, except that, instead of vetch earth, there was used some of the imported material prepared especially for this plant and known as vetch Nitragin. The field used was remarkably uniform in fertility, as shown by the nearly uniform yields of corn on all plots in 1897. Seed of hairy vetch was sown on one-twelfth acre plots November 4, 1897, at the rate of 30 quarts per acre. On two untreated plots seed was sown in the ordinary way. On the other plots the seed was dipped in a solution of vetch Nitragin.

The plants grew off slowly on all plots and the soil contained sufficient nitrogen to keep the non-inoculated plants abreast of the others until spring. Then differences appeared: the non-inoculated plants being in large part reddish or brownish. The inoculated plants had a healthy green foliage, branched much more freely than the others, and attained a length of vine several times greater than did the plants on the untreated plots.

On the inoculated plots large clusters of tubercles were found on the roots of plants, while on the plants grown from untreated seed tubercles were absent. About May 1 hairy vetch was ready to be cut for hay. It was cut May 9, the

HAIRY VETCH.
Four inoculated plants. Four non-inoculated plants.

growth on only one of the non-inoculated plots being cut, the other being plowed under as part of another experiment. The growth on the two non-inoculated plots was about equal, the plants on both being reddish to brownish and having branches, most of which were only about 6 to 12 inches long. The marked differences between the inoculated and noninooulated plots were easily observed by visitors, even when standing at a considerable distance away.

Yield per acre of hairy vetch from inoculated and non-inoculated seed.

Plot No.	Seed.	Yield per acre.	
		Green Forage.	Cured Hay.
		Lbs.	*Lbs.*
10	Inoculated	8460	3180
12	Inoculated	11520	3360
Av.	Inoculated	**9990**	**3270**
Av.	Not inoculated	**1560**	**564**

In this experiment the average yield of cured hay per

HAIRY VETCH PLOTS.
Inoculated plants shown in upper part of picture; non-inoculated plants in lower part or foreground.

acre was 3270 pounds with inoculated seed and only 564 pounds with ordinary seed. This is an increase of 2706 pounds of hay per acre as the result of inoculation.

Inoculation Practicable.

The cost of Nitragin, about $2.25 per acre, the risk of finding that it has spoiled while in transit or before use, and the dislike of many farmers to undertake some unusual operation, are influences which will prevent most farmers from employing this method of inoculation.

There is a cheaper, simpler and more practicable method of inoculation. This consists in using, instead of Nitragin, the earth from about the roots of tubercle-bearing leguminous plants. He who already has even a small area of clover growing in his fields, pastures or lawn can practice inoculation at practically no expense. He can use this clover dirt in inoculating any true clover. If he has a plot of vetch he can use the soil from the vetch plot as inoculating material for vetch seed, or he can doubtless use effectively on vetch the earth from a part of his garden where English peas have recently grown and formed tubercles.

In using earth from the garden one should first make sure that the roots of plants growing in it are not infested with nematode worms. The nematode pest occurs in many localities in the Gulf States and is especially prevalent in gardens. Nematode injuries consist of enlargements on the roots of plants which might be confused with the beneficial root tubercles found on all thrifty leguminous plants. Although the two have no connection, they may exist on the roots of the same plant at the same time. They may be distinguished by the fact that generally the nematode worm causes the portion of the small root attacked to enlarge equally or nearly equally in all directions. In other words the nematode swelling and the small roots are practically concentric, the root having the appearance of growing through the swelling. The small tubercle, on the other hand, is attached to the side or surface of the root. Later stages of the nematode swellings are not so easily described.

The method of inoculating with soil that is usually recommended consists in scattering broadcast on the plowed ground about one ton per acre of soil from a field of clover, vetch, etc. This earth should be harrowed in promptly and thoroughly.

Another method which can be used when the supply of earth for inoculation is limited, consists in stirring the soil into water and dipping the seed in the liquid. It was this method which gave us here a tenfold increase in the yield of vetch sown in October, 1896. It would increase the chances of success to combine both methods, inoculating both seed and soil as just described.

The writer would not be understood as recommending that Nitragin be used on all the seed for large areas of clover, vetch, alfalfa, etc., sown in "cloverless" regions. Its cost and the risk of having it spoil before it is used almost prohibit its use on an extensive scale. But it is certain that Nitragin may be profitably used on the seed for a small area with a view to using the soil from the area thus inoculated for use as the inoculating material for large fields sown in subsequent years. In other words Nitragin finds its most appropriate use as a "starter," in somewhat the same sense that progressive dairymen sometimes cause cream to sour by using a small quantity of sour milk from a creamery where the highest quality of butter is made, thus obtaining a stock of germs that are concerned in giving the highest flavor to butter. A bottle of Nitragin is sufficient for five-eighths of an acre, and the soil on that area is sufficient to inoculate the next year scores of acres.

Employed in this way, the Nitragin may be used with great profit. Of course, earth from an old clover field may also be used as a starter for clover on a small area, furnishing the next year material for use on many acres. Any farmer can strike a balance between the two methods, setting the cheapness of the inoculating earth over against the greater amount of labor of applying it. It has been claimed that the use of Nitragin affords more complete inoculation, or a more uniform distribution of the germs and of the resulting tubercles. We have made no experiments bearing on this last point.

Lespedeza Earth as Inoculating Material for Crimson Clover.

In October, 1896, an inoculation experiment was begun with crimson clover. As this was before the days of Nitragin, and as we had not at hand at that time a field of any one of the true clovers, it was decided to try the effect, as an inoculating material, of earth from a field of lespedeza or Japan clover. This earth was sown at the rate of 720 pounds per acre, broadcast, and harrowed in with the crimson clover seed. Although the earth employed was well supplied with the germs which cause the development of tubercles on lespedeza plants, the crimson clover plants growing on the plots where it was applied formed no tubercles and failed utterly, attaining a height of only about three inches.

Numerous experiments conducted by the writer accord with European experiments, which show that, with few exceptions, the inoculation of any leguminous plant can be affected only by the root-nodule bacteria from a plant belonging to the same genus. Thus the germs found in lespedeza tubercles have no power to originate tubercles on crimson, red or white clover; vetch germs have likewise no inoculating power toward the clovers, alfalfa, etc.

The first word in the botanical name of a leguminous plant generally gives the key by which to determine whether its root-nodule bacteria are capable of inoculating any other given leguminous plant. The general rule is this: If the first word (generic name) of any two legumes is identical, the root-tubercle bacteria on either are capable of causing tubercles to grow on the other. Examples to illustrate this principle follow: (a) Crimson clover (*Trifolium incarnatum*), red clover (*Trifolium pratense*), white or creeping clover (*Trifolium repens*), inoculated with the same material; (b) alfalfa (*Medicago sativa*), bur clover (*Medicago maculata*), inoculated with the same material.

The above rule does not cover all cases; for example, the root-nodule bacteria of the garden pea is capable of inoculating vetch, in spite of the fact that the first or generic names of the two plants are not identical.

Natural Methods of Inoculation.

The fact that clovers and clover-like plants have inhabited the earth for ages and have regularly formed tubercles without artificial inoculation will cause many persons to be skeptical regarding the value of inoculation. The fact that usually wild and cultivated legumes are naturally inoculated does not indicate that inoculation of certain rarely grown plants is unnecessary under all conditions. It would be just as logical to argue against plowing as a preparation for hay grasses on the ground that the grasses grow luxuriantly in their wild state without any preparation of the land.

Natural methods of inoculating legumes, or of bringing the appropriate root-tubercle bacteria in contact with the roots of young legumes are as follows:

(1) Decay of tubercles, on old legume roots, thus freeing thousands of bacteria in the soil where the seed will be dropped and where the next generation of legumes will grow.

(2) Transportation of germs thus freed by means of winds, flowing water, etc.

(3) Inoculation of seeds before they fall by means of germ-laden soil settling upon them or spattering upon them during rains.

(4) Changes in the nature or food habits of the root-nodule bacteria by which it is claimed that these germs may in time so adapt themselves as to cause tubercles on any legume grown continuously on the same field for several years.

The writer is not in possession of very direct evidence on this latter point, made by European writers, but there is certainly some indirect evidence in its favor.

Wherever any of these agencies are active, inoculation is never absolutely necessary, and often superfluous.

When clover follows clover on the same land for several years in succession, we have an example of the first mentioned of these natural agencies. Of course in such a case artificial inoculation is unnecessary.

The case is similar when vetch is sown on land where closely related wild plants have previously grown, a class very common in uncultivated places, wood-lands, etc. In or near garden spots and around the residence vetch is often independent of artificial inoculation.

When clover is sown in a region where clovers are extensively grown and where the dust and surface drainage waters are laden with the corresponding germs, we have an example of the second agency. The uselessness of artificial inoculation of alfalfa in the West, where it is so universally grown, is also apparently to be explained in the same way. We have found the cow pea under all natural conditions to be independent of artificial inoculation in the South, doubtless because of the same agency.

The third agency is exemplified in the case of bur clover, the burs of which usually contain some of the soil on which they have grown. The writer's experiments indicate that this plant does not need artificial inoculation if the seed is planted without being hulled. Likewise we have found lespedeza to be independent of inoculation.

As perhaps illustrative of the change by which certain bacteria adapt themselves to plants on which they would not originally cause tubercles, we may refer to the fact that on land where vetch and clover during the first year develop few or no tubercles, after a few years of continuous growth of the same plant on the same land, tubercles are found in abundance. A case of this kind occurred here; hairy vetch, an annual plant, made a poor growth the first year, a fair growth the second year on the same plot, and a luxuriant development in subsequent years; and this, too, in spite of the fact that in the earlier years better seasons occurred and fertilization was heavier than in the later years. This particular case may also owe something to the agency of germs transported from an adjacent field where a closely related plant had been grown.

Let us admit that if grown continuously on the same land for a sufficient length of time, clover and vetch may reach the point of producing a normal supply of tubercles. Can the farmer living in a region where the appropriate root-tubercle bacteria are not abundant afford to wait on slow-acting natural agencies to inoculate his fields? Under such circumstances artificial inoculation must be regarded, not as in opposition to natural agencies, but as a means of hastening and increasing their activity.

Once inoculated, whether by natural or artificial means, a soil remains inoculated as long as the same legume is grown upon it. Indeed the growth of several non-leguminous crops (such as cotton, corn, oats, etc.,) does not cause the loss of the ability of this soil to produce tubercle-bearing plants of the original legume.

Cause of Frequent Failure of Nitragin.

The effects of Nitragin, given in a preceding paragraph, are sufficiently startling to convince the most conservative that inoculation comes as a new and revolutionary factor in the agriculture of the Gulf States. In view of the revealed ability to grow clovers, vetches, etc., on soils previously unfit for them, the possible benefits from inoculation can scarcely be overestimated.

But he who attempts to use Nitragin will, if he overlooks certain considerations, meet with some disappointments. The greatest obstacle to the general use of Nitragin in certain "cloverless" regions is the fact that this valuable material is perishable. It loses its inoculating property if long exposed to light, or if subjected to much heat, or if kept for more than two or three months. It endures longer in a cool than in a warm temperature. Nitragin shipped from Germany early enough to reach the Southern farmer in time for use on fall-sown seed runs great risk of being exposed to a temperature sufficiently high to cause fermentation, and consequent death, of the germs which it contains.

So many bottles of Nitragin ordered in time for use in our fall experiments have reached us in a worthless or dead condition that we would advise those who may wish to obtain a few bottles of Nitragin as a "starter," to order the shipment made from Germany about the first of February, so that the Nitragin will arrive in time for use on seed sown in March. While we have found to be dead some of the Nitragin imported in winter, the losses have been less at this season than with importations in the early fall.

In some cases this dead Nitragin had been used on seed sent out to farmers as "inoculated" before its worthless condition had been noted, thus causing failure and disappointment.

Co-operative Tests of Crimson Clover and Hairy Vetch.

More than fifty tests of crimson clover have been made by farmers in different parts of this State. The first tests were made entirely with untreated seed. Each party making the test was requested to send to the writer late in the spring three average plants for examination.

When untreated seed was used the plants were almost invariably small and either devoid of tubercles or supplied with only a limited number of very small tubercles.

The same was true with hairy vetch.

Our first supply of Nitragin was received January 6, 1897. It was an unsuitable time for sowing seed of any legume, but as soon as the weather permitted, seed of crimson clover and of other legumes were treated and sent through the mail for trial in different parts of the state. When used, the Nitragin was several months old and apparently too old to be of any value. At any rate the reports received indicated failure, the responsibility for which might be charged to either the unsuitable date of sowing or to the probable spoiling of the Nitragin. Moreover, there was delay in getting the seed into the ground.

In the second co-operative test the conditions were scarcely better. The very dry weather prevailing in the fall of 1897 made it inexpedient to treat the seed before November. One lot of seed was treated here November 10, another November 17, and still another November 27.

As this Nitragin had been shipped from Germany in September, at least some of the bottles had fermented before being used. The sample plants sent in again showed every evidence of failure and the general absence of an adequate supply of tubercles.

There was one instance where crimson clover plants from inoculated seed were strikingly better than those from ordinary seed.

At Eutaw, Mr. R. E. Kirksey received the seed within two days after they had been treated and sowed promptly, November 12. The following spring he reports as follows:

"Some of the plants on the inoculated plot were dark green and a foot high, others not so high or green on the same plot. The plants on the other plot (seed not inoculated) were very small and yellow."

It is clear that Nitragin, kept here for some time in bottles, then opened, applied in solution to seed, and sent to farmers through the mails, has generally failed to inoculate the plants growing from the seed thus treated.

This failure of co-operative tests, in connection with our success in using fresh Nitragin, suggests that those who use Nitragin must themselves open the sealed bottles, use the material on the proper seed, and plant the seed promptly.

This general failure of Nitragin distributed with numerous delays as above, does not argue against the necessity of inoculation for crimson clover and hairy vetch in many parts of the state. The great number of plants found to be nearly or quite free from all tubercles or from those of proper size, indicates that effective inoculation would generally be beneficial to these plants.

These tests of crimson clover and hairy vetch made by farmers indicate, if taken as a whole, that these two plants cannot be successfully grown on most of the soils where they have been tried under our direction without effective artificial inoculation.

Relative Yields of Rye and Hairy Vetch.

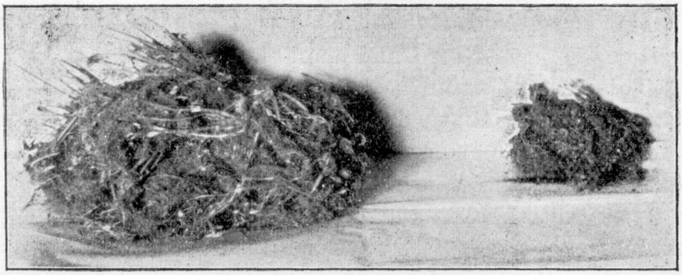
Rye and hairy vetch were grown under identical conditions on the sandy field sown November 4, 1897.

All plots were fertilized with like quantities of mineral fertilizer, using 36 quarts of seed per acre on the rye plot and 30 quarts per acre on the vetch plots.

One twelfth-acre plot of rye (Plot 1) was cut April 7, when in full bloom. The rye on the other (Plot 2) was turned under as a fertilizer for the succeeding crop. First, however, on May 7, 1898, the nearly mature rye on a carefully selected and average square yard of Plot 2 was harvested, as were similar areas of inoculated vetch and of non-inoculated vetch on adjacent plots.

The roots, to a depth of 6 inches below the surface and from an area of one square yard, were also separated from the soil by sifting, and then by repeated washing. Practically all the roots were found in the upper 6 inches.

Acre-yields of hay, calculated from such small areas are liable to considerable error, but in this case they agree rather closely with the figures obtained by weighing the entire pro



CRIMSON CLOVER.

Roots and stubble from one square yard of inoculated crimson clover

Roots and stubble from one square yard of non-inoculated crimsom clover.

duct of the one-twelfth-acre plots, indicating approximate correctness.*

The results follow, the weights being for air-dry material, or the natural dry condition of hay, straw, grain, etc :

*The variations between the acre-yields as calculated from the large and small plots is due to the fact that the yields on large plots included weeds, and in certain cases some accidentally inoculated plants. In the small areas, used for sampling, no accidentally inoculated plants were included and all weeds were separated.

Weight of air dry material of rye and hairy vetch; also weight of crimson clover.

PLOT NO.		ON 1 SQUARE YARD.		ON 1 ACRE.	
		Tops.	Roots.	Tops.	Roots.
(*Field M*)		*Lbs.*	*Lbs*	*Lbs.*	*Lbs.*
1	Rye, cut in full bloom, Apr. 7	-- ---	----- --	1980	--- --
2	Rye, nearly mature..........	0.67	0.54	3243	2614
11	Hairy vetch, not inoculated..	0.04	0.08	194	387
13	Hairy vetch, inoculated......	0.63	0.30	3049	1452
(*Field T*)					
2	Crimson clover, not inoculated	0.02	0.05	106	266
1	Crimson clover, inoculated...	1.00	0.30	4840	1452

The nearly mature rye on plot 2 yielded only a little greater weight of tops than did inoculated vetch. The roots of rye were much heavier than those of vetch, partly due, it is believed, to the greater amount of sand mixed with the finer rye roots.

Crimson clover, being in a different field, cannot be compared in yield with rye and vetch.

Nitrogen in Inoculated and Non-Inoculated Plants.

The thoroughly dried tops and roots from sample areas of one square yard each were analyzed by Dr. J. T. Anderson, associate chemist of this station.

His results,—which are averages of several determinations in each case,—and the figures derived from them, are given in the following table:

Percentage and amounts per acre of nitrogen in tops and in roots and stubble.

PLOT NO.		Percentage of nitrogen in air dry		Weight of nitrogen per acre in		
		Tops.	Roots and stub'le	Tops.	Roots and stub'le	Total product.
(*Field M*)		*Perct.*	*Per ct.*	*Lbs.*	*Lbs.*	*Lbs.*
2	Rye, nearly mature	0.52	0.35	16.9	9.1	26.
11	Hairy vetch, not inoculated	1.23	1.19	2.4	4.6	7.
13	Hairy vetch, inoculated	2.71	1.37	85.6	19.9	105.5
(*Field T*)						
2	Crimson clover, not inoculated	1.62	0.97	1.7	2.6	4.3
1	Crimson clover, inoculated	2 48	1.63	1.20	23 7	143.7

The quality as well as the quantity of the crop was very favorably influenced by inoculation, the percentage of nitrogen in the tops being practically doubled. The higher the percentage of nitrogen the greater is both the food value and the fertilizer value of a plant.

The tops of the rye, including the nearly mature grain and the straw, contained only 0.52 per cent. of the nitrogen, or less than one-fifth as much as was contained in the tops of inoculated vetch plants. The roots of rye contained only 0.35 per cent. of nitrogen, or about one-fourth as much as the roots of inoculated vetch plants.

Of intense practical interest are the figures showing the amount of nitrogen per acre contained in the several crops. Vetch on one acre contained in the entire plant 105.5 pounds of nitrogen, rye only 26 pounds, or about one-fourth as much, and the dwarfed vetch plants still less than rye.

We may get some measure of the superiority of inoculated vetch over rye as a fertilizer by noting the fact that the nitrogen in one acre of the former exceeded that in an equal area of rye by 79.5 pounds. This 79 5 pounds of nitrogen would represent approximately the amount of nitrogen assimulated by vetch *from the air*, if we should assume that vetch was able to obtain no more of its nitrogen from the soil than was rye; this assumption that rye can draw from the soil at least as much nitrogen as hairy vetch seems plausible, in view of the well known strong foraging habits of rye, as evidenced in its successful growth on poor soil.

If this assumption is correct, inoculated vetch plants have obtained practically three-fourths (105.5—26=79.5 pounds per acre) of their nitrogen *from the air.*

These figures seem to afford a rough measure of the fertilizing or renovating value of leguminous plants.

Of the total nitrogen in the entire plants the roots and stubble contained 19 per cent. in the case of inoculated vetch, 16 per cent. with inoculated crimson clover, and 35 per cent. with nearly mature rye. In all cases the stubble was shorter than the mower would leave it, being only about 2 inches long in the samples analyzed. It is doubtless safe to conclude that with stubble of ordinary length fully one-fifth, and possibly one-fourth, of the total nitrogen would be left in the soil after cutting the hay.

With short stubble there was left on the soil in the roots and stubble of vetch about four-fifths as much nitrogen as was afforded by plowing under the rye plants entire. In longer or ordinary stubble and in its roots vetch doubtless supplied as much nitrogen as both tops and roots of nearly mature rye.

Fertilizer Experiment With Hairy Vetch.

Three of the one twelfth-acre plots in the field sown with hairy vetch November 4, 1897, were used to ascertain the relative profits of fertilizers applied at two different rates. The land was sandy upland, liberally fertilized in recent years with commercial fertilizers.

Seed of hairy vetch, inoculated with Nitragin, was sown broadcast November 4, at the rate of 30 quarts per acre. The seed was worked in with a cultivator; the fertilizers were then spread broadcast and harrowed in.

Acid phosphate at the rate of 240 pounds per acre, together with muriate of potash at the rate of 40 ponnds per acre, and the same fertilizers in half the quantities named above, were employed. No nitrogenous fertilizer was applied to any plot. One plot received no fertilizer of any sort.

In the following table $10 per ton is assumed as the price of hay:

Fertilizer experiment with hairy vetch.

PLOT NO.	FERTILIZER PER ACRE.	HAY PER ACRE.		Cost of fertilizers.	Profit from fertilizers.
		Yield.	Increase over unfertilized plot.		
		Lbs.	*Lbs.*		
16	No fertilizer	2244			
15	120 lbs. acid phosphate; 20 lbs. muriate of potash	2604	360	$1.25	$0.55
12	240 lbs acid phospate; 40 lbs. muriate of potash	3360	1116	2.50	3.08

Although liberal amounts of commercial fertilizers had been used in this field for several years previous, mineral fertilizers were profitably applied to hairy vetch. The larger application of fertilizers was more profitable than the smaller.

It is believed that on average sandy land and in seasons of normal rainfall the effects of fertilizers wonld have been more pronounced.

Leguminous plants (such as vetch, clover, cowpeas, etc.,) when amply supplied with tubercles, need no nitrogenous fertilizers, but are highly responsive to acid phosphate and potash salts. These plants make heavy demands on the mineral plant food of the soil.

BULLETIN NO. 97. SEPTEMBER, 1898.

ALABAMA

Agricultural Experiment Station

OF THE

AGRICULTURAL AND MECHANICAL COLLEGE,

AUBURN.

DAIRY AND MILK INSPECTION.

C. A. CARY.

BIRMINGHAM
ROBERTS & SON.
1898

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☞ The Bulletins of this Station will be sent free to any citizen of the State on application to the Agricultural Experiment Station, Auburn, Alabama.

CONTENTS.

Dairy and Milk Inspection.

WHY INSPECT DAIRIES AND DAIRY PRODUCTS?

For the people in general, especially for invalids, infants and young children, the question of a pure milk supply is one of the foremost sanitary problems. The quantity of the staple dairy products (milk, cream, butter and cheese,) that are consumed annually make it all the more necessary that such foods should be pure and wholesome. Great Britain is said to consume annually 250,000,000 gallons of milk. The United States uses yearly 5,209,125,567 gallons.

The fact that man can contract tuberculosis, typhoid fever, Asiatic cholera, scarlet fever, diphtheria, infant intestinal diseases, and possibly malaria, yellow fever and anthrax, by consuming infected milk makes it of vital importance to the public that such a valuable food should be officially inspected, and every possible means should be used to keep dairy milk clean, pure and free of disease-producing germs. Numerous epidemics* of the above named infectious diseases have been traced to an infected milk supply.

It is also essential that the inspectors prevent the use of preservatives in dairy products, because such drugs are injurious to the human body. Commercial preservatives are used by ignorant or unscrupulous dairymen and milk dealers in order to keep the milk sweet for a longer time. There may be no intentional wrong on the part of the milk vendor. Ignorance and innocence may be excusable as long as human life is not at stake; but when human health is ruined and lives are sacrificed the law must come to the rescue and protect public health. The city, the state or the federal government performs no more important function than that of preventing disease and protecting the health of its citizens.

The question of cleanliness of milk is closely related to its

*See pages 248-252.

purity. When an eminent bacteriologist finds that a sample of market milk in his city contains more germs than an equal quantity of sewage in the same city, it suggests the need of thorough and practical milk inspection.

Milk, cream and butter may vary in their composition. Some milk may contain less than 3 per cent. of milk fat; also much less than 9 per cent. of solids not fat; consequently such milk would contain an excess of water. Some cows may produce such poor milk, but a cow that will pay for her feed will produce a richer and better milk. However, the unscrupulous milk dealer may abstract cream and add water and coloring matter until the milk looks yellow and rich. The average purchaser pays just as much for this poor milk as rich milk is worth. The law steps in and establishes a legal standard; then prices should be gauged according to the degree of richness of the milk, or according to the minimum legal standard.

Moreover, when milk is teeming with millions of germs that feed upon the nutritive materials of the milk its value as a food is partially or totally ruined. As a rule any germ that grows or multiplies in milk destroys partially or wholly one or more of its nutritive ingredients; hence its value is decreased.

What has been said of milk is in the main true of cream and butter. They may contain disease-producing and ferment-producing germs; they may vary in chemical composition, a result of defects in the mode of collecting the cream and in the manufacture of the butter. Cream or butter may be adulterated and may be greatly reduced in value by partial or complete decomposition.

Dairy and Milk Inspection should begin at the dairy with the tuberculin test. Every cow should be tested before she is permitted to go into the dairy barns or mingle with the herd. Every dairy owner will save time and trouble by keeping all newly purchased animals completely isolated from his herd until they have been thoroughly tested for tuberculosis and other infectious diseases. When tuberculosis once gains admission to a herd the expense of eliminating it from the herd is always great. Losses from death and condemnation of infected animals will occur at intervals for a number of years.

When a herd becomes infected the cows that react with the tuberculin test should be quarantined or destroyed. The Danish method of quarantining tuberculous cows and sterilizing the milk from such cows can not be employed in this country without having an inspector conduct the process of sterilization. Some authorities believe that tuberculous milk may contain a sufficient quantity of the poison or toxine to injure the health of persons who consume such infected milk, especially if the persons are tuberculous. Hence it is the cheapest and safest to remove all tuberculous animals from the dairy herd and never thereafter use their milk as human food.

The barns, stalls and watering troughs where tuberculous animals have been kept, fed and watered should be thoroughly cleansed and disinfected. Thereafter the herd must be tested with tuberculin at least every six months. If proper hygienic conditions are maintained the number of cows that react will be fewer at the second test than at the first.

The dairy herds that supply the city of Montgomery with milk have been tested twice with tuberculin. All of the cows have been tested once and part of them twice; between the first and second tests several herds were changed by the sale of tested cows and the purchase of untested cows. The first test showed that about one per cent. of the entire number were tuberculous. In the second test about two and one-fourth per cent. of the entire number tested reacted.

A dairy herd was tested by a qualified veterinarian in a place in Alabama where no law exists to enforce the removal of tuberculous animals from the dairy; over 50 per cent. of that herd of cows reacted. Tuberculin tests in Alabama have thus far proven that many herds are free of tuberculosis, some herds are slightly infected and others have been seriously infected. Hence the necessity for thorough inspection.

How to Make the Tuberculin Test.—Begin with a small number of animals (say five to ten), and after experience has been gained 20 to 30 may be tested at a time. It is not a good plan to test animals when the days are very hot, unless the barn is well ventilated and can be kept so cool that the cows will not become overheated during the test.

The animals being tested should be fed the same kind of feed, in the same quantity, and at the same time each day of the test; they should also be watered at the same time each day. Likewise the cows should be milked at the regular time during the test. In short the cows that are being tested should be kept under exactly the same conditions during the two days of the test.

If the animals to be tested are not kept in their stalls over night have them placed in their stalls at 5 o'clock in the morning. Begin taking and recording their temperatures at 6 o'clock and repeat this every two hours until 6 or 8 o'clock in the evening. At 8 or 10 o'clock in the evening inject subcutaneously 2 to 3 c.c. of tuberculin into each adult animal weighing 1,000 pounds or less; if the animal weighs 1,200 to 1,500 inject not less than 3 c.c.; for calves use at least 1 c c. These doses apply to that form of tuberculin that is ready for use and not to the concentrated form.

The most convenient place for injecting the tuberculin is on the side of the neck or at the upper part of the shoulder. The best form of hypodermic syringe is one that permits the needle to slip on or into the barrel, and can be thoroughly sterilized by steam, hot water or hot air.

On the following morning begin to take the temperatures at 6 a. m. and repeat the same every two hours until 6 or 8 p. m., as on the previous day.

Now compare the temperature records for the two days. If the temperatures are two or more degrees higher on the second day, for three or more consecutive readings or records, than on the first day the animal is said to have "reacted." In other words the reaction says that the animal has tuberculosis. If the temperature rises for one or two readings, then falls for one or two readings and then rises, such fluctuations will indicate that the animal is more or less suspicious and should be tested again in two or three months; in the mean time this animal should be quarantined. When the temperatures on the second day are not sufficiently high to indicate a good reaction, yet higher than on the first day, the animal may be regarded as a suspect, and should be quarantined and retested in three or more months; this is especially true if there are tuberculous animals in the herd. If the temperatures run above 102 degrees F. for several readings on the first day it may be difficult to obtain a distinct reaction. When the temperature remains at or above 103 degrees F. for several readings on the first day that animal should be removed and tested at some later period when its temperature is more nearly normal. As a rule it is not best to test a cow in heat, or a cow near the end of pregnancy, or a cow that has recently calved, or any animal that has just been driven a long distance, or any animal that has just been taken from a car or a boat.

Always use good thermometers; the six-inch Hicks thermometer is one of the best. Keep the thermometer at least five minutes in the rectum when taking the temperature. Fresh tuberculin should always be employed. This department makes tuberculin and supplies the city of Montgomery, and several veterinarians in Alabama, with tuberculin upon condition that all reports of the tests are to be forwarded to this department.

The following examples from actual records made in Alabama with tuberculin furnished by this department will illustrate cases of reactions, suspicious cases and cases without reactions:

NO.	DAY.	6a.m	8a.m.	10am	12 m	2p.m.	4p.m.	6p.m.	REMARKS.
1	First	101.2	101 6	101.2	101	101.8	101.8	101.6	
	Sec'd	101.8	101.6	101.4	101 4	101.6	101.4	101.8	Normal or healthy.
2	First	101.2	102	102	101.6	101.8	102	102.2	Good reaction.
	Sec'd	105.4	106	105.2	105.4	105.2	104.2	104	Tuberculous. [day.
3	First		102.6	102.7	103 3	103.6	103.7	103.6	Temp. too high 1st
	Sec'd	102	102	102.7	105.2	103 6	103.5	106	Suspicious case.
4	First		101	101.4	101.8	101.5	102.1	101.7	
	Sec'd		100 5	101.6	102.7	104 8	105.7	105.3	Reaction.
5	First	101.2	101.6	100.2	101.6	102.6	102.6	102	
	Sec'd	103	103	102.2	102	103.2	103.2		Suspicious case.
6	First		102.3	102.9	102.7	103.4	103.6	103 6	
	Sec'd	102.2	102.2	103	103.7	104.6	103 8	104.8	Suspicious case.

Tuberculosis is not the only disease that would disqualify a cow for the dairy. Animals having anthrax, Texas fever, malignant catarrh, contagious pleuro-pneumonia, cow-pox, infectious mastitis, foot-and-mouth disease, pneumonia, peritonitis, enteritis, gastritis, acute indigestion, actinomycosis, should not remain in the dairy while diseased, but may be returned in case of complete recovery. In other words, when cows have any disease with systemic fever, or if there is any danger of toxic products being thrown out of the system with the milk, such animals should be removed from the dairy until they completely recover. Inflammation of one or more quarters of the udder (mammitis or garget) will usually be accompanied by curdled milk and sometimes by pus and broken down tissue elements; in such cases the milk should not be used until the parts affected become healthy.

It may be well to state here that in any disease which decreases the flow of milk it is a good plan to have the cow milked three or more times a day, in order to stimulate the secretion of milk and remove the morbid products from the udder; but the milk should not be used as human food.

The **Kind** and the **Condition** of the **Feed** used at a dairy should be carefully and frequently investigated. Distillery swill, old brewery grains, rotten or decayed grain of any kind, moldy hay, rotten potatoes or turnips, spoiled silage, or any kind of partially decayed feed, should be excluded from the dairy. Fresh brewery grains should be fed sparingly. As a rule good turnips should be avoided because a very small amount is liable to contaminate the milk. Loud smelling, fermenting silage should not be in the stalls at time of milking, because the milk is liable to absorb the bad odor and the bacteria in the silage are liable to infect the milk. Bitter weeds and wild onions should be removed from pastures, if possible, since they transmit a bitter or onion taste and odor to the milk. Col. J. M. Falkner, of Montgomery, Ala., claims that he can remove all of the bitter taste and the onion odor by aerating the milk or cream with compressed air. Since the bitter principle of most weeds that affect milk is volatile it seems possible that compressed air aeration will remove them from the milk. Boiling or sterilizing in open vessels is said to remove the bitter principle from milk.

The **time** and **manner of feeding** are important. As a rule it is not possible to have dust-free air in a barn if the cows are fed just previous to milking. If the hay or feed is dusty it should be sprinkled and fed a sufficient time before milking so that the dust may be settled, the stalls ventilated, cleaned and sprinkled or flooded previous to the time of milking.

The Water Supply for the cows should be carefully guarded. It may come from a deep well, with sufficient protection from surface drainage—it may be kept in clean tanks, and yet the watering troughs may be foul and filthy. The writer has observed instances where the trough was so foul and smelled so badly that the animals turned from the trough and drank the water that had collected in the puddles in the yard. Too frequently the troughs are surrounded by mud and manure, which make them very difficult to approach and extremely liable to become contaminated by the splashing and spattering of filth. The trough should be located on a slightly elevated place and surrounded with rock, brick or cobble stones and a layer of gravel, so arranged that the drainage will be away from the trough and that it will never become muddy or sloppy around the trough. The watering trough should be thoroughly scrubbed with brushes, etc., at least once per week. The dropping of saliva and particles of food from the mouth soon makes the trough foul if there is nothing else to contaminate it. Avoid ponds, artificial lakes, contaminated runs or creeks that receive surface drainage from pastures or cow lots, and shallow wells that are located in cow lots or other filthy places.

Carefully arrange the **Drainage** of the barns and lots. The stalls should be of proper length, neither too short or too long, and the gutter for carrying off the urine should be in good condition, kept clean and flooded as often as possible. The liquid manure tank which receives the urine from the gutters should be as far away from the barn as possible. The manure pile should also be some distance from the barn and as a matter of economy should be protected from the rain. It is a good plan to flood and wash the stalls and gutters once or twice per day, because nothing is more frequently injurious to the milk than the dry manure particles that float around in the air and settle on the cows, walls, etc., and then drop into the milk at time of milking. Filthy barns may be responsible for the greatest amount of bacterial infection of the milk.

Good Ventilation will help purify and disinfect the barns. Doors, windows and ventilators should be sufficiently numerous to enable one to direct the drafts and to flood the barn with pure air and sunshine. Winter and summer ventilation may differ in degree, but it should not be neglected in winter even in colder places than in Alabama. Air spaces should be sufficient to give at least 500 cubic feet of air to each cow.

Dairy cows should be given six hours of **exercise** in the open air every day. Of course this is best taken in a pasture, but exercise in a lot, morning and evening, is a relief from the close confinement in stalls. The opposite extreme may be found where the cows are exposed to all kinds of cold, rainy weather. Such treatment means great loss, because it is cheaper to give protection than to give a greater amount of feed in order to produce extra animal heat.

The **location** of the **barn** and other **dairy buildings** should be carefully selected. It is best to locate them upon elevated places where surface drainage can be readily obtained. Combination buildings should be avoided. It is unwise to have silos, milk room and stalls all under one roof or too near one another. Cow stalls should never surround a silo, because ventilation is poor and the cows suffer with heat. The stalls should be so arranged that the feed may be given to each animal from the front. The partitions between the stalls should prevent one animal from reaching another. The stalls should be at least four feet wide and have the proper length. If the stalls are too long the manure and urine will not fall into the gutter; if the stalls are too short the hind quarters and the tail will be in the gutter filth when the cow lies down.

The **cow** should be kept **clean** by brushing and, if necessary, by washing. This not only prevents milk from becoming infected, but also improves the condition of the cows to such a degree that they will give more milk. A clean cow, properly groomed, will give more and purer milk than an ungroomed cow. Dairy cows should be thoroughly brushed and cleaned at least once per day; the best time to do this is at 8 or 9 o'clock in the morning. Just before milking, the udder, the abdomen, the flanks and thighs should be brushed, to remove all loose hair and dust particles. It is a good plan to wash the udder, especially the teats, but they should be completely dry before milking.

The **milker** should observe strict **personal cleanliness.** When milking he should wear a special suit of washable overalls and jacket or a long washable apron with sleeves. It is necessary that he should have three or four changes of milking suits or aprons. The hands should be washed and the finger nails be cut close and well brushed. After milking one cow he should thoroughly cleanse his hands before milking another, because this insures greater cleanliness and prevents the transmission from one cow to another of such diseases as infectious garget and cow-pox. The practice, which is too common among negro servants, of wetting the teats with the milk, and milking the cow entirely by stripping, cannot be too severely condemned. The milking should be done with the full hand by producing a wave of pressure that begins at the upper part of the teat or the lower part of the quarter and passes down over the teat to its lower end; this is produced by the successive closing of the thumb and fingers in a grasping manner. This involves no pulling or friction, and every drop of the milk can thus be removed from the udder. By using the stripping process in milking the friction and pulling causes scales and dust particles to fall into the milk.

In order that the reader may comprehend the necessity for cleanliness in all things in connection with the dairy a list of dirt **impurities found in milk** by microscopic examination will here be given:

Manure particles; soil particles; cow and human hair; mold, bacteria and other fungi; woolen, cotton and linen threads; fodder and other food particles; parts of insects; down from birds; skin scales, etc.

As much as 3 to 15 milligrams of dry impurities have been found in one litre of milk in some of the dairies in Germany. As a rule most of the impurities get into the milk at the time of milking. The fact that the dairy cows in Europe are kept more hours per day in the stall than the cows of America will account for this great quantity of impurities. When dairy cows are kept in the stalls only a short time in the morning and evening and spend the rest of their time on clean pastures they can easily be kept clean; yet they will not be hair-clean and dust-clean without brushing and sometimes washing.

But some one may say that the strainer and the separator will remove all these filth particles from the milk. It is true that many of these impurities are removed, provided they are not soluble; but these particles inoculate the milk with various kinds of bacteria and introduce injurious soluble impurities that cannot be removed by the strainer or the separator. Milk is a good food for bacteria and many of them begin to grow and multiply as soon as they get into it; then they destroy some of the nutritive materials in the milk. Sometimes the dust particles may carry disease-producing bacteria into the milk; this is frequently the case if any of the cows in the dairy have tuberculosis in a form in which the tubercle bacilli are thrown off in the excretions; it is also true if any of the dairy servants have tuberculosis and expectorate indiscriminately around the dairy. It is just as essential to have healthy servants in a dairy as it is to have healthy cows.

Grotenfelt gives the following primary principles to regulate the work in a dairy barn:

1. The manure is to be cleaned out one and one-half hours before milking time.

2. The stable is to be aired every time it is cleaned out.

3. The cows should be watered before every milking.

4. The feeding should take place at least one and one-half hours before milking.

5. The cow should have a rest of one and one-half hours three times a day, during which time the stable is closed.

(This is applicable only where cows have no run or pasture, or are kept closely confined for milking three or more times per day.)

6. The cows should be groomed twice a day; their udders, hind limbs, flanks and abdomen should be washed before every milking.

7. The cows should be allowed to exercise in winter during the warm part of the day; (in summer or almost any season in Alabama they may be allowed to exercise during any part of the day that is most convenient.)

The **source** of **water** used at the dairy for washing cans, bottles, buckets, hands, etc., is very important. It should be from a deep well that is entirely separated from the barn, from the cow lots, or any source of surface filth. The surface drainage should be away from the well and the well should be so located that the seepage will not come from any contaminated source. The deeper the well the less liable it is to be contaminated with germs. Also the deeper the water in the well within certain limits the purer will be the upper portions of that water, providing it is not constantly being contaminated by surface drainage or seepage water. As a rule, it is best to have the level of the water in the well some distance below the surface unless the well is cemented some distance below the surface. Most bacteria will not grow or multiply in water unless it contains some organic matter. Hence the bacteria that accidentally get into pure well water become inactive and sink to the bottom of the well. In other words, more bacteria are found at the bottom of the well than in any other portion of the water; consequently, the water should not be drawn directly from the bottom of the well, but may be drawn within eight or ten feet of the bottom. The outlet of a water tank should not be from the bottom; but should be some distance above the bottom so that the germs and dirt which settle will not be carried out with the water that is used directly or indirectly for human or animal consumption, or to wash dairy apparatus. However, it is wise to have an outlet directly in the bottom of a water tank so that the tank may be thoroughly cleansed. A water tank should be cleansed three or four times per year; this may be done by thoroughly scrubbing and washing the bottom and sides of the tank. In cleaning a well it is essential that the wall of the well, some distance above the bottom, should be thoroughly cleaned with brush and water; then remove all the loose dirt and water from the bottom of the well.

If there is sufficient organic matter in well-water, germs may be growing upon the surface and sometimes below the surface; but, as a rule, the organic matter in well water is insufficient to keep the germs growing, and the inactive or non-growing germs soon sink to the bottom of the well.

When water runs low in wells, as in the fall of the year, infectious diseases (typhoid fever, etc.,) are more prevalent.

Steam and hot water must of necessity be used in order to cleanse many of the dairy utensils; but this should in no way lead one to omit securing a pure water supply for all dairy purposes. If bottles are used, they and crates in which they are carried should be thoroughly cleansed and the bottles should always be sterilized previous to filling, because infectious diseases (diphtheria, scarlet fever, etc.,) may be carried from one family to another if the bottles are not always sterilized immediately after cleansing and before filling them. **Delivering milk in bottles** is the cleanest and **best method.**

Composition of Milk.

The chief constituents of milk are water, fat, casein, albumen, milk-sugar, and ash. Other substances are found in milk in small quantities, but they are not of sufficient importance to require discussion here. The terms **milk solids** or **total solids** embrace all the substances (solids) in milk except the water. The term **milk serum** is almost equivalent to skim or separated milk; it embraces all the milk substances except the fat. The **solids not fat** or the **serum solids** include all the solid constituents of milk except the fat; the solids not fat are the casein, albumen, milk-sugar, and ash.

The quantity of **water in milk** varies from 80 to 90 per cent. As a rule cow's milk will contain from 84 to 88 per cent. of water. In South Carolina the law fixes the maximum limit of water in milk at 88.5 per cent.; Minnesota, Massachusetts and New Hampshire, at 87 per cent.; five other states, at 87.5 per cent., and eight other states, at 88 per cent. The city of Montgomery fixes the maximum limit at 87.5 per cent. It is obvious that a high percentage of water means a poor milk and a low percentage of water means a rich milk, provided there are no solid adulterants added to the milk.

The **fat in milk** is in the form of an emulsion in the milk serum. An enormous number of fat globules are suspended in the milk serum. The size of the fat globules may vary slightly in the different breeds of cattle. One drop of milk may contain 100,000,000 fat globules. Chemically speaking, milk fat is a compound of fatty acids and glycerine. About 92 per cent. of pure milk fat is a mixture of glycerine and insoluble fatty acids (palmitic, stearic and oleic acids), and about 8 per cent. of milk fat is made up of glycerides of volatile fatty acids (butyric, caprylic and caproic acids). The glycerides of the volatile acids of milk fat are very unstable; they give the flavor and aroma to butter and serve to distinguish genuine from artificial butter. When the glycerides of these volatile fatty acids are decomposed by bacteria or light, the volatile acids are set free and they produce the unpleasant odor in rancid butter.

The fat in cow's milk ranges from 3 to 6 per cent.; the average is about 4 per cent. As a rule if the fat in a cow's milk falls below 3 per cent. she does not pay for her feed. The mixed milk from a dairy herd should not fall below 3 per cent. in fat contents, and, except in unusually rich milk, it will not exceed 5 per cent. The minimum legal standard for most of the states is 3 per cent.; Georgia and Minnesota require milk to contain 3.5 per cent. of butter fat; Rhode Island places the minimum limit at 2.5 per cent. The city of Montgomery requires milk to contain 3 per cent. of butter fat, and the limit should be raised to 3.5 per cent.

Milk-sugar or **lactose** is very similar in chemical composition to cane sugar, but it is not nearly so sweet and is less soluble in water. Normal cow's milk contains from 4 to 6 per cent., with an average of about 5 per cent., of milk-sugar. This average may be reduced to about 4 per cent. in sour milk. Sour milk is a result of the action of bacteria upon the milk-sugar. The bacteria decompose the milk-sugar and one of the products of this decomposition is lactic acid, which curdles the milk or precipitates the casein. If milk is kept free of bacteria, or if all the bacteria in milk are destroyed by sterilization and the milk is thereafter kept free from germs, it will remain sweet indefinitely.

Casein and **albumen** are the chief protein compounds of milk. When the milk is first drawn from the udder the casein is in the form of caseinogen, but it is soon changed into casein. Casein contains phosphorus and sulphur, which chemical elements are not found in any of the other protein compounds of milk. Dilute acids precipitate the casein and thus curdle the milk. If the acid is neutralized by some alkali (lime water or soda) the casein will be redissolved. Rennet will also precipitate casein, and the curd thus formed is used in making cheese; but this curd cannot be redissolved by adding lime water or soda. The quantity of casein in cow's milk will vary from 2 to 3.5 per cent.

The **albumen** of milk is somewhat similar to that in blood and in the white of an egg. It is not precipitated by dilute acids or by rennet, but it can be coagulated by heating the milk to 170 degrees F.; it then collects in a film on the surface of the milk. The quantity of albumen in cows' milk will range from .5 to .8 per cent.

There are other unstable, and somewhat indefinite, protein compounds in milk, but they are small in quantity and the chemists do not agree as to their properties.

The average amount of total protein constituents in milk is 3.3 per cent. of the entire milk. "Milk with a low fat content will contain more casein and albumen than fat, while the reverse is generally true in case of milk containing more than 3.5 per cent. of fat."

The **ash** or **mineral matter** is made up of "chlorides and phosphates of sodium, potassium, magnesium and calcium; iron oxide, and sulphuric and citric acid are also present in small quantities among the normal mineral milk constituents." The average amount of total ash in cows' milk is about .7 per cent. The mineral constituents of milk are least liable to variation.

Clostrum or the first milk is that which is secreted immediately after the birth of the calf. It contains a large percentage of albumen and ash, and a small amount of milk sugar. It is thick, yellow, and coagulates when boiled. The first milk is said to be nature's purgative to remove the meconium from the alimentary canal of the offspring. In four or five days the clostrum is no longer secreted and the milk becomes normal.

Milk is slightly heavier than water; its **specific gravity** ranges from 1.029 to 1.034 at 60 degrees F. The variation in the specific gravity is due to the variations in the relative quantities of water and the solids in the milk. Milk that is rich in fat will usually have a low specific gravity, because the fat is lighter than water. If, however, the fat be removed the specific gravity will be raised; skim milk ranges from 1.033 to 1.037. The addition of water to milk, or the removal of fat from milk, are the two most common methods of fraudulently changing the composition, specific gravity and value of milk.

Variations in the **composition** of normal or pure **cow's milk** are due to the variations in the breed, individuality of the cow, to the methods of feeding and handling, and to the length of time since the cow became fresh. It is a matter of common observation that certain breeds give richer milk than others, while some breeds may give large quantities of relatively poor milk. Different cows of the same breed will vary to some extent in the quality and quantity of their milk. A well balanced ration given in sufficient quantity will cause a cow to yield milk to her greatest capacity. The breed, the individuality of the cow, and the length of time since calving will also have a direct influence upon the quantity; but the quantity of milk may be most quickly and easily changed by changing the feed and the method of handling the cow. However, the richness of the milk or the proportion of fats and other milk solids cannot be radically changed by varying the composition or the kind of feed. Feeding fat or giving feed almost free from fat will not materially change the composition of the milk. Giving dry feed and restricting the amount of water allowed the cow may decrease the quantity of milk and slightly increase the proportion of total solids in the milk.

Comparative composition of various kinds of milk. *

Kind of Milk	Water	Total Solids	Total solids: Protein: Casein	Albumin	Total protein	Fat	Carbo-hydrates (milk sugar)	Mineral matters (ash)	Fuel value per lb.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct*	*p c.*	*Per ct.*	*Per ct.*	*Calo's*
Woman	87.4	12.6	1.0	1.3	2 3	3.8	6.2	0.3	319
Cow...	87.2	12.8	3.0	.5	3.5	3.7	4 9	.7	313
Dog	75.4	24.6	6.1	5.1	11.2	9.6	3.1	.7	671
Ewe	80.8	19.2	5.0	1.5	6.5	6.9	4.9	.9	503
Buffalo.	81.4	18 6	5.8	.3	6.1	7.5	4.1	.9	506
Cat.....	82.1	17.9	3.1	6.0	9.1	3.3	4.9	.6	400
Goat.	85.7	14.3	3.2	1.1	4.3	4.8	4.4	.8	365
Llama..	86.5	13.5	3.0	.9	3.9	3 2	5.6	.8	312
Ass.....	89.6	10.4	.7	1.6	2.3	1.6	6 0	.5	222
Mare ...	91.5	8.5	1 2	.1	1.3	1.2	5.7	.3	180

* Konig, Chemie der menschlichen, Nahrungs und Genussmittel, 3d ed., I, pp. 267-362.

Determining the Per Cent. of Fat in Milk.

The most simple and practicable method for closely estimating the per cent. of fat in milk is the one discovered by Prof. Babcock, of Wisconsin. It is now universally called **The Babcock Test.**

The necessary apparatus consists of a centrifugal machine; graduated milk, cream, and skim milk test bottles; pipettes; an acid measure; and sulphuric acid having a specific gravity of 1.82. This apparatus may be obtained from any dairy supply house. If the centrifugal machine has a diameter of 20 inches it should be capable of making not less than 700 revolutions per minute; if the wheel is 12 inches in diameter it should make 1,200 revolutions per minute. The size and speed of the wheel should be sufficient to give enough centrifugal force to separate the fat.

Procuring the Sample of Milk to be Tested.—The best time to procure the sample is immediately after the milk has been drawn from the cow and before the cream begins to rise. Milk that has stood some time should be poured from one vessel into another until the cream is evenly and thoroughly distributed in the milk. It is impossible to secure an average sample of the milk when the cream is partly churned or small granules of butter appear on the surface of the milk. It is not practicable to sample a large quantity of curdled milk, but a small amount may be thoroughly mixed if the curd be dissolved by slowly adding powdered soda.

The sample should be thoroughly mixed just before the pipette is filled. The pipette should be rinsed two or three times with the milk before it is filled; fill the pipette up to the 17.6cc. mark; empty it into the graduated milk test bottle, care being taken to let the milk flow from the pipette slowly down the inside of the neck of the milk bottle.

In order to get the best results the temperature of the milk should be between 60 and 70 degrees F., especially if the acid used has a specific gravity of 1.82. The milk may be cooler if the acid is a little stronger.

The acid measure is now filled up to the 17.5 c.c. mark with sulphuric acid (not less than 1.82 or more than 1.83 sp. gr.); the acid should be poured slowly down the inside of the neck of the milk test bottle. Now thoroughly mix the acid and the milk in the bottle by gently shaking the bottle with a circular motion. The casein is precipitated and then dissolved, and the solution soon becomes very dark brown in color, a result of the charring of the milk sugar by the sulphuric acid. If the acid is too weak, or there is not enough acid used, it will not dissolve all of the casein; if it is too strong, or there is too much acid, the fat may be slightly charred and black specks may collect at the bottom of the fat column.

The bottles are now placed in a centrifugal machine in such a position that the wheel will be evenly balanced; then the machine is turned at full speed for five minutes; the bottles are taken out, filled with hot water up to the graduated scale point No. 7; they are then put back into the machine and whirled at full speed for one or two minutes. Some authorities advise, after whirling the bottles five minutes, to add or to fill the bottles with hot water up to the neck; whirl them one minute; then fill with hot water up to the point 7 and whirl again for one minute. After the last whirling take out the bottles, stand them in hot water, read and record the percentages of fat. The per cent. of fat is indicated by the length of the column of liquid fat in the graduated neck of the milk tube. In measuring the length of the fat column the reading should be taken from the lower end to the extreme upper limit of the fat.

The color of the fat will indicate to some extent the strength of the acid used: if the fat is quite dark the acid is too strong; if white, undissolved material collects at the bottom of the fat; or the fat is very light in color, the acid is too weak; if the fat has a golden yellow color the acid has the proper strength.

The following precautions should be used in making the Babcock test:

1. Secure a fair or average sample of the milk. The Scovell sample tube or the "milk thief" may be used in procuring samples from a large dairy can.

2. Secure acid of proper strength; acid having 1.82 specific gravity is usually the best. If the milk is very rich 20 to 21 c. c. of the acid may be used.

3. Be careful to pour the acid into the bottle so that it will follow the inside surface of the bottle to the bottom. This can be accomplished by slightly inclining the neck of the test bottle.

4. Carefully, slowly and thoroughly mix the acid and milk in the bottle.

5. In adding hot water to the bottles to bring the column of fat up into the graduated neck, use soft, rain, or distilled water; never use hard water.

6. Be careful in measuring the fat; it must be kept hot by standing the bottle in hot water, in order to measure it correctly.

7. Keep the acid tightly corked with a rubber or glass stopper, because it will quickly absorb moisture from the air and

become too weak. Never pour water into strong sulphuric acid.

8. The graduated test bottle, the pipettes, the acid measure, should be thoroughly cleansed immediately after finishing the test. The waste from the bottles contains a large per. cent. of sulphuric acid and this is very corrosive; it should be emptied only into glass or glazed earthen vessels.

9. The temperature of the milk should be between 60 and 70 degrees F.

For the **analysis** of **cream** special cream testing bottles are made; the best one is Winton's. Cream may be diluted with a definite quantity of water and the milk test bottles can then be used, but the cream test bottles give more accurate results. Market or dairy cream may contain as low as 9.5 per cent. of fat or as high as 40 per cent. However the per cent. of fat in cream will usually range from 15 to 30. Cream containing 25 per cent. of fat is rated as a rich cream.

There are also special bottles for **testing skim** or separated milk, **buttermilk** and **whey,** in order to find their fat content. The double-necked test bottle is the one that should be used. With it the fat may be estimated to single hundredths of one per cent.

The **Gravimetric Method** of **determining** the **fat** content of milk is the most accurate. There are several modifications of this method, but the process given here is known as Adams' method.*

"About 5 grams of milk are rapidly and accurately weighed in a tared platinum dish. A paper coil, made by loosely rolling up a strip of fat-free paper, about 20 inches long and 2½ wide, held in position by a wire clamp, is held, one end up, in the dish, allowing a portion of the milk to be absorbed. The coil is reversed and the remainder of the milk to the last trace is absorbed by the other end of the coil, care being taken to handle it by the clamp only. The coil is placed in the air bath, being held in vertical position by introducing the loop of the clamp into a clasp attached to the sides of the bath. As in the case of the determination of the solids, the temper-

* New York City Board of Health report 1896, p. 168.

ature must be constant from 100 to 105 degrees C. Two and one-half hours drying is usually sufficient. The coil is known to be dry when a cold watch-glass being held over one end of it, immediately after it is removed from the bath, does not show a deposit of moisture. In making this test the coil must be held in a vertical position. The dry coil is placed in an extracting apparatus, the form known as Knoefler's being preferred, connected with an upright condenser and a tared flask, and extracted with a pure anhydrous ethyl ether for two hours. The ether is distilled and may be used again, the flask placed on water bath until all odor of ether has disappeared, then in air bath having a constant temperature of 100–105 degrees C. for one-half hour or until fat is of constant weight. The coil should be re-extracted until there is no longer a gain of fat. The weight of fat is calculated in the usual way. The flask used above should be dried in air bath and cooled in air-bath before weighing. A flask containing the fat should be cooled in the same way. Care must be taken not to electrify the flask by rubbing the same when dry. The ether used must be free from residue, water and alcohol. Fat-free paper (commercial) must be proved to be free from extractive matter."

The Total Solids may be determined as follows:

"Five grams of milk (thoroughly mixed by gentle agitation) are weighed in a dry, tared, flat-bottom, 'lead-tin' or platinum capsule (diameter $1\frac{5}{8}$ inches, and $\frac{3}{4}$ of an inch deep; it is important that the dish is no smaller than this). This dish is placed on a water bath, a piece of clean filter paper being in contact with the bottom, and when the water has apparently all evaporated is transferred to an air bath (carefully regulated to maintain a temperature of from 100 to 105 degrees C.) and allowed to remain for $2\frac{1}{2}$ hours. After cooling in a dessicator dish, and the contents are weighed, return to air bath for one-half hour and again weigh. If necessary this reheating and reweighing are repeated until solids cease to lose in weight. From this final weight calculate total solids." *

* New York City Board of Health Report, 1896, p. 168.

A close estimate of the **total solids** and the solids not fat may be made when the fat content and the specific gravity of the milk are known. Determine the per cent. of fat by the Babcock Test and the specific gravity by the use of the Quevenne lactometer. (Full directions for determining the specific gravity with the lactometer may be found in Farrington and Woll's "Testing Milk and Its Products," pages 80 to 85.) The specific gravity of milk should not be taken until one-half hour (better six or eight hours) after the milk has been drawn, since the specific gravity is always lower if taken immediately after the milk is drawn than it is when the milk has stood for some time. This may be due to the escape of gases or to mechanical changes in the proteids. Be careful to have the temperature of the milk as near 60 degrees F. as possible when the specific gravity is taken. After thoroughly mixing the sample, pour the milk into the lactometer cylinder and take the specific gravity at once before the cream begins to rise. If the cream rises the specific gravity will be that of skim milk.

Farrington and Woll have derived the following simple formulæ and rules for estimating the solids not fat and the total solids:

"Solids not fat equal 1/4L plus .2f

Total solids equal 1/4L plus 1.2f

"L being the lactometer reading at 60 degrees F. and f the per cent. of fat in the milk.

"Rule a. To find the per cent. of solids not fat in the milk, add two tenths of the per cent. of fat to one-fourth of the lactometer reading, and

Rule b. To find the per cent. of total solids in the milk, add one and two-tenths times the per cent. of fat to one-fourth of the lactometer reading."

The following method of determining the solids not fat is taken from the Maine Experiment Station Report for 1897, page 94; but the table and the method were derived by Prof. Babcock, of Wisconsin Experiment Station:

"**Method of Making the Test.**—To take the specific gravity with the lactometer it is necessary (1) that milk be free from air bubbles, and in order to insure this it should stand at least one-half hour after being drawn; (2) that it should be thoroughly mixed by pouring from one vessel to another, avoiding any violent motions that would be likely to collect air bubbles, then brought to the proper temperature, 60° F., placed in a vessel of sufficient depth and diameter to allow the lactometer to float freely, and the mark on the stem to which the instrument sinks read. The lactometer can easily be read to half spaces when it is necessary to be quite accurate. In case it is not convenient to bring the milk to the temperature of 60° F., a correction may be made, where the variation is not more than 10°, by adding to the lactometer reading 0.1 for each degree the temperature exceeds 60°, and subtracting 0.1 for each degree below 60. For example, a lactometer reading of 32 at 65° F., corrected would read 32.5; at 55° F., corrected, 31.5.

After finding the per cent. of fat, and taking the lactometer reading, the per cent of solids not fat may be found by the table given on page 235. Find the per cent. of fat in one of the side vertical columns, and the lactometer reading at the top of the table in the line of figures marked lactometer reading, then look down the column of figures directly under the lactometer reading till on line with the per cent. of fat, and the figures found at this point will be the per cent. of solids not fat in milk.

For example, suppose the per cent. of fat is 4.5 and the lactometer reading is 32, then the per cent. of solids not fat will be 8.92. Suppose the lactometer reads 33 instead of 32 in the above example, then the per cent. of solids not fat would be 9.17. The per cent. of solids not fat added to the per cent. of fat gives total solids."

Per cent. of fat.	Quevenne Lactometer Readings at 60 Degrees F.											Per cent. of fat.
	26	27	28	29	30	31	32	33	34	35	36	
1.0	6.70	6.95	7.20	7.45	7.70	7.95	8.20	8.45	8.70	8.95	9.20	1.0
1.1	6.72	6.97	7.22	7.47	7.72	7.97	8.22	8.47	8.72	8.97	9.22	1.1
1.2	6.74	6.99	7.24	7.49	7.74	7.99	8.24	8.49	8.74	8.99	9.24	1.2
1.3	6.76	7.01	7.26	7.51	7.76	8.01	8.26	8.51	8.76	9.01	9.26	1.3
1.4	6.78	7.03	7.28	7.53	7.78	8.03	8.28	8.53	8.78	9.03	9.28	1.4
1.5	6.80	7.05	7.30	7.55	7.80	8.05	8.30	8.55	8.80	9.05	9.30	1.5
1.6	6.82	7.07	7.32	7.57	7.82	8.07	8.32	8.57	8.82	9.07	9.32	1.6
1.7	6.84	7.09	7.34	7.59	7.84	8.09	8.34	8.59	8.84	9.09	9.34	1.7
1.8	6.86	7.11	7.36	7.61	7.86	8.11	8.36	8.61	8.86	9.11	9.37	1.8
1.9	6.88	7.13	7.38	7.63	7.88	8.13	8.38	8.63	8.88	9.13	9.39	1.9
2.0	6.90	7.15	7.40	7.65	7.90	8.15	8.40	8.66	8.91	9.15	9.41	2.0
2.1	6.92	7.17	7.42	7.67	7.92	8.17	8.42	8.68	8.93	9.18	9.43	2.1
2.2	6.94	7.19	7.44	7.69	7.94	8.19	8.44	8.70	8.95	9.20	9.45	2.2
2.3	6.96	7.21	7.46	7.71	7.96	8.21	8.46	8.72	8.97	9.22	9.47	2.3
2.4	6.98	7.23	7.48	7.73	7.98	8.23	8.48	8.74	8.99	9.24	9.49	2.4
2.5	7.00	7.25	7.50	7.75	8.00	8.25	8.50	8.76	9.01	9.26	9.51	2.5
2.6	7.02	7.27	7.52	7.77	8.02	8.27	8.52	8.78	9.03	9.28	9.53	2.6
2.7	7.04	7.29	7.54	7.79	8.04	8.29	8.54	8.80	9.05	9.30	9.55	2.7
2.8	7.06	7.31	7.56	7.81	8.06	8.31	8.57	8.82	9.07	9.32	9.57	2.8
2.9	7.08	7.33	7.58	7.83	8.08	8.33	8.59	8.84	9.09	9.34	9.59	2.9
3.0	7.10	7.35	7.60	7.85	8.10	8.36	8.61	8.86	9.11	9.36	9.61	3.0
3.1	7.12	7.37	7.62	7.87	8.13	8.38	8.63	8.88	9.13	9.38	9.64	3.1
3.2	7.14	7.39	7.64	7.89	8.15	8.40	8.65	8.90	9.15	9.41	9.66	3.2
3.3	7.16	7.41	7.66	7.92	8.17	8.42	8.67	8.92	9.18	9.43	9.68	3.3
3.4	7.18	7.43	7.69	7.94	8.19	8.44	8.69	8.94	9.20	9.45	9.70	3.4
3.5	7.20	7.45	7.71	7.96	8.21	8.46	8.71	8.96	9.22	9.47	9.72	3.5
3.6	7.22	7.48	7.73	7.98	8.23	8.48	8.73	8.98	9.24	9.49	9.74	3.6
3.7	7.24	7.50	7.75	8.00	8.25	8.50	8.75	9.00	9.26	9.51	9.76	3.7
3.8	7.26	7.52	7.77	8.02	8.27	8.52	8.77	9.02	9.28	9.53	9.78	3.8
3.9	7.28	7.54	7.79	8.04	8.29	8.54	8.79	9.04	9.30	9.55	9.80	3.9
4.0	7.30	7.56	7.81	8.06	8.31	8.56	8.81	9.06	9.32	9.57	9.83	4.0
4.1	7.32	7.58	7.83	8.08	8.33	8.58	8.83	9.08	9.34	9.59	9.85	4.1
4.2	7.34	7.60	7.85	8.10	8.35	8.60	8.85	9.11	9.36	9.62	9.87	4.2
4.3	7.36	7.62	7.87	8.12	8.37	8.62	8.88	9.13	9.38	9.64	9.89	4.3
4.4	7.38	7.64	7.89	8.14	8.39	8.64	8.90	9.15	9.40	9.66	9.91	4.4
4.5	7.40	7.66	7.91	8.16	8.41	8.66	8.92	9.17	9.42	9.68	9.93	4.5
4.6	7.43	7.68	7.93	8.18	8.43	8.68	8.94	9.19	9.44	9.70	9.95	4.6
4.7	7.45	7.70	7.95	8.20	8.45	8.70	8.96	9.21	9.46	9.72	9.97	4.7
4.8	7.47	7.72	7.97	8.22	8.47	8.72	8.98	9.23	9.48	9.74	9.99	4.8
4.9	7.49	7.74	7.99	8.24	8.49	8.74	9.00	9.25	9.50	9.76	10.01	4.9
5.0	7.51	7.76	8.01	8.26	8.51	8.76	9.02	9.27	9.52	9.78	10.03	5.0
5.1	7.53	7.78	8.03	8.28	8.53	8.79	9.04	9.29	9.54	9.80	10.05	5.1
5.2	7.55	7.80	8.05	8.30	9.55	8.81	9.06	9.31	9.56	9.82	10.07	5.2
5.3	7.57	7.82	8.07	8.32	8.57	8.83	9.08	9.33	9.58	9.84	10.09	5.3
5.4	7.59	7.84	8.09	8.34	8.60	8.85	9.10	9.36	9.61	9.86	10.11	5.4
5.5	7.61	7.86	8.11	8.36	8.62	8.87	9.12	9.38	9.63	9.88	10.13	5.5
5.6	7.63	7.88	8.13	8.39	8.64	8.89	9.15	9.40	9.65	9.90	10.15	5.6
5.7	7.65	7.90	8.15	8.41	8.66	8.91	9.17	9.42	9.67	9.92	10.17	5.7
5.8	7.67	7.92	8.17	8.43	8.68	8.94	9.19	9.44	9.69	9.94	10.19	5.8
5.9	7.69	7.94	8.20	8.45	8.70	8.96	9.21	9.46	9.71	9.96	10.22	5.9
6.0	7.71	7.96	8.22	8.47	8.72	8.98	9.23	9.48	9.73	9.98	10.24	6.0

To Determine Ash or Salts in Milk, "proceed as directed in the air-bath method for determining the total solids in milk, using a platinum dish." "The dry solids, after weighing, are gently ignited over a rose burner or in a muffled furnace, taking care not to allow the heat to rise above a dull red. When ash appears white or gray cool in a dessicator and weigh. Calculate percentage of salts or ash." *

In milk inspection, as a rule, it will not be necessary to make an accurate chemical determination of the casein and albumen or the milk sugar. The question of the kind and quantity of sugar in the various forms of condensed or evaporated milk is important and should be investigated. For methods of determining the casein, albumen and milk sugar, we refer the reader to Farrington and Woll's "Testing Milk and Its Products," "Fresenius," and Bulletin No. 43, p. 189, Chemical Division of U. S. Department of Agriculture.

Milk Adulteration.

Adding water and **abstracting cream** are the most common fraudulent means of adulterating milk. With a legal milk standard it is not difficult to detect such frauds. If there is no legal standard the inspector or his sample collector should go to the dairy and collect a control sample which he knows has not been adulterated. Every cow's milk will not meet the required legal standard in fat or solids not fat. But the purchaser of milk buys with the idea that the milk conforms to the legal standard. If it does not the vendor should reduce the price of milk accordingly, or, better still, procure cows that will yield standard milk. The mixed milk of a herd, as a rule, will meet the legal standard if the milk is not adulterated.

The removal of cream may be detected by the Babcock test the fat removed by skimming, or the deficiency in fat may be determined by the difference between the per cent. of fat obtained in the sample and the per cent. required by law, or the per cent of fat found in the control sample. In other words, the legal standard per cent. of fat minus the per cent. of fat

* New York City Board of Health Report, 1896, p. 169.

found in the sample, equals the per cent. of fat removed by skimming.

The following formulæ, with slight changes, are taken from Woll's Handbook for Farmers and Dairymen, 1897, pages 207-8:

In the formulæ let

Lf equal legal standard fat per cent.

Sf equal sample fat per cent.

LSnf equal legal standard per cent. of solids not fat.

Snf equal sample per cent. of solids not fat.

For rapid, practical results, determine the fat by the Babcock test, and the solids not fat by the lactometer with the rules, and table previously given.

I. If cream alone is removed from the milk it may be detected by

Formula: $Lf - Sf =$ per cent. of fat removed.

II. Calculations of watered milk may be based on the percentage of solids not fat in the milk by

Formula: $100 - \frac{Snf \times 100}{LSnf} =$ per cent. of foreign water in milk.

Example: If sample contains 7.2 per cent. solids not fat and 9 per cent. is the legal standard for solids not fat then

$100 - \frac{7.2 \times 100}{9} = 20$ per cent. by weight of foreign water in the sample of milk or $\frac{1}{5}$ of the milk is added water.

III. The quantity of water added may be expressed in per cent. of water added based upon the weight of the original milk.

Formula:

$\frac{100 \times LSnf}{Snf} - 100 =$ per cent. of water added to original milk.

Example—Same as in II:

$\frac{100 \times 9}{7.2} - 100 = 25$ per cent. of water added or $\frac{1}{5}$ of milk is added water.

IV. Milk may be watered and skimmed. Determine per cent. of foreign or added water by II or III; and the per cent. of fat removed by this

Formula:

$Lf - \frac{LSnf \times Sf}{Snf} =$ per cent. of fat abstracted.

Example: If sample contains 8 per cent. of solids not fat and 2.5 per cent. of fat, and if 3 per cent. fat and 9 per cent. of solids not fat are the legal standards, then

$$3 - \frac{9 \times 2.5}{8} = .18\tfrac{3}{4} \text{ per cent. by weight of fat removed.}$$

Chemical Adulterants or Impurities.

Drugs are added to milk as preservatives; some are added to change the specific gravity of milk and occasionally coloring matter is added to make the milk appear richer.

Commercial milk, cream or butter may contain one or more of the following adulterants: Boracic acid, borax, salicylic acid, sodium salicylate, carbonate of soda, bicarbonate of soda, lime water, formalin. The majority of commercial preservatives are made up of one or more of the following drugs: Borax, boracic acid, sodium salycilate, salicylic acid, and formalin. As a rule, any preservative or coloring matter that is used in milk without giving due notice to the purchaser must be considered as a fraudulent adulteration. The following test may be made to determine the presence or absence of chemical adulterants.

"**Borax** and **Boracic** Acid: 100c.c. of milk are made alkaline with lime water dried, and the mixture gently burned to ash. The residue is acidified with concentrated hydrochloric acid. and the mixture washed in a small flask with 20c.c. of methyl alcohol. The flask is connected with a condenser and about 10c.c. of the methyl alcohol distilled into a small platinum dish. The dish is placed in a dark closet or room and the alcohol ignited, when, if a trace of boric acid or borax were present, it burns with a grass-green flame. Blank tests must be made with the re-agents used to prove absence of boric acid in them."*

"Place in a porcelain dish one drop of milk with two drops of strong hydrochloric acid and two drops of turmeric tincture; dry this on water bath; cool and add a drop of ammonia by

* N. Y. Board of Health Report, 1896, p. 169.

means of a glass rod. A slaty color, changing to green, is produced if borax is present."*

"Salicylic Acid or Its Salts: The milk is coagulated by means of a few drops of acetic acid and filtered, the filtrate is shaken with ethyl ether in a separating funnel. The ether is carefully drawn off and evaporated in a glass dish on the water bath. The residue, if any, is treated with a very little water, filtered, and a drop of neutral ferric chloride added. A violet color indicates presence of salicylic acid or its salts."†

"20c.c. of milk are acidulated with sulphuric acid and shaken with ether; the ether solution is evaporated, and the residue treated with alcohol and a little iron chloride solution; a deep violet color will be obtained in the presence of salicylic acid."‡

"Alkaline carbonates may be detected by the strong alkaline character of the ash, and by its effervescing with dilute acids. A quantitative determination may be made by titrating the water solution of the ash with n/10 sulphuric acid, using lakmoid as an indicator." ¶

"To 10c.c. of milk add 10c.c. of alcohol and a little of a one per cent. rosolic acid solution. Pure milk will give a brownish yellow color; milk to which soda has been added, a rose red color. A control experiment with milk of known purity should be made."§

"Formaldehyde or 'Formalin': A few drops of milk are floated on a small amount of concentrated sulphuric acid, containing a trace of ferric chloride. If formaldehyde is present, a violet blue ring will appear at the line of demarkation."‖

"A solution of diphenylamin is made with water and just enough sulphuric acid to secure a proper solvent effect. The milk to be tested, or better the distillate therefrom, is added to this solution and boiled. If formalin is present, a white

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* Farrington and Woll's Testing Milk, p. 195.

† N. Y. City Board of Health Report, 1896, p. 169.

‡ Farrington and Woll's Testing Milk, p. 196.

¶ N. Y. City Board of Health Report, 1896, p. 169.

§ Farrington and Woll's Testing Milk, p. 197.

‖ N. Y. City Board of Health Report, 1896, p. 169.

flocculent precipitate is formed; if the acid used contains nitrates a green precipitate is formed."

Skimmed or watered milk, or skimmed and watered milk, may have sufficient cheese or butter color added to give it a rich yellow appearance, which readily deceives the average purchaser.

"The presence of foreign coloring matter in milk is easily shown by shaking 10c.c. of milk with an equal quantity of ether; on standing, a clear ether solution will rise to the surface; the solution will be yellow colored if artificial coloring matter has been added to the milk, the intensity of the color indicating the quantity added; natural, fresh milk will give a colorless ether solution."*

"Annato or Butter Color: 100c.c. of milk, made strongly alkaline with sodium carbonate, are placed in a small cylinder; a strip of filter-paper, about $\frac{1}{2}$ inch wide and five inches long, is introduced, and the whole allowed to stand in the dark for twelve hours. If annato is present, the strip of paper, after washing, will be a pale salmon color, which is changed to a decided pink by moistening with a solution of stannous chloride, and after drying at the temperature of the room to a bluish color, on treatment with strong sulphuric acid."‡

Acidity of Milk.—Freshly drawn milk exhibits an amphoteric reaction to litmus; it colors red litmus blue, and blue litmus red; but in a short time after the milk is drawn, it shows an acid reaction to the phenolphtalein test. This acidity is probably due to acid phosphates, to carbonic acid gas and to the acid reaction of the casein. This milk will not taste sour and is considered sweet. The acid or sour tasting milk is due to lactic acid, which is a product of the action of bacteria on lactose or milk sugar. If there is .3 to .35 per cent. of lactic acid in milk it will taste sour. The acid-forming bacteria get into the milk at the time of milking, through uncleanliness; and after milking, through careless handling (keeping it in a warm room, unclean bottles or cans, adding

*Farrington and Woll's Testing Milk, p. 92.

‡ N. Y. City Board of Health Report, 1896, p. 169.

impure water, exposing to germ-laden air, etc.) Within certain limits, the greater the number of bacteria per c.c. of milk, the greater the acidity of the milk. Hence a test for the acidity of the milk will give a more or less definite idea of the degree of bacterial infection, and this will suggest the cleanliness or uncleanliness of the milking and of the handling of the milk thereafter. The temperature at which the milk is kept and the age of the milk must always be taken into consideration in drawing the conclusion as to the dairy cleanliness or uncleanliness. As a rule, any acid test showing a higher per cent. of acidity than .07 is due to lactic fermentation.

Test for Acidity of Milk. "20c.c. of milk is measured into a porcelain casserole; a few drops of an alcoholic phenolphtalein solution are added, and a soda solution (n/10) is dropped in slowly from a burette until the color of the milk remains uniformly pinkish on agitation. 1c.c. of n/10 alkali corresponds to .009 grams of lactic acid, or to .045 per cent. when 20c.c. are taken."*

Farrington's alkaline tablet test may be used more readily and conveniently.†

A test for cleanliness or uncleanliness in milking and in handling milk may be more definitely determined by a bacteriological examination; this will determine the number of bacteria per cubic centimeter and the various kinds of bacteria in the milk.

Bacteria in Milk.

The first few streams of milk drawn from the udder contain bacteria; the remainder of the milk may come from the udder free of germs; but it soon becomes contaminated by mixing with the first milk, by dust, dirt, hair and other particles from the cow's udder and skin; from the hands and clothes of the milker; from the air; from the unclean milk vessels; and from the impure water used in washing the milk vessels and used in fraudulently adulterating the milk. When the

* Farrington and Woll's Testing Milk, p. 195.

† Farrington and Woll's Testing Milk, pp. 99–105.

udder is diseased, as in tuberculosis, infectious mastitis, etc., the milk as it comes from the udder may contain tubercle bacilli or the other infectious germs.

Milk being a good food for bacteria, a great majority begin to grow and multiply as soon as they get into the milk. This is especially the case if the temperature of the milk is not reduced below 45 degrees F. in a short time after the milk is drawn from the udder. Very few germs can grow at such a low temperature, and those that can grow under such a condition will do so very slowly; many times the milk may be used before these low temperature germs can seriously injure it.

Determining the number of bacteria in a cubic centimeter of milk is called a **quantitative bacteriological analysis.** Determining the different kinds of bacteria and their peculiar characteristics is called a **qualitative bacteriological analysis.** Many times these analyses are very difficult, tedious, and expensive. The most important conclusion to be drawn from the number of bacteria in a given quantity of milk is that, as a rule, the greater the number of bacteria the greater the filth in the milk and in the handling of the milk. Grotenfelt found that samples of milk drawn "in a pasture on a fresh, somewhat damp summer morning showed the following average results as regards their bacterial content:"

Immediately after drawing from the udder, 10 bacteria per c.c. of milk; one half hour after milking, 88 bacteria per c.c.; two hours after milking, 1,530 bacteria per c.c. These numbers are very small, and show that the milk was as nearly free of bacteria as it is practicable to obtain it. The milking was done in a clean, dewy pasture, surrounded by woods, where the air was still. These were clean conditions. Grotenfelt further says that a sample of milk drawn in a filthy and dark cow stable showed, in three fourths of an hour after milking, "not less than 670,000 bacteria per c.c." "The bacterial content of three samples of milk taken on three consecutive days from this stable did not vary much—the analyses showing the following average figures per c.c.: 730,000; 560,000, and 780,000."

Sedgwick and Batcheldor found in milk from the Boston milk supply an average of 2,335,500 bacteria per c.c. in 57 samples of milk. Sixteen samples of milk collected from groceries in Boston contained 4,577,000 per c.c., and those samples obtained from "well-to-do families on the Back Bay" contained an average of 1,438,000.

Sedgwick found that sewage of Lawrence, Mass., contained from 100,000 to 4,000,000 bacteria per c.c.

Bitter places the maximum limit for milk fit for human food at 50,000 bacteria per c.c., and Buffalo puts the limit at 10,000 per c.c.

The above examples of quantitative bacteriological analysis show that the greater the filth surrounding the milking, the more the milk is handled or changed from vessel to vessel and exposed to germ-laden air, and the older the milk, the greater the number of the bacteria in the milk. In order to obtain pure milk, cleanliness must begin with the barns, cows, vessels and milkers before the milk is drawn, and be continued during the milking and throughout all the processes of handling the milk. Furthermore, the milk must be kept at or below 45 degrees F. **Cleanliness is the great means of preventing bacterial contamination. Continuous vigilance along the line of cleanliness is the price of pure, clean, wholesome milk.**

The question of the **kind** of **bacteria** is very **important** in most instances, and somewhat indifferent in other cases. As long as the number of ordinary bacteria in milk is low they do not seriously injure the milk, unless the bacteria are disease-producing, or they injure the products (butter, cheese) to be made from the milk. There are germs, such as Conn's "Bacillus No. 41," that are valuable because they act in such a manner as to produce a pleasant flavor and aroma in the butter made from the milk. Likewise there are useful bacteria which produce an agreeable flavor and chemical change in cheese. But, as a rule, all bacteria that grow and multiply extensively in milk or cream which is to be used without change as human food, injure more or less its nutritive value. There is possibly one exception to this general statement, but this exception has not been firmly established; some germs are said to assist in the process of digesting the milk in the alimentary canal. This supposition, however, is in want of positive proof. Experiment station men say that sour milk, which contains less nutrient material than sweet milk, will generally produce better results when fed to pigs than similar milk in a sweet condition. Woll says that this may be due to the stimulation of the appetite by the lactic acid in the sour milk, or in its aiding digestion by increasing the acidity of the stomach juices.

Sour Milk.—The class or group of bacteria that act on milk sugar and produce lactic acid are very numerous and are nearly always present in the milk. They multiply so rapidly that the milk soon becomes very sour. As a rule these lactic acid-producing bacteria grow more rapidly than any other germs, especially until the quantity of acid reaches .8 per cent.; then the lactic acid germs cease to grow. The germ that is said to be the most common lactic reagent is Hueppe's *Bacillus acidi lactici*. This germ will not grow in milk when the lactic acid reaches the limit of .8 per cent.; yet all the milk sugar is not changed into lactic acid. Several kinds of acid-producing bacteria may be growing at the same time in the milk; but, as a rule, one kind soon gains the ascendancy.

In the process of "ripening cream" one or more of the lactic acid-producing bacteria are used. Sometimes most of the accidental germs are destroyed by heating the cream or milk to about 158 degrees F.; after cooling it to below 100 degrees F., the cream or milk is inoculated with a specific germ that will produce the ripening or souring, and at the same time give a pleasant taste and aroma to the butter. As a rule, if the milk and cream are kept clean the ripening will take place as the result of the few germs that accidentally infect them; and the butter will have a pleasant taste and aroma.

The lactic acid-producing bacteria form the greatest number of accidental germs in milk; they are non-spore forming bacteria and consequently can be killed by heating the milk to 158 degrees F. for 20 or 30 minutes.

Alkaline-Producing Germs.—There are several bacteria that will cause milk to exhibit an alkaline reaction. At times these germs are very injurious, yet they may not seriously interfere with the milk unless it stands for some time. However, they frequently prevent the ripening of cream and thus seriously interfere in the process of making butter. When they predominate in the dairy the best way to eradicate them is by thoroughly cleaning and disinfecting the barns, buckets, cans, churns, etc. At the same time it may be best to inoculate the fresh milk or cream, or pasteurized milk or cream, with a favorable germ by using a pure culture, or by using ripe cream or buttermilk from another dairy where they are making good butter.

Butyric Acid Fermentation may be a result of the action of one of several groups of bacteria upon the glyceride of butyric acid. This action sets free the butyric acid and produces the well known rancid or bitter taste of old butter. Butyric fermentation may occur in milk and give it a bitter taste. This bitter taste may be distinguished from the bitter that is produced by the cow eating bitter weed (*Helenium tenuifolium*, etc.,) by the fact that the bitter from the bitter weed is present in the milk immediately after it is drawn, and the **bitter taste produced by bacteria** appears some time after milking, or may appear some time after the milk has been boiled or cooked. According to Freudenreich certain forms of casein and milk-sugar fermentations may result in producing a bitter product. Some claim that the bitter product is produced by spore-forming bacteria that act chiefly upon the casein or albumen. Bitter-producing germs must be fought by cleanliness and disinfection. Bitter milk from bitter weeds must be fought by removing the weeds from the pasture or feed; by aerating the milk or by boiling the milk in an open vessel. The last mentioned method is doubtful.

Ropy, Stringy or **Slimy Milk** may be produced by a number of different species of bacteria. It may be a result of a series of fermentations, a kind of decomposition. Some investigators have isolated from ropy milk micrococci or spherical celled bacteria, while others have isolated bacilli or rod like bacteria. In fact, nearly twenty species of bacteria have been found that will produce ropy milk. In some cases the ropiness appears to be due to "the swollen outer cell membrane of the bacteria themselves; in others it is due to different substances formed from the proteids in the milk, and, occasionally, the milk sugar." (Russell.)

Ropy milk bacteria can be eradicated from the dairy by cleanliness, disinfection, and possibly by sterilizing. In Holland slimy or ropy fermentation of milk is desired in the manufacture of Edam cheese. The Norwegians make a popular drink by producing a slimy change in milk; the milk is infected by introducing the leaves of the common butterwort.

Chromogenic or **Color-Producing** germs are sometimes found in milk. **Red Milk** may be due to the presence of blood from an injured or diseased udder. In such cases the milk will appear red at the time of milking. Milk may appear red when one or more of pigment-producing germs grow in it. The most common germ that produces this red tinged milk is called the *bacillus prodigiosus*. This germ is reported to be rarely, if ever, found in America. However, in October, 1897, the writer isolated it from a rotten cotton boll. Another red milk germ is the *bacillus lactis erythrogenes* (Hueppe). *Sarcina rosea* is also said to produce a red color in milk. These red milk germs not only develop a red pigment in milk, but also produce coagulation of the casein. The *bacillus prodigiosus* may form trimethylmin, which gives milk a herring like smell and taste. Cleanliness and disinfection are the means of getting rid of the red milk germs.

Blue Milk may be a result of the growth of certain germs in milk. This must not be confounded with what is commonly known as blue milk, which is blue-tinted, poor milk, or milk that appears blue after the cream has been removed. The blue pigment, developed by the *bacillus cyanogenus*, will appear, in from one to three days after infection or inoculation, as isolated, bluish-colored patches on the surface of the milk; after a time the entire surface of the milk may become coated with a blue film. The action of this germ on the milk is unknown. Butter made from infected cream will not keep well. This germ is easily killed by heat and disinfectants, but it will survive a long period of drying.

Yellow Milk may appear as the result of the action of several species of germs. Some of these precipitate and then dissolve the casein. Some produce a bright lemon color in milk, while others give the milk an orange tint. Violet and green tints may be produced by certain pigment-producing germs. These germs are rarely found in milk. When they occur, more attention to cleanliness will eliminate them from the dairy.

The Yeasts usually produce in milk an alcoholic fermentation; they change the milk sugar into alcohol, water and carbonic acid gas. Skimmed milk may be inoculated with yeast and a very nutritive drink, called kephir or koumiss, will be produced. Kephir is usually made from cows' milk, while koumiss is made from mares' milk. Yeast fungi are the predominating organisms in these alcoholic fermentations of milk; but there may be some bacteria and molds in the mixture. Koumiss is said to be more easily digested than milk and is sometimes given to invalids instead of milk.

Casein Ferments are all spore-forming bacteria, and consequently are very difficult to destroy. The *tyrotherix* group of bacteria, first studied by Duclaux, and the potato bacillus (*bacillus mesentericus vulgatus*) and the *bacillus subtilis* are some of the germs that produce casein fermentation. Some germs may break up or decompose the casein and produce unpleasant smelling gases, carbonic acid gas, ammonia and water; such germs usually decompose the casein without precipitating it. Other germs may precipitate and then dissolve the casein. Still other casein ferments simply coagulate the casein; some of these coagulate the casein very like the rennet ferment. In fact Conn has prepared a germ in the form of a dry powder, which acts like rennet on milk casein. Casein ferments may act after the lactic fermentation is completed; and, "in all probability, they are intimately concerned in the curing of cheese in which the casein is broken down into soluble compounds." (Russell.)

DISEASE-PRODUCING BACTERIA.

The most important disease-producing germ that is found in milk is the *bacillus tuberculosis.* This germ may gain admission to the milk from a tuberculous udder; it may occasionally get into the milk with the dust that has been infected by the expectoration of tuberculous persons and tuberculous cattle. Tubercle bacilli do not grow or multiply to any appreciable degree in commercial milk, because the growing temperature limits* are between 80 and 104 degrees F., and, when under the most favorable growing conditions, they grow very slowly. In the mixed milk from a herd or in the milk from a single cow the number of tubercle bacilli are so few that it is very difficult to find them by microscopic examination. Generally not more than one cow in a herd will have tuberculosis of the udder or of the lymphatic glands near the udder; consequently, in the mixed milk of a herd, the tubercle bacilli are so few that it is almost impossible to detect them. In some cases the germs in milk may be thrown to the bottom of a small vessel and then examined. The following method,† described by Hammond, a student of the McGill Veterinary College, is one of the most practicable:

"Taking milk to which (preferably in order to arrest the growth of other bacteria which are apt to hide the tubercle bacilli) 5 per cent. of glacial carbolic acid has been added, put 15 c.c. of the milk into each of the two tubes, then centrifugalize it for 25 minutes (preferably in the hand centrifugal machine manufactured by Bausch and Lomb, Rochester, N. Y.); the supernating fluid is poured off; the precipitated debris, bacteria, etc., which contains the bacilli, is then treated with about 3 c.c. of a 5 per cent. caustic potash solution, is mixed up thoroughly by giving a good shake and is left for two or three minutes. The tube is then filled up to the 15 c.c. mark with distilled water and centrifugalized for

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* The variety of tubercle bacilli in fish may grow at a much lower temperature, and the variety of tubercle bacilli in birds may grow at a higher temperature.

† American Veterinary Review, Aug., 1898, p. 322.

about twenty minutes. If now the supernating fluid be taken off the minute quantity of debris at the base of the tube can be examined right away; or, if the material is required in a purer condition, completely free from caustic potash, a series of dilutions and centrifugalizations with distilled water can be carried on."

With a drop of the sediment from the bottom of a tube make a smear on a clean cover glass; stain with Gray's or Ziel's carbol-fuchsin, warm and allow stain to remain five to ten minutes; decolorize for a few seconds in a 10 to 20 per cent. acid solution (hydrochloric, nitric or sulphuric acid); wash in distilled water, dry and mount in balsam. Examine with a one-twelfth or a one-sixteenth-inch oil-immersion objective. The tubercle bacilli will have a distinct red color, while all other germs will be decolorized.

A few drops of the sediment from the bottom of a centrifugalized milk may be injected into the abdomen, under the skin or into a vein, of a rabbit or guinea pig. In from ten to twenty days the guinea pig will have developed sufficient tuberculous changes to permit one to make an accurate microscopic test for tubercle bacilli.

The question as to whether a tuberculous cow without apparent tuberculosis of the udder will throw off tubercle bacilli in the milk is not fully determined; but it is very probable that such cows will not give infectious milk. Some authorities have conveyed tuberculosis to pigs by feeding them milk from tuberculous cows: the udder may have been involved in all of these cases. No doubt many infants, children and some grown persons contract tuberculosis by drinking infected milk. If the dairy cows have not been tested with tuberculin for tuberculosis it is always the safest to pasteurize or sterilize the cream, butter and milk that comes from such a dairy. Some have thought that the separator would remove all the germs from the milk and cream, but the fact is that germs remain in the cream and the milk after the process of separation. Consequently dairy herds that supply milk, cream or butter to the public should be tested with tuberculin, and all animals that react should be removed from the herd. Cream and butter from a tuberculous cow are almost as infectious as the milk.

The most practicable and positive method of determining the presence or absence of tuberculosis in a herd is the tuberculin test. Every cow should be tested at least once a year; and in herds where tuberculosis has been found every cow should be tested twice a year. Remember that a physical examination of the cow or a microscopic test of the milk are not as far-reaching or accurate in picking out of the herd every animal that is tuberculous as the tuberculin test. However, these aids to a diagnosis may supplement, or may be used in connection with, the tuberculin test.

It may be well to state here that tubercle bacilli, from man, cattle, birds and fish, are the same or identical, but slightly modified by the variations in the condition of the different hosts. Yet, under favorable conditions, tubercle bacilli from cattle can be transmitted to man, and the bacilli from man may be transmitted to cattle. Tubercle bacilli from birds and fish cannot readily be transmitted to man or other animals, but such infection may occur because the germ is only slightly modified in fish and birds.

Typhoid bacilli have been found in milk. Hart reports fifty epidemics of typhoid fever with 3,500 cases, and Dr. Freeman, of New York, collected records of fifty-three epidemics with 3,226 cases; in all of these epidemics the typhoid bacilli were distributed by milk infected with that germ. When typhoid cases appear along a certain milk-wagon route, or when many of the patrons of a certain milk depot contract typhoid fever, the health officers at once search for the source of the infection at the dairy from whence the milk comes.

The milk is most frequently infected with typhoid bacilli by using infected water to wash the milk cans, bottles, separators, hands, etc. The water in a well or river may become infected by surface drainage. This is very frequently the case when a dairy hand or some one near the dairy has typhoid fever. It is usually a result of careless handling of stools and urine from a typhoid patient. According to a recent investigator,* the urine from a typhoid patient will contain typhoid

* Central Bl'tt fur Bac., Band XXIII, No. 14, p. 517.

bacilli for one to two months, during the fever and convalescing period and for some time afterwards.

Typhoid bacilli will grow and multiply very readily in milk when the temperature is between 80 and 100 degrees F. According to Frænkel and others,* typhoid bacilli may live, and in some instances grow, in butter-milk having an acid reaction. According to Russell,† milk may become infected with typhoid germs in the following ways:

"1. Infection by the milker who has been near a person sick with the fever, and whose clothes have become infected.

"2. Infection of the milk by allowing it to stand in a room that was next to that occupied by a typhoid patient.

"3. Direct infection of milk vessels by infected water used for cleansing purposes."

Diphtheria is another disease that is sometimes transmitted by means of infected milk. Ernest Hart, of England, collected statistics of seven epidemics of diphtheria, with 500 cases; and Dr. Freeman, of New York, obtained records of eleven epidemics, with 501 cases: all of these eighteen epidemics were transmitted by means of infected milk. Klein claims that he found diphtheria bacilli in the milk of two inoculated cows. Abbott failed to find the germ in a similar experiment. The actual infection of cows with diphtheria bacilli may not be fully determined, but the clinical records of diphtheria epidemics show conclusively that milk can be the carrier of the germ. Sternberg says: "Milk is a favorable medium for the growth of this bacillus, and, as it grows at a comparatively low temperature (58 degrees F.), it is evident that this fluid may become a medium for conveying the bacillus from an infected source to the throats of previously healthy children." ‡

Abbott says that the bacillus of diptheria is destroyed by heating, for ten minutes, at 58 degrees C. or 136.4 degrees F. Hence pasteurizing or sterilizing will readily destroy them. But the best plan is for the inspector to see that there is no

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* Central Bl'tt. fur Bac., Band XXIII, No. 17, p. 752.

† Russell's Dairy Bacteriology, p. 97.

‡ Manual of Bacteriology, p. 362.

contamination at the dairy or in the handling of the milk by persons that have been near diphtheria patients, or by keeping the milk in or near rooms or houses where diphtheria exists.

Scarlet Fever may be transmitted by means of infected milk. The real cause of this disease has not been discovered, yet several epidemics of scarlet fever have been traced to infected milk. Hart records fifteen epidemics of scarlet fever, with 800 cases, and Dr. Freeman gives twenty-six epidemics, with 1,593 cases: all of these forty-one epidemics were traced to infected milk. It has been reported that cattle and horses have scarlet fever, but this has been disputed by good authorities. No person or substances coming from a house where scarlet fever exists should be permitted at or near a dairy; at least such persons should never be allowed to work in a dairy. Neither should milk be placed in or near an infected house.

Asiatic Cholera has been transmitted in India by means of infected milk. Milk may become infected by the use of infected water or by infected clothes of a dairy servant. The comma bacillus can live and grow in milk until the milk becomes distinctly acid. This germ is killed by heating for ten minutes at 52 degrees C. or 125.6 degrees F. During cholera epidemics the milk supply should be carefully guarded, since it may be the means of spreading the disease.

Epidemics of acute poisoning, throat troubles and foot-and-mouth disease have been reported as having been transmitted by infected milk. It is also possible that cow-pox, yellow fever and malarial fever may be transmitted by means of infected milk.

The most common and constant germ found in the manure of cattle and other animals is the *bacillus coli communis*, which closely resembles the typhoid bacillus. It, no doubt, causes serious intestinal troubles (indigestion, diarrhea, etc.,) among infants and children; consequently it is imperative that every effort be made to prevent manurial infection of milk.

Milk may be put in condition to be kept sweet and wholesome by various processes. The use of drugs or chemical agents is, in any form, an adulteration; therefore they cannot be legally used. Physical agents, that do not change or decrease the nutritive value of the milk, may be used. But the best way to keep milk sweet and fresh is to prevent infection or contamination of the milk by strict and forced cleanliness. **Clean, raw milk is now considered the purest, the most easily digested, and the best of all kinds of milk.**

But if the dairy is not run on strict lines of cleanliness and all diseased cows are not removed from the herd, the dairyman, the milk-dealer, or the consumer may be compelled to use some physical agent to destroy the germs and thus preserve the milk, and many times prevent disease. **Germ-laden milk should be pasteurized or sterilized.**

Pasteurization of milk consists in heating the milk to 158-167 degrees F. for 20 to 30 minutes; then it should be cooled as rapidly as possible; placed upon ice and kept there until used. Physicians are inclined to object to pasteurized milk, because the useful (?), digestive-aiding bacteria and the albumen ferments are destroyed. Pasteurization will not destroy the spores of the injurious germs, but it will nearly always kill the adult bacteria in the milk, and if the process is repeated on three consecutive days it will destroy all of the bacteria in the milk.

Technically speaking, **Sterilization** means the complete destruction of all the germs in milk. This may be accomplished by heating the milk to 212 degrees for 15 minutes at or about the same time on three consecutive days; or by heating the milk, under pressure, to 260 to 300 degrees F. Ordinarily, sterilization means heating the milk to 212 degrees F. for 20 to 30 minutes. It will impart a burnt or cooked taste to the milk, coagulate the albumen, cause the globules of fat to unite, convert the soluble into insoluble lime salts, destroy the useful (?) germs, and change the color of the milk. Some of these changes seroiusly interfere with the nutritive value and digestibility of the milk. Ordinary sterilization will not always kill the spores of the injurious bacteria, yet it will kill all of the adult germs. Sterilized and pasteurized milk may become sour in 48 hours if it is not kept on ice.

For an extended discussion of the methods of sterilization and pasteurization see Bulletin No. 44 of the Wisconsin Experiment Station, and Bulletin No. 53 of the Alabama Experiment Station.

How to Disinfect a Barn or Dairy House.—The ceiling and the walls should be as smooth as possible, so that little or no dust will be caught by them; they should also be made of material that will stand washing. It goes without saying that the floors should be made to stand frequent flooding and scouring. In disinfecting the first requisite is thorough cleansing of ceiling and walls with water, soap and brush. If possible use hot instead of cold water. The floors should then be scrupulously cleansed. The walls and ceiling may next be covered with a whitewash that contains one fluid ounce of formalin or carbolic acid to every gallon of whitewash; or formalin may be added to water in the proportion of one fluid ounce to one gallon of water, and sprinkled over the ceiling, the walls and floors at night. The building should then be kept closed until next morning, when it may be thoroughly ventilated. A 2 to 4 per cent. solution of creolin may be used instead of the formalin solution. A strong formaldehyde gas generator may be kept going in the cleaned and closed building during the night. If the dairy buildings are kept scrupulously clean it will not be necessary to disinfect them more frequently than once a year.

Modified Milk.—This term usually means the changing of cow's milk so that its composition will be very near the same as mother's or woman's milk. According to chemical analyses cow's milk contains about three times as much casein as woman's milk, and the latter contains 6.2 per cent. of milk sugar, while the former contains only 4.9 per cent. Hence, if cow's milk is fed to an infant, the milk should be so modified that its composition will closely approximate that of mother's milk. In some of the large cities the Walker-Gordon Laboratory Company prepare and sell modified milk; but a relatively accurate modified milk may be made at home under the direction of the family physician or the qualified graduate nurse. This subject is very plainly treated in "The Care and

Feeding of Children," by Dr. Holt. This little book costs only 50 cents, and every mother should read it and practice what it teaches.

The law given below is the one in force in the city of Montgomery, Ala. The minimum limit for milk fat or butter fat should be 3.5 instead of 3 per cent. Furthermore the provision that permits persons who own one or two cows to sell milk without paying city license or without having their cows inspected for tuberculosis is very poor sanitary medicine. These cows, above all others, are most liable to have tuberculosis, because they are so closely confined, fed family slops, and are more frequently in close contact with tuberculous persons. Every cow which produces commercial milk should be frequently inspected and tested, once or twice a year, for tuberculosis.

AN ORDINANCE

To Regulate the Sale of Milk in the City of Montgomery.

Be it ordained by the City Council of Montgomery, as follows:

Section 1. That all milk dealers, firms or corporations and dairymen, who sell or supply milk in any way to or for the people of Montgomery shall be required to take out an annual license from the City Clerk at the rate of five dollars for ten cows and under, and ten dollars for any number exceeding ten cows; provided, that this shall not apply to persons who have not exceeding two cows for family use, selling their surplus milk to immediate neighbors.

Sec. 2. *Be it further ordained*, That no person, firm or corporation shall sell, exchange or deliver, or transport, or have have in his or her or their possession for the purpose of sale any milk which contains more than eighty-seven and fifty one-hundredths (87.50) per centum of water, or less than 3 per cent. of butter fat, and the specific gravity of which at sixty (60) degrees Fah. shall be between one and twenty-nine one-thousandths (1.029) and one and thirty-three one-thousandths (1.033); and all milk of a lower grade or quality than specificed by this section shall be taken and condemned as adulterated and impure, and the vendor thereof fined as provided for in section VII.

SEC. 3. *Be it further ordained*, That all skimmed or separated milk that is to be sold or held for sale in any way by any person, firm or corporation, shall contain not less than nine (9) per centum of milk solids, exclusive of butter fat. Violations of this section shall be punished as provided for in section VII.

SEC. 4. *Be it further ordained*, That all additions to milk of water, ice, chalk, borax, salicylate of soda, or any coloring matter, or any substance which changes the taste, the specific gravity, the color, or the normal chemical constituents of the milk, shall render it impure, unfit for sale, and the possessor thereof liable to a fine.

SEC. 5. *Be it further ordained*, That all dairy cows, which produce milk for the Montgomery market shall be free from all diseases that would in any way affect the milk, especially of all infectious diseases that are communicable to man or produce an elevation of systemic temperature, such as tuberculosis, anthrax, Texas fever, pneumonia, parturient apoplexy (milk fever), malignant catarrh, etc., etc. No cow shall be used in a dairy which supplies milk to the people of Montgomery, unless she has been tested by the inspector with tuberculin for tuberculosis. All dairy cows thus tested shall be marked in the ear with a tag bearing a serial number, and "Montgomery, Ala.," and such cows may be re-tested as often as the inspector may deem it necessary.

SEC. 6. *Be it further ordained*, That dairy cows producing milk for the Montgomery market shall not be fed distillery waste, usually called "swill," or upon any substance in a state of putrifaction or rottenness, or upon any other substance that is unwholesome, or that will in any way affect the healthfulness of the milk.

Furthermore, the cows of the dairy shall be allowed free movement in the open air at least six (6) hours every day. The barns, sheds and stalls in which said cows are fed and milked shall be properly ventilated, lighted, drained and cleaned, all of which shall be subject to inspection by the inspector.

SEC. 7. *Be it further ordained*, That any violation of the foregoing sections shall be punished by a fine of not less than one ($1.00) dollar or more than one hundred ($100.00) dollars for each and every offense.

Adopted September 28, 1896.

Approved September 30, 1896.

The **references** consulted in the preparation of this bulletin were:

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BULLETIN No. 98. NOVEMBER, 1898.

ALABAMA

Agricultural Experiment Station

OF THE

AGRICULTURAL AND MECHANICAL COLLEGE,

AUBURN.

ORCHARD NOTES.

F. S. EARLE.

BIRMINGHAM
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1898

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☞ The Bulletins of this Station will be sent free to any citizen of the State on application to the Agricultural Experiment Station, Auburn, Alabama.

CONTENTS.

Orchard Notes.

APPLES.

Notwithstanding the vast planting of fruit trees throughout the South during recent years, very little attention has been given to the apple. It is an unfortunate fact that Alabama does not begin to grow apples enough to supply the home market, and that those brought in from the North are usually poor in quality and are sold at so high a price as to prevent their coming into general use as food. It is not unusual for apples and oranges to sell at the same price per dozen in our markets. There seems to be no good reason why we should not have a much more abundant home supply of this most useful fruit. In the laudable effort to achieve our agricultural independence by growing all possible food supplies at home, apples are worthy of attention as well as corn or pork. It is true that Middle and South Alabama are below the apple belt proper, and it is perhaps not likely that apple growing will ever reach large commercial proportions in these parts of the State, but with a little care a good home supply can be grown. Some portions of North Alabama seem to be particularly well adapted to apples, and the planting of commercial orchards is earnestly recommended in those localities. No horticultural investment is safer or more certain to yield reasonable and regular profits than a suitably located orchard of properly selected market apples.

It is just at this point that the prospective planter will meet his greatest difficulty, for it is still an open question what varieties are best adapted to the different parts of the State. One great cause for failure in apple planting at the South has been the selection of varieties not suited to our con ditions. Many of the familiar Northern market varieties will fail entirely if planted here. Some varieties, it is true, are suited to a wide range of conditions, and will succeed both North and South, but if we are to build up an important Southern apple industry we must mostly rely on apples of Southern origin.

As an aid in the study of this important question of varieties there has been planted at this Station during the last two years an orchard of between eighty and ninety kinds selected from those that seemed to give most promise of being useful for this section. It will, of course, be a number of years before results of value can be expected from this planting.

It is also intended to procure scions of all the promising native seedlings and local varieties that can be found in different parts of the State. By bringing them all together on the Station grounds it is hoped that ultimately some may be selected that will prove more valuable under our conditions than the standard kinds now usually planted. The co-operation in this work of all persons in the State who are interested in fruits, is earnestly desired, and the Station will feel under special obligations to any one who will send scions of fine native apples, or who will put us in communication with parties who can furnish such scions. Scions may be cut at any time during the winter while the trees are dormant, and can be sent by mail done up with a little moss or damp grass to keep them fresh.

An apple orchard of some forty-five varieties, two trees of a kind, was planted on the Station grounds in March, 1885. The location selected was rather an unfortunate one, being on a poor gravelly knoll. Apples thrive best on a moist and rather stiff soil. Frequent changes in the management have not led to the carrying out of any continuous system of orchard culture, and a small orchard always seems to suffer more in proportion than a large one from the depredations of insects, birds and boys. For these reasons, although the orchard has borne some fruit for several years past, it is not yet possible to express any final opinion as to the value of the different kinds. There is, however, one result that may be recorded now, and that is as to the comparative vigor and hardiness of the trees. Many kinds of apple trees are feeble and short lived here, and in planting an orchard it is, of course, vitally important to select only such kinds as are likely to make vigorous, long lived trees. Of the forty-five kinds originally planted in this orchard, fourteen are now dead, seven are still alive but seem feeble and out of condition, while the following twenty-four kinds have proven healthy and fairly vigorous under the rather severe conditions of this test:

American Golden Russet,	Ben Davis,
Cannon Pearmain,	Carter's Blue,
Early Red Margaret,	Elgin Pippin,
Golden Pippin,	Habersham,
Hames,	Hews' Virginia,
Hiley's Eureka,	Horn,
Kittageskee,	Limbertwig,
Rawls' Jennet,	Red Astrachan,
Romanite,	Shannon Pippin,
Shockley,	Terry's Winter,
Thornton's Seedling,	Winesap,
Yellow English,	Topp's Favorite.

Of these the largest trees are Red Astrachan and Romanite.

It must not be understood that this list is recomended for general planting. It is only intended to record the fact that these trees have remained sound and healty under rather trying conditions. Much more is required than the mere fact of a healthy tree to make a profitable market apple.

As a provisional list covering a range of season from early summer to late winter the following may be suggested:

Early Harvest,	Red June,
Red Astrachan,	Horse,
Carter's Blue,	Ben Davis,
Limbertwig,	Winesap,
York Imperial,	Yates.
Shockley.	

Drawbacks to Apple Culture in Alabama.

The two most serious enemies to profitable apple growing so far encountered are the various summer rots that attack the green fruit on the tree, and the green louse or aphis. The first of these can doubtless be held in check in some measure by thorough spraying with Bordeaux Mixture, but they are notoriously hard diseases to fully control. A careful selection of varieties will do much to do away with this trouble, as some kinds are much more resistant than others.

The green aphis is very abundant here, and is a veritable pest, especially on young trees. Persistent attempts have been made during the past three summers to control this insect by spraying with the mechanical mixture of kerosene and water. With the Deming pump, set to throw only ten per cent. of kerosene, great damage is done to the new leaves and young shoots, and though many of the lice are killed enough are always protected by the curled up leaves to quickly restock the trees. It has not been found possible to rid the trees of them by this means. This is in striking contrast to the result with the somewhat similar plum aphis. The plum foliage is not at all injured by applications as strong even as twenty per cent. kerosene; and at this strength a single spraying will entirely clean up the worst infested tree. Other remedies will be tried during the coming season.

The apple scab, so troublesome in most parts of the North and East, is seldom seen here. The codlin moth, which causes worms in the fruit, and the borers in the trunks, are both troublesome, but perhaps no more so than in most apple growing regions. Twig blight, which is the same as the fire blight in the pear, often does considerable harm by killing the blossoms and fruit spurs. Apple wood is not as susceptible to this disease as pear wood, and it seldom progresses far enough to threaten the life of the tree. It seems probable that blight rarely passes the winter in apple wood, but that it is brought to the trees afresh every spring from blighting pear trees.

"WHOLE ROOT" VS. "PIECE ROOT" APPLE TREES.

In April, 1897, the Station received from the Department of Agriculture at Washington, Division of Pomology, twenty varieties of Hungarian apples. There were three trees of each kind. One had been grafted on a whole root, one on the upper half of a root, and one on the lower half of a root. The trees were all rather undersized yearlings. They were carefully inspected as planted, but no constant difference could be noted in favor of either method of grafting. If anything, the half root trees had developed a better root system than the whole root trees, but the tops averaged about alike. Notwithstanding the lateness of the season most of the trees lived, but they made very little growth during the first year. The past summer they have mostly made a very good growth. The following measurements, the heights in feet and tenths, the caliper near the ground in inches and tenths, were made on October 31, 1898:

	WHOLE ROOT		TOP HALF ROOT		BOTTOM HALF ROOT	
	Caliper	Height	Caliper	Height	Caliper	Height
Oszi-Vaj	.7*	4.0	1.0	6.5	.7	5.3
Sabadka	.7	5.3	....	....	1.0	5.9
Yakor	.4*	3.5	1.0	5.5	1.0	5.0
Sekula	.9	4.0	.8	3.7	.9	5.5
Kecskemet	1.1	5.0	.9	4.7	1.2	6.3
Buda Summer	1.1	5.0	1.0	4.5	....	....
Pasman	.8	4.0	....	....	....	....
Magyur	.3*	3.0	1.1	6.7	1.1	5.7
Eper	.5*	4.0	1.0	7.0	1.0	7.0
Metell	1.1	7.0	1.3	7.5	1.3	7.5
Hyari Piros	1.1	5.7	....	....	1.0	5.5
Ponyik	1.0	3.5	1.0	3.5	1.0	3.5
Cillagos	.5	2.7	.6	3.0	.7	3.7
Saxon Priest	.7	3.0	.6	4.0	.5*	3.0
Selymes	.9	4.7	....	....	.9	4.3
Summer Wafer	1.2	6.5	1.1	6.0	1.2	6.7
Noble Savar	1.3	8.0	1.1	7.0	....	....
Dam	....	....	.9	3.5	.7	3.0
Metalybi	.8	4.0	....	....	....	....
Battyani	1.1	4.0	1.1	5.0	1.	4.0
Average, leaving out those accidentally injured	.953	4.829	.966	5.206	.98	5.246
Number of trees dead	1		5		4	

* Tree accidentally injured in cultivation.

After throwing out those where the growth has been retarded by some accidental injury the average of the measurements shows a slight advantage both in caliper and height in favor of the trees made on the lower half of the root. The whole root trees average slightly smaller than either of the others. These differences are too slight to be very convincing, but they seem to indicate that the extravagant claims of the advocates of "whole root" trees are not well founded.

Northern vs. Southern Grown Apple Nursery Stock.

Of the apple trees planted at the Station during January, 1898, part were grown in Missouri, part in Alabama, and part in Georgia. All were first-class in every particular and while planting them the evenly good quality of the stock from the different sources was particularly noted.

On March 11 it was observed that the Missouri grown trees were beginning to leaf out freely, while those from Alabama and Georgia were still entirely dormant. Trees from the Department of Agriculture at Washington, planted the spring before, and those in the old orchard, were also dormant. The young trees all finally started a little before the old ones, but those from Missouri averaged at least ten days earlier than the others. They not only leafed out but started into rapid growth much the earliest, and held the advantage all through the first part of the growing season. Finally the Southern trees caught up with them, and there was little, if any, difference between the lots at the end of the season.

These trees will be watched with interest another spring to see if they still feel the effect of their former Northern environment; but it is altogether probable that they will have become so acclimated as to start no earlier than the others.

Japanese vs. French Pear Stocks for the South.

Twenty Bartlett pear trees were planted in February, 1896, on poor, gravelly soil. All were from the same nursery and have received the same treatment. Ten of the trees were on Japanese seedling roots, and ten on the usual French seedlings. From the first the trees on Japanese roots have been the most vigorous, and now they average fully twice the size of those on French roots.

The Stringfellow Method of Short Root Pruning.

The method of pruning away practically all the roots of a young tree before planting it, leaving only short stubs half an inch long or less, seems to be finding an increasing number of advocates. This new method runs so exactly counter to the established practice and teaching of generations of orchardists and nurserymen that conservative people find it difficult to believe the favorable reports of it that they see in print. Having been taught all our lives the necessity for keeping the root system of the young tree as nearly intact as possible when moving it from the nursery to the orchard, it gives one a shock to be told that it would be better to cut it away entirely. The advocates of this system claim that with trees so treated the new roots, springing direct from the crown and from the short stubs, assume a more natural position and strike down more deeply into the soil than when trees are planted in the usual way; and that consequently the tree is more vigorous and longer lived. Second, they point to the undoubted fact that the new plan is much the cheaper. Less care would be required in digging the trees in the nursery; a good share of the top and roots could be cut away before shipping, thus saving in boxing and freights; and finally the expensive digging of large holes could be dispensed with, and in properly prepared soil the tree, whittled to a neat stub, could be simply shoved into the ground, or planted in a dibble hole like a cutting.

This system of planting originated on the gulf coast of Texas, and has been most extensively practiced there. Being familiar with gulf coast soils and knowing their soft, moist character and great drouth resisting capacity, and their especial adaptability to the growth of all kinds of cuttings, my own opinion was that most of the successes reported with short root pruning were due to the character of the soil, and that it would be likely to fail disastrously on hard and clayey or drouthy land.

In planting some pears and peaches during February, 1896, it was determined to try the experiment. In two rows each of pears and peaches, running twenty-four trees to the row, half the trees were root pruned, leaving stubs less than half an inch long. The others were planted in the usual way; alternating three of the root pruned and three not root pruned trees. The peaches were Lady Ingold, Hale's Early, Alexander, Elberta, Tillotson, Early Crawford, Mountain Rose, and Stump. The pears were Bartlett on French roots, Bartlett on Japanese roots, and Keiffer on Japanese roots. All were well grown one year olds. The soil was a hard, gravelly hillside, with stiff clay sub-soil, and so poor and drouthy that it only made five bushels of corn to the acre the previous season. No more trying condition could be conceived for the test, and it was with many misgivings that the carefully whittled stubs, looking like inverted walking canes, were planted in such uncongenial surroundings. All, of course, were fertilized and cultivated alike. To add to the severity of the test a drouth set in early in April, with unseasonable heat, lasting till the first week in June.

On April 15 it was noted that the root pruned trees were starting much more feebly and slowly than the others, but by April 27 they had fully caught up, and from that day to this the closest inspection has failed to detect any difference between them. One peach tree from the pruned and one from the unpruned lots have died. The pears are a perfect stand. Certainly so far no increased vigor has been observed in the root pruned trees; but on the other hand no disadvantage can be detected, and the conditions could hardly have been more severe. What the final difference will be, if any, on the health and longevity of the trees, of course, remains to be seen.

The Blooming Season of Plums.

The flowers of many varieties of plums are now known to be infertile to their own pollen. In order to produce full crops it is necessary that the flowers receive pollen from some other variety. To insure this cross pollenation it is necessary to mingle different varieties in the orchard and not plant large blocks of any one kind. Since different varieties of plums have slightly different blooming seasons it becomes necessary to carefully note the blooming habit of each variety, in order to so mate the kinds that those standing near each other in the orchard shall bloom at the same season.

At the South the difference in the blooming season of different kinds is much greater than at the North. The proper mating of varieties is consequently even more important here than there; nor can we be guided by Northern experience, since the sequence of blooming is often quite different here.*

The following notes on the blooming of plums on the Station grounds are published as a contribution to this important subject.

In 1896 the blooming season was rather late. On March 2 some varieties were almost in bloom, but none were quite open.

March 9:

Abundance—buds separated, not opening.

Babcock—just opening.

* For a full discussion of this subject, with tables giving the blooming season of the different varieties at the North, see Bulletin 53 of the Vermont Experiment Station, by F. A Waugh.

Bailey's Japan—buds white, not open.
Berckmans—just opening.
Blood Plum—full bloom.
Burbank—nearly full bloom.
Chabot—just opening.
Excelsior—nearly full bloom.
Golden Beauty—almost dormant.
Kelsey—full bloom.
Kerr—buds not open.
Mariana—just opening.
Ogon—dormant.
Prunus Pissardi—nearly full bloom.
Red June—buds hardly separated.
Satsuma—full bloom.
Wild Goose—just opening.
Crawford Peach—just opening.

In 1897 the blooming season was nearly two weeks earlier. No notes were taken, but the sequence was nearly as in 1896.

1898. February 14—Blood plum No. 3 (of Berckmans), full bloom.

February 26—Wild Chickasaw plums beginning to bloom.

March 11—Wild Chickasaw plums past full bloom.

Table showing blooming of Plums in 1898.

VARIETIES		MARCH 11	MARCH 17 *	MARCH 21
Yellow Fleshed Botan	(Berckmans)	Buds breaking	First blooms	Nearly full bloom
Burbank	(Berckmans)	Showing white	Full bloom	Mostly fallen, leaves half grown
Kelsey	"	Half flowers open	Mostly fallen	Fruit setting, leaves half grown
Maru	"	Dormant	Dormant	Buds swelling
Berckmans	"	Showing white	Half flowers open	Full bloom
Blood No. 3	"	Out of bloom, leaves one inch long	Leaves half grown	New shoots three inches long
Blood No. 4	"	Full bloom	Flowers fallen	Fruit size of peas
Munson	"	Showing white	Nearly full bloom	Past full, falling
Chabot	(G. L. Tabor)	Showing white, a few open	Full bloom	Past full, falling
Long Fruited	"	Dormant	Dormant	Buds swelling
Babcock	"	Showing white	Nearly full bloom	Past full, falling
Orient	(Stark Bros.)	Buds breaking	Full bloom	Past full
Berger	"	Nearly dormant	First blooms	Blooming, some buds still dormant
Gold	"	Buds breaking	Full bloom	Mostly fallen
Red June	"	Dormant	First blooms	Blooming, many buds dormant
Red Nagate	(G. L. Tabor)	Dormant	Nearly dormant	Blooming, many buds dormant
Botan	"	First blooms	Nearly full bloom	Full bloom
Normand	"	Showing white	Half full bloom	Past full, falling
Bailey's Japan	"	First blooms	Full bloom	Mostly fallen
Wickson	"	Nearly full bloom	Mostly fallen	All fallen, fruit setting
Burbank	"	First blooms	Full bloom	Mostly fallen
Excelsior	"	Past full bloom	Fallen	Fruit size of peas
Abundance	"	Buds breaking	First blooms	Nearly full bloom
Willard	"	Dormant	Dormant	Entirely dormant
Golden Beauty	"	Nearly dormant	Buds breaking	Showing white
Yellow Japan	"	First blooms	Half full bloom	Mostly fallen
Newton	(T. V. Munson)	Dormant	Dormant	Buds separating
Rockford	"	Buds breaking	Half full bloom	Past full
Pres. Wilder	"	Nearly dormant	Showing white	First bloom
Satsuma	"	Full bloom	Falling	Fruit size peas
Hammer	"	Dormant	Dormant	Nearly dormant
Wayland	"	Buds breaking	Buds breaking	First blooms
Lone Star	"	Full bloom	Fallen	Fruit setting
Chas. Downing	"	Dormant	Buds breaking	Buds white
Transparent	"	Showing white	Full bloom	All fallen, setting
Wild Goose	"	Buds breaking	First blooms	Full bloom
Weaver	"	Dormant	Nearly dormant	Buds white
Wyant	"	Dormant	Dormant	Entirely dormant
Emerson	"	Full bloom	Fallen	Fruit setting
Wooten	"	Buds breaking	First blooms	Full bloom
Yosobe	"	Dormant	Dormant	Entirely dormant
Milton	"	Buds breaking	Buds white	Full bloom
Hawkeye	"	Dormant	Dormant	Entirely dormant
Botan	"	Buds breaking	First blooms	Full bloom
Hattankio	"	First blooms	Full bloom	Past full
Whittaker	"	Buds breaking	Buds white	Full bloom

*Thermometer 80°—Everything rushing.

March 21. Peaches now in fullest bloom. Late blooming kinds like Alexander beginning to open.

These kinds may be roughly classified as to time of blooming in the neighborhood of Auburn about as follows, each group comprising those blooming near enough together in ordinary seasons to affect cross pollenation:

Earliest Bloomer—Blood plum No. 3.

Very Early Bloomers—Blood plum No. 4, Kelsey, Satsuma, Wild Chickasaw, Wickson, Excelsior, Emerson, Prunus Pissardi, Lone Star.

Both these groups bloom before peaches and are liable to be killed by spring freezes.

Early Bloomers—Burbank, Mariana, Berckmans, Chabot, Botan, Bailey's Japan, Yellow Japan, Hattankio, and Babcock. These bloom about with the early blooming peaches.

Medium Bloomers—Yellow Fleshed Botan, Munson, Babcock, Orient, Berger, Gold, Red June, Normand, Abundance, Rockford, Transparent, Wild Goose, Wooten, Botan, Kerr. These bloom with the later peaches and are comparatively safe from frost.

Late Bloomers—Maru, Long Fruited, Red Nagate, Golden Beauty, Newton, President Wilder, Wayland, Chas. Downing, Weaver, Milton, Whittaker.

Very Late Bloomers—Ogon, Willard, Hammer, Wyant, Yosobe, and Hawkeye.

A number of the names given in the above lists are usually considered synonyms. They are given just as the trees were sent out by four prominent nurseries. No attempt is made at this time to untangle the nomenclature.

Spraying with Whitewash to Retard Blooming.

The success reported by the Missouri Experiment Station (Bull. 38) in retarding the blooming of peaches in the spring by keeping the trees whitened by spraying with whitewash, suggested the trial of a like experiment here.

On February 2, 1898, every other tree in one row each of peaches, plums and pears was sprayed with whitewash. A rain followed within a few days that washed off part of the whitewash, so about a week later the same trees were sprayed again. This second spraying left them quite thoroughly whitened. The trees at this time were still entirely dormant. On March 11, these trees were carefully examined, but it was impossible then or at any later time to detect any difference between the sprayed and the unsprayed trees. It is true that the whitewash had been partly washed off by rains subsequent to the second spraying, but the sprayed trees were still conspicuously whitened and could be distinguished at a considerable distance. This experiment is not considered conclusive, but the result is recorded for what it may be worth.

Japanese Persimmons.

This comparatively new fruit seems to be gradually winning its way to popular favor. Its many good qualities suggest that it should be much more widely planted both for home use and for market. It grows readily in all parts of Alabama and is a very abundant and constant bearer. It starts into growth quite early in the spring so that the wood is occasionally injured by late freezes, but the flowers, coming as they do on the new wood of this season's growth, are never killed by cold. Trees begin bearing very young, often the first year after planting. They are of dwarfish habit, and may be planted as close as ten or twelve feet apart each way. They should receive liberal fertilizing and good cultivation to enable them to carry their heavy annual crops.

Considerable confusion exists as to the names of varieties of Japanese persimmons. The trees on the Station grounds were mostly procured from G. L. Tabor, of Glen St. Mary Fla., and his names are used in the following notes. Some of the trees have borne three consecutive crops, the oldest were planted in 1895.

Tabor's No. 23. Fruited in 1897 and 1898. Productive, early, fruit small to medium, irregularly flattened to nearly globular, point flat or sunken, dark orange red, flesh dotted and streaked with black or entirely yellow in seedless specimens, sweet, fine flavor, without astringency even when still hard, cracks and rots in wet weather. Tree resembles Zingi; a strong grower.

TANE NASHE. Fruited in 1897 and 1898. Tree feeble, slow grower, not very productive, fruit one of the finest, large, sub-conic, pointed, yellowish red, sometimes blotched with black, flesh yellow, usually seedless; astringent till fully ripe, then sweet, melting, good. Medium season. So far it decidedly lacks in vigor and productiveness here.

YEDDO ICHI. Fruited in 1896, 1897 and 1898. Very productive, fruit medium, flattened to depressed globular, smooth, yellowish red with white bloom, flesh yellow, seedless, astringent till nearly soft, then sweet, good. Season medium to late. Much like Tane Nashe in tree and fruit, scarcely so large but much more productive and reliable; one of the best we have tested; leaves fall rather early. Tabor classes this with the dark fleshed kinds, but with us it has been uniformly yellow and seedless.

OKAME. Fruited in 1896, 1897 and 1898. Very productive, fruit large, flattened and somewhat angled, deep orange red with some bloom, flesh yellow, mostly seedless, astringent till soft, late; tree stronger grower and leaves smaller and hanging longer than in Yeddo Ichi and Tane Nashe. The best market variety we have fruited.

COSTATA. Fruited in 1896, 1897 and 1898. Fairly productive, fruit large, sub-conic, pointed, somewhat angled, dark orange with bloom, flesh yellow, seedless, astringent till soft. Tree a good grower. A good market variety, but scarcely equal to Okame or Yeddo Ichi.

TABOR'S NO. 129. Fruited in 1898 only. Very productive, Fruit small, somewhat acorn shaped, pointed, dark yellowish red with glandular sub-pellucid dots, some bloom; flesh dark brown, seedy, very crisp, juicy and high flavored, not at all astringent, can be eaten while quite hard, one of the best in quality, early, tree a good grower.

HYAKUME. Fruited in 1898. Fairly productive, fruits large, subovoid, flesh somewhat blackened. A showy kind.

YEMON. Fruited in 1896, 1897 and 1898. Productive, fruits large, smooth, slightly flattened, light yellow, flesh yellow or dark, slightly astringent till soft, early, leaves fall early. A valuable kind.

ZINGI. Fruited in 1897 and 1898. Productive, fruit small, nearly globular, dark red, flesh dark, nearly black, slightly astringent till nearly soft, crisp, good quality, early, tree a strong grower with foliage hanging late.

The dark fleshed early kinds like Zingi and Tabor's No. 23 and No. 129 are badly wasted by the attacks of various fruit eating insects, and they seem somewhat inclined to crack and rot in wet weather. It is doubtful if they will prove as profitable for market as the later yellow fleshed kinds. They have, however, a rather more sprightly flavor and will be relished by people who find the others a little too cloying.

Our present experience would indicate Okame, Yeddo Ichi, Costata and Yemon as the best market kinds, and valued about in the order named.

BULLETIN NO. 99. DECEMBER, 1898.

ALABAMA

Agricultural Experiment Station

OF THE

AGRICULTURAL AND MECHANICAL COLLEGE,

AUBURN.

COTTON RUST.

F. S. EARLE.

BIRMINGHAM
ROBERTS & SON.
1898

☞ The Bulletins of this Station will be sent free to any citizen of the State on application to the Agricultural Experiment Station, Auburn, Alabama.

Cotton Rust.

SUMMARY.

Cotton Rust is primarily a physiological disease. It is induced when any sudden check to active growth so lowers the vitality of the plant as to permit the attack of *Macrosporium nigricantium*, *Alternari sp. Cercospora gossypina* or other fungi that are facultative parasites and that spot and destroy the leaves.

It has also been called Black Rust, Yellow Leaf Blight, and Mosaic Disease.

It occurs throughout the older cotton states. It is worse on old worn sandy lands, but it may occur on any land when the humus is exhausted, also sometimes on wet poorly drained lands, and occasionally on any character of soil under unfavorable weather conditions.

It may usually be entirely prevented by ameliorating the soil conditions, giving better drainage, incorporating more vegetable matter in the soil, and by supplying abundant plant food in complete fertilizers, especially those rich in potash.

The cheapest and most available method of soil improvement is by green manuring with cow peas and other leguminous crops, supplemented by mineral fertilizers and the feeding of much more live stock.

On some soils potash salts act as an almost complete preventive of cotton rust.

Sulphate of potash, muriate of potash and kainit seem to be equally effective in proportion to the per cent. of potash contained.

At present prices, the muriate is the cheapest form in which to apply potash.

In Central Alabama, especially in the more sandy soils, the disease commonly known as Rust often causes serious injury to the cotton crop. This disease causes the spotting and finally the premature falling of the leaves, thus bringing the growing season to an end in August or early September instead of in November. As a result the number of bolls that mature is greatly reduced, and the fibre in those that do open is often light and inferior.

The name Rust is evidently a misnomer for this disease, since it has nothing in common with the true rusts like those that attack small grain. It is, however, thoroughly established in popular usage, and that, after all, should be the guide in selecting popular names for plant diseases. It is true that other diseases are sometimes confused with this one under the name of Cotton Rust; but nineteen out of twenty cotton growers have this disease in mind when they use this name.

This disease has been fully discussed by Dr. Atkinson in Bulletins 27, 36 and 41 of this Station, and later in the comprehensive work on the Cotton Plant, issued by the United States Department of Agriculture as Bulletin 33 of the Office of Experiment Stations. In these publications it has been variously called "Rust," "Black Rust," "Yellow Leaf Blight," and "Mosaic Disease." The simple term Rust is retained here as being the one in general popular use.

The officers of this Station have continued the study of this disease and it seems opportune to record our more recent experience with it in view of the heavy losses occasioned by it during the past two years, and especially to call attention to it in connection with the present serious crisis that confronts our cotton industry.

The following quotation is from Dr. Atkinson's article on Cotton Diseases in Bulletin 33, pages 279-283, of the Office of Experiment Stations, referred to above.

It is reproduced here as expressing his latest published views of this disease, and because the earlier bulletins of this Station are now largely out of print.

Mosaic Disease, or Yellow Leaf Blight.

"The later stages of this disease probably form the larger part of the troubles which are termed "black rust." The name mosaic disease, or yellow leaf blight, is quite characteristic of the early stages of the trouble as it is here defined, and renders it possible to differentiate it readily from the other troubles, which are often spoken of as "black rust," but which are in reality quite different in their nature. The term "yellow leaf blight" was first used by the author in 1892.* "Mosaic disease" was added to this term or used synonymously, a few months later.† The latter seems the more appropriate, but since the former was first used in differentiating this peculiar disease from the others, it seems well at least to continue its use in the literature of the subject for the present. During very rapid progress of the disease also the mosaic character of the leaf is not so apparent as during the normal development.

"In 1891 a preliminary investigation of the so-called black rust was made.‡ The study was confined entirely to the organisms present on the leaf and other parts of the plant, and it was not possible at that time to do more than to record the presence of certain fungus organisms, to observe their botanical characters, and to note the fact that their presence at least hastened the destruction of the plant.

"The following year investigations taken up at the beginning of the season confirmed the view that the organisms hastened the destruction of the plant, and at the same time demonstrated the fact that the organisms did not initiate the disease but only aggravated it.

"The results of the trials of Bordeaux mixture, eau celeste, and copper sulphate indicated that this disease could not be prevented by the application of fungicides, and confirmed the conclusion, drawn from observations of a different character, that it was due to physiological causes.

"Experiments conducted under the direction of the author in several localities in Alabama during two seasons showed a considerable reduction of the disease on plats where kainit was the fertilizer used.

"At Auburn an experiment was conducted on three plats. Plat No. 1, on which cowpeas had been grown, received before plowing a heavy dressing of kainit and acid phosphate. No nitrogenous fertilizer was applied. Plat No. 2 received nitrate of soda in addition to other fertilizers, but no kainit. Plat No. 3 received a complete fertilizer. In July there was a perceptible yellowing of the plants in plat 1, while plats 2 and 3

*Alabama College Sta. Bul. 36.
†Alabama College Sta. Bul. 41.
‡Alabama College Sta. Bul. 27; Bot. Gaz, 16 (1891) No. 3, pp. 61-65.

bore a rich green foliage. The yellow color of the plants in plat 1 was evenly distributed over the leaf, there being no indication of the mosaic arrangement so characteristic of the disease. In September the plants were matured, and only a few showed any sign of the disease. The yellow color of the plants was due to the acid phosphate and kainit ripening the plants prematurely (acid phosphate being known to produce this effect), along with a suffused yellowing of the plants.

"Early in August the plants in plats 2 and 3 were badly affected, the leaves showing the checkered appearance of the disease, and were an easy prey for such fungi as *Macrosporium nigricantium* and *Cercospora gossypina*, resulting in their curling up, drying and falling off.

"In a field of cotton of 3 or 4 acres near the scene of the above experiment the plants in May and June were very promising, but in August the disease had appeared to such an extent that the yield fell off at least one-half of what would have ordinarily been expected. The fertilizer used in this case was stable manure, cotton seed and acid phosphate.

"These experiments seem to show what has for some time been held by a number of intelligent planters who have experimented with kainit as a fertilizer. It has been quite frequently noted that with quite large applications of kainit there was no appreciable increase in the yield of cotton. This occurs in those seasons when the rains are quite frequent, not long continued, and keep the soil moist and the plant in normal growth. On the other hand, during dry seasons as well as seasons of drought followed by long-continued rains, kainit has a perceptible, sometimes a remarkable influence in increasing the yield. This, with the well-known effect of such salts in changing the physical condition of the soil, leads to the belief that the increased yield and the comparative freedom from disease result from the action of the kainit in binding more firmly together the soil particles, so that it is more retentive of moisture or more able to draw it up from below.* Salt and wood ashes are known to produce much the same results in the soil.† Rolling the land is frequently resorted to in order to produce the same effect. In the cultivation of cotton the more progressive planters are careful to prepare the land well before planting, and then to cultivate only the surface soil afterwards, in some cases scraping the surface of the soil with a "sweep" to a depth of only a few inches. This leaves the underlying soil undis-

*Alabama College Sta. Bul. 36.

†See article on climatology and soils, p. 160.

turbed, and there is no break in the continuity of the surface film on the soil particles below the few inches which have been stirred. The few inches of soil which have been stirred thus act as a mulch.

"*Characters of the disease.*—In the normal and usual progress of the disease there first appears a peculiar yellowing of the leaf, which gives it a checkered or mosaic appearance. The yellow color appears in small areas, and bears a definite relation to the venation of the leaf, being bounded by veinlets which subtend areas more or less rectangular in outline. The green color is found along the larger and intermediate veins. The portions of the mesophyll lying along the veins, being near the channels for the distribution of the nutriment, receive a better supply of moisture and assimilative material than the areas farther away, and those along the smaller and terminal ramification of the vascular channels at a time when the supply is being cut short because of unfavorable conditions of the soil. They are thus enabled to hold the green color and continue the activities of the leaf for a longer period, while the angular areas most remote from the sources of supply are the first to feel the loss, and the deficient nutrition is manifested by the yellow color of the parts.

"During the first stages of the disease this color may become very pronounced, but later it may be marred by the appearance of discolored spots produced by the growth of fungus organisms in the tissues, weakened by the failing nutrition of the plant. Soon, however, there appear minute brownish spots in the yellowish areas, which increase in size centrifugally, assuming a circular outline and marked by concentric rings. The concentric rings are probably due to the periodic growth of the fungus threads within the tissues, the periodicity being produced by variations in the temperature. The first fungus, which in most cases appears following the mosaic condition of the leaf, is *Macrosporium nigricantium* Atk. As the leaf thus becomes in a badly diseased condition, the Macrosporium is likely to be soon followed by an Alternaria.* The black hyphæ and spores of these two fungi soon give a black appearance to nearly the entire leaf, from which the disease takes the name of "black rust." These are not, however, the only fungi which are found as accompaniments of the later stages of the disease. *Colletotrichum gossypii* South-

*This may be *Alternaria tenuis* Nees, which Gasparrini found with other molds as an accompaniment of the disease of cotton in Italy known as Pelagra. (See Gasparrini, Observationi sopra una malattia del cotone, etc. Inst. D'Incoraggiamento. Napoli, 1865.)

worth is sometimes found, and *Cercospora gossypina* Cooke, as well as its perfect stage, *Sphærella gossypina* Atkinson is a very common accompaniment of the trouble. The accompaniment of the Cercospora stage of *Sphærella gossypina* frequently produces a separate type of the disease, especially when this fungus is more abundant than either the Macrosporium or Alternaria. This usually occurs when the disease progresses quite rapidly through the earlier stages, so that the yellow color is soon diffused somewhat evenly over the entire leaf or a large part of it."

During the summer of 1896 the rust appeared to a limited extent in the cotton plots grown on the Station farm. The experiments in progress included fertilizer tests (see Bulletin 76, p.p. 20-23), in some of which considerable quantities of kainit were used, but under the prevailing soil and weather conditions it seemed to have no appreciable effect in controlling the disease, the rusted areas crossing the kainit plots irregularly. This unexpected result served to call attention to the fact that neither the supply of potash in the soil nor the effect of the kainit on its mechanical condition were the only factors to be considered in studying the rust problem.

The season of 1897 proved to be a very bad one for cotton rust. In the poorer sandy fields south of Auburn the stalks were nearly all bare of leaves by the first of September. In riding about the country it was everywhere noticed that on the old fence rows that had been cleared up and put in cultivation since the passage of a stock law a few years ago, the cotton was still green; and it remained green and vigorous throughout the season in striking contrast to the bare rusted stalks in the remainder of the fields.

Here then seemed to be a key to the trouble. These old sandy fields had been cultivated in cotton season after season for many years, until their original fertility had been entirely exhausted. The supply of vegetable matter or humus in particular was very scanty. The small amount of commercial fertilizer put down with the seed in the spring, usually about 100 pounds per acre, served to give the young plants a start, but by midsummer it was exhausted, leaving the plant with nothing to support it during the trying process of flowering and fruiting. The consequent weakening of the vital forces of the plant, the stoppage of growth, and the partial ripening of the leaves left them in a state unable to resist the attacks of the various species of fungi connected with this disease that developed rapidly during a period of warm rains early in August.

The fence row land on the other hand had for years been allowed to grow up in weeds and bushes that had shaded it and caught the wash from the cultivated portions. It was black with humus formed from the annual decay of the weeds, leaves and grass. In other words, its fertility had been conserved and built up while that of the cultivated portion had been wasted. As a consequence its chemical and mechanical composition, in other words its tilth, was such as to retain sufficient moisture and furnish appropriate food to keep the cotton plant in a constant condition of vigorous growth and thus to enable it to repel its fungous foes.

This observation repeated again and again by the roadsides was more convincing than any single experiment could have been, no matter how carefully planned or elaborate. It seemed to teach the plain lesson that to prevent Cotton Rust it was first necessary to restore the lost fertility of our worn out lands, not only by supplying lacking chemical elements like potash, but above all by supplying the needed vegetable matter for the formation of an abundant supply of humus, so necessary for preserving a uniform water supply.

In order to test this view more fully and to bring the matter somewhat widely to the attention of representative farmers, a simple co-operative experiment was planned, and the following circular letter was sent to numerous addresses in this and other of the cotton States :

AUBURN, ALA., Dec. 29, 1897.

" DEAR SIR—The loss caused by Cotton Rust in many parts of the State during the past season serves to forcibly call attention to the need for further study of this obscure disease. The rust referred to is the one that has been variously called "Black Rust," "Yellow Leaf Blight," and "Mosaic Disease" in the publications of this Station. The exact symptoms vary with the character of the season, but its chief features are, first, a weakening of the vitality of the plant from any cause during mid-summer; and second, the rapid development on the weakened leaves of one or more species of fungi, causing dead blackened spots and ultimately the premature falling of the leaf. Fortunately the species of fungi connected with this disease do not have the power of attacking cotton foliage that is in a strong, actively growing condition. The lessened vitality that renders the leaves subject to attack may be caused by improper soil conditions, by prolonged drought, by too much rain, or probably by any other cause that tends to suddenly check the growth of the plant. If it were possible to keep cotton actively growing without any set backs throughout the entire season, there would be little or no liability to loss from rust.

"Obviously, then, our problem in seeking are medy for this disease is to learn to so treat our cotton fields as to maintain as nearly as possible this desired condition of continuous, uninterrupted growth.

"Owing to the great diversity of our soils and the varying character of the seasons, it is difficult or impossible to devise any one plan of treatment that would prove successful in all cases. The Experiment Station, therefore, earnestly desires your co operation in studying this question under the conditions existing in your own locality.

"Experiments conducted by Dr. Atkinson and others show that in some cases applications of kainit have a remarkable effect in preventing rust. My own observations during the past two years seem to show, at least for our thin hill lands, that those soils well supplied with vegetable matter, such as new ground, old fence rows, and lots near stables have suffered much less than old fields, where the vegetable matter or humus has been exhausted by constant cropping.

"Since this question is one of such general interest will you aid us by answering the following questions, and by carrying out the simple experiment suggested below, and reporting its results to me?

"1. Have you suffered from the rust either in 1896 or 1897? If so, what per cent. of your crop do you estimate as lost?

"2. What is the character of your soil? In what kind of locations has the rust been worse with you?

"3. Have you used kainit in your fertilizer? If so, in what quantity and what effect, if any, have you observed from it as to rust?

"4. Is new or old land most subject to rust in your locality?

"5. Have you noticed whether plants growing in old fence rows, near barns or in other unusually rich spots, withstand the rust better than those in the open field?

EXPERIMENT.

"Stake out four plots each 1 rod wide and 4 rods long in the field you consider most likely to rust badly. Be sure that the soil in all the plots is of uniform quality, and that it has had similar treatment as to crops and fertilizers for the past two years. Do not place the plots so that the wash from one will run down over another, but give each as nearly as possible the same slope and exposure. On the first plot broadcast evenly a big one-horse wagon load (1000 pounds) of fresh stable manure and plow it in. Plot 2, give the same quantity of stable manure but add 20 pounds of kainit and plow in. Plot 3, give 20 pounds of kainit but no stable manure, plow. Plot 4, plow at the same time as the others, but give no application.

"The plots should be prepared well in advance of planting, say before the middle cf February, so that the soil may become somewhat compacted and the manure be partially decomposed. Treat these plots exactly like the rest of the field, fertilizing, bedding, planting and cultivating all alike. Make notes from time to time on their comparative growth and appearance, and if the rust appears count the plants on each plot separately, noting the number entirely free from rust, the number slightly affected, and the number seriously injured. Send me samples of the rusted leaves in order to determine certainly the nature of the disease.

"Be careful not to confuse this rust with the "Angular Leaf Spot," where the leaves show clear watery spots and blotches; with the "white mildew," where the leaves look white and frosted on the under side; with "Frenching," where the stem is brown inside and the whole plant sickly; nor with the "Boll Rot."

"The object of this experiment is two-fold, to test the effect of kainit in preventing the disease under as many widely varying conditions as possible; and also to test the effect of largely increasing the soil humus and consequently its water holding and drought resisting capacity. The stable manure is suggested as being the quickest and easiest way of doing this on a small scale. Under the present agricultural conditions at the South, plowing under cow peas and other renovating crops would have to be depended on for doing this on a larger scale.

"All communications in regard to plant diseases should be addressed to the undersigned. F. S. EARLE,
"Biologist Experiment Station, Auburn, Ala."

The sending out of the above circular led to an interesting and extended correspondence from which the following letters and portions of letters are published, as showing a rather close agreement among widely scattered observers as to the conditions favoring this disease, and also as indicating to some extent its geographical distribution.

From Director R. J. Redding, Experiment, Ga.:

"I have had but little experience with so-called cotton rust. I have for many years been an advocate for, and have practiced, high manuring with complete fertilizers, and have had very little rust. I favor the theory that rust—so-called—is invited by a deficiency of plant food in the soil, and that it rarely, if ever, appears on soils that have been liberally and judiciously fertilized. We have never had a dozen plants so affected on this Station Farm, and I attribute our exemption to rotation, complete fertilizers, and plenty of them."

Those who have had the pleasure of inspecting the splendid farm of the Georgia Experiment Station, and of noting the almost perfect state of tilth to which it has been brought, will be in a position to appreciate the more fully the above forcible statements by Director Redding.

From Prof. J. S. Newman, Clemson College, S. C.:

" * * * Yes, I observed the experiments conducted by Prof. Atkinson. The effects of potash were very marked, and were corroborative of results which I had previously obtained. In one of the early bulletins* of the Alabama Station you will find a report of the number of rusted stalks on plots upon which no potash was used compared with the number where it was used.

"There is no question about the fact that kainit exerts an influence beneficial to plants by its power of conserving moisture, and I think there is little doubt also of its effect in preventing rust on cotton independently of this power. Its effect in periods of drought have been very marked in effecting increased growth."

From Director R. L. Bennett, Arkansas Experiment Station, Fayetteville, Ark.:

*Bul. 22, pp. 19-21.

"Cotton rust occurs only to a very limited extent in this State, and farmers are indifferent to it. There is little worn land in this State, and still less fertilizers are used on cotton."

From Prof. P. H. Rolfs, Biologist of the Florida Experiment Station, Lake City, Fla.:

"I have yet to receive the first specimens of diseased cotton in the State of Florida. Of course, this does not mean that this plant is not diseased in this State, but it is not one of those plants that is grown by those people who are most interested in better farming and better cultivation. Still, we have some very excellent people who are growing cotton and making money out of it in this State." [Doubtless sea island cotton is referred to.]

From Prof. B. C. Pittuck, Agriculturist of the Texas Experiment Station, College Station, Texas:

"The position and nature of our experimental work this year render us unable to co-operate with you in this test.

"1. Little or none in our section.

"2. Prairie; postoak loam underlaid by stiff blue clay subsoil.

"3. We have used kainit, but no rust occurred; hence effect has not been noted.

"4. Rust when observed, with one exception, has always been on old land.

"5. Have never noticed rust on land rich in humus."

From Director William C. Stubbs, Audubon Park, New Orleans, La.:

"I will instruct the farm managers of our three stations to notice any appearances of rust in cotton, and also to assist you in tracing the cause. We have such a variety of soils upon the three stations that we can very easily, perhaps, assist you in tracing this out; although I beg to say that we are rarely ever troubled with rust on either of our stations, notwithstanding we are cultivating uplands at Calhoun that originally would not make a bale to ten acres. I agree with you, however, that soil exhaustion of humus is the main cause on our uplands. This is demonstrated very largely in a country where fences have been removed, and we frequently find the cotton rusted to the old fence row; there we find it entirely clear of rust. If you will read a bulletin that we have published, you will find that a rotation of oats, cowpeas, cotton, corn and cowpeas, with suitable fertilizers for each crop, has proven in North Louisiana to be one of the most certain and rapid methods of building up our poor soils, and at the same time giving an increased profit with each crop."

This three-year rotation of oats (or other small grain) followed by peas, cotton, and corn with peas is essentially the one that has been recommended again and again by all the Southern Experiment Stations. There can be no doubt that its general adoption, together with the breeding of enough live stock, horses, mules, cattle, sheep and hogs, to consume on the farm the crops of oats, corn and peas and the cotton seed, would revolutionize Southern agricultural conditions, and banish forever many of the evils with which we are now confronted. The great success in growing hairy vetch and crimson clover recently made at this Station by means of soil inoculation (see Bulls. 87 and 96) indicate that these winter-growing legumes may be used in connection with the above rotation with even greater beneficial results.

From H. Benton, Acting Director of the Canebrake Experiment Station, Uniontown, Ala.:

"I shall be glad to co-operate with you in proposed experiments with cotton rust.

"1. My individual crop has suffered from rust but little either in 1896 or 1897, but on thin lands, not properly rotated, near me 'rust' frequently causes a loss of from one-fourth to one-third of the crop.

"2. The character of soil subject to rust in this section is what is called here 'White Prairie' and 'Yellow Shelly Land,' probably worse on the latter. I have never seen any rust on the Station except in a rich black bottom, and that in quite a small place. I am unable to account for it in this particular place, as other places where the land seems the same are never troubled with it [perhaps lack of drainage.]

"3. I will give experience for past year on a neighbor's farm. Size of plots 1-16 acre:

	Yield Seed Cotton.
Plot 1—16 lbs. common salt plowed in July 21	$72\frac{1}{2}$ lbs.
Plot 2—8 lbs. sul. potash plowed in July 23	$79\frac{3}{4}$
Plot 3—Bordeaux mixture sprayed July 23	71
Plot 4—Bordeaux mixture and saturated sul. potash sprayed July 23	$65\frac{1}{2}$
Plot 5—Nothing	$54\frac{3}{4}$

"Old land is most affected by rust. Seldom find it in new or rich land.

"Plants growing in fence rows, old barn lots or rich spots seldom become affected with rust, but when they do the disease seems to be as deadly as on poor soil."

From J. W. Eubank, Pine Level, Ala.:

"1. Yes, in both years, 1896 and 1897, about 20 per cent.

"2. Sandy with yellow clay sub-soil. It has been worse on black floury soil that is common in pine lands.

"3. I have not used kainit.

"4. Old worn land every time.

"5. Have noticed it for a series of years, dating back as far as 1849. My long experience and close observation have long since settled the question of cotton rust with me. All forms, colors, and names of rusts in or peculiar to the cotton plant are nothing more or less than poverty. Give the soil all the plant food and moisture required by the cotton plant, with proper cultivation, and all forms of rust peculiar to the plant will be unknown."

From W. G. Bevill, Bevill, Ala.:

"Will say in response to your questions:

"1. I have suffered from rust in 1896 and 1897 about 33⅓ per cent. where kainit was not used.

"2. Sandy land, some with clay subsoil and some without. It is worse when there is no clay subsoil.

"3. I used kainit in 1897 on part of my crop, between 75 and 100 pounds per acre. Where I did not use the kainit rust reduced the yield at least 33⅓ per cent. with the same amount of other fertilizers.

4. "Old land seems to rust worse than new. I had one patch of an acre and a half that I fertilized with about 450 bushels of barnyard manure, composted with about 400 pounds each of acid phosphate and kainit. If it had any rust at all, I did not see it. I gathered from the 1½ acres over 1,500 pounds of lint cotton. There are several large trees around one side of the patch, and about a dozen peach trees on the other. Where it was not injured by the trees it made a the rate of three bales to the acre."

Mr. Bevill has evidently discovered the true remedy for cotton rust. Unfortunately, in some seasons, such heavy manuring may lead to serious loss from boll rot.

From G. R. Banks, Tallassee, Ala.:

"1. I have suffered very little from rust in 1896 or 1897, yet there have been some spots of it each year on my place.

"2. I have every variety of soil. Rust is worse in the gray soils that are the poorest; however, of a very wet year the black loam lands suffer, sometimes seriously, as well as level red lands.

"3. I have not used kainit.

"4. Old lands.

"5. They certainly do. Some twelve years since I removed a fence by burning it. It shows plainly now, and I do not remember seeing rust on it. I threshed wheat about twenty years ago, and left the straw in the field. There has been no rust in any of the places. Where fodder has been stacked in the fields the same good results are visible. Where there are large crops of peavines (say 15 to 20 tons per acre when green) left to rot on the ground, I have never seen rust for several years. I, however, attribute this to the mechanical as well as chemical condition of the soil. I have experienced good results in preventing rust by using a mole-shaped, 15-inch foot subsoil plow following a two-horse turning plow on level red lands."

This report is very interesting and instructive, especially in regard to the benefit from the use of the subsoil plow. It illustrates the necessity for studying local conditions, and of adapting remedial measures to them, since on the light soils of the Station Farm (see Bull. 76 and 89) and on the sandy land of Mr. Moore near Auburn (see p. 301) subsoiling has given very little result.

From J.M. Ballard, Superintendent of Experiment Farm, Jackson, Ala.:

"1. I have suffered from rust, both in 1896 and 1897, on account of drouth, which lasted throughout the cotton growing season. It is hard to ascertain the proper per cent. of loss by rust, but can say with safety 10 per cent.

"2. My soil is a coarse red soil of a thirsty nature. Rust is most prevalent in the thin sandy portion, those places most destitute of vegetable matter.

"3. I have used kainit with success at the rate of 200 pounds per acre.

"4. Old lands which have been in cultivation for a number of years and which have about exhausted all their vegetable matter are most subject to rust in this section.

"5. I have noticed that new ground, fence rows and lots near stables withstand rust better than old lands void of humus."

From J. H. Evans, Therissa, Ga.:

"I have been using German kainit on parts of my lands most affected by rust for several years and am well pleased with the results."

From S. M. Cathcart, Rehoboth, Ala.:

"We have cotton rust more or less every year on our old worn lands. It is worse on sandy swamp or bottom lands. My soil is gray sandy upland with sandy subsoil, and sandy bottom lands with sandy subsoil. I have used kainit some. Think it prevents rust to some extent. Cotton rusts very little on new land, old fence rows and rich spots near barns. I think if we will keep the soil filled with vegetable matter there will be very little rust."

From Frank Shackelford, Sr., Colquitt, Ala.:

"My experience coincides with yours that cotton seldom rusts that grows on fence rows, ditch banks or other unusually rich spots, especially so if made rich by barn yard manure."

From H. H. Hayes, Camden, Ala.:

"1. My cotton was not damaged by rust in 1896, but in 1897 it was injured about one-fourth by black rust.

"2. My land is a gray sand with clay foundation about ten or twelve inches deep. It rusts worse where the sand is coarsest. There was not much difference in 1897, nearly all the gray land rusted.

"3. I have not used kainit.

"4. New land does not rust. Old fence rows do not rust. Rich places do not rust. Old land rusts worse than fresh land.

"I think the seasons have more to do with cotton rust than the land. Some years one place will rust and the next year it will not, and some other places will rust that did not that year."

From H. L. Bedford, of the Cotton Planters' Journal, Bailey, Tenn.:

"1. Have never been seriously troubled by rust.

"2. My soil is a clay loam. Rust is worse on worn land deficient in drainage. Observed it once on new land full of partially decomposed vegetable matter, such as chips, trash, etc.

"3. Yes, frequently, in varying quantities, but took no notice of effect in relation to rust.

"4. Old land.

"5. Have never noticed it in places mentioned."

From George McDonald, Cuthbert, Ga.:

"We suffer very little in this section from cotton rust."

From Ernesto Madero y Huosl, Parras, Coahuila, Mexico:

"We have not noticed in this vicinity any other than the ordinary diseases of the cotton plant, such as the *root worm* in the month of April, or the leaf worm from August to September when the season is rainy. We have not seen yet the "black rust" about which you inquire, and we do not know its symptoms, but it must be said that our lands are very fertile and rich, consequently giving very good crops."

From William Strang, Piggott, Ark.:

"I have not grown cotton in the last fifteen years. The immediate cause of my quitting it was a failure of my crop through the rust. I had in five acres of rich gum land, nearly fresh, had been cropped two years in corn and was full of humus. Cotton was planted early in May, and had been thinned to a stand and cultivated. About the second week of June we had much rain and continued cloudy, chilly weather. The sudden checking of growth was disastrous, and the field made less than a bale. Similar land in the same locality was similarly affected, but cotton on poorer soils did not suffer nearly so much. I have always attributed the rust to the sudden checking of the growth."

This may or may not have been the disease under investigation. The sudden checking of growth from any cause is certainly one of the predisposing causes.

From G. W. Rhodes, Saville, Ala.:

"I have suffered very little from rust the past year, as I do not plant lands that will rust. We have a variety of soils in this county, mostly a gray land with subsoil from one to ten feet deep, though we have a red clay or stiff soil and also a fine close gray soil. Our deep sandy soil is more subject to rust than the others, but all will rust when badly worn. The cause of rust in our section is the lack of proper vegetable matter or humus. New ground will not rust until the humus is exhausted. As the land becomes worn rust will appear unless humus is supplied. I have noticed cow lots built on old worn lands where the cows were penned until the land became rich. When the pens were removed and the lands planted in cotton there was no rust on the rich spot, but all around it rusted badly. * * * I have tried kainit with compost and with other manures. While probably there is some good in it, in my judgment it should not be recommended to eradicate rust.

From C. C. L. Dill, Dillberg, Ala.:

"1. I have used kainit and have not suffered from rust during 1896 and 1897. Before I began the use of kainit I lost by rust.

"2. Soil sandy loam with clay subsoil.

"3. I use 100 lbs. kainit, 100 lbs. acid phosphate, and 100 lbs. guano per acre in the drill.

"4. In rich land, new or old, where the plants are strong and thrifty, I have never been seriously injured by rust.

5. "The very best cotton that we have is in old fence rows, near barns or old cow pens, especially the cow pens."

From R. P. Johnson, Smithville, Ga.:

"We have had rust in this section the past year a little worse than the previous year, next crop we expect to have still more. I have had the rust problem solved ever since it first made its appearance to any extent in this section. Have not planted any cotton for ten years. I am satisfied that I could plant a crop and not have a rust spot on it. Why? Because it has had a rest from constant clean culture. It has been run in corn, watermelons, peas, oats, vegetables, and right here lies the whole solution of the rust trouble: diversity of crops is the key note to the whole business."

From G. H. Turner, Burgess, Miss.:

"1. Yes, some of our cotton suffered badly in 1897. We suppose loss would amount to at least 50 per cent. in some patches, while in others in similar soils and under apparently exactly similar conditions there was none.

"2. A sandy loam. Rust has been worst in low land, branch bottoms, and on old well worn land that was deficient in humus. The mere fact of its lowness cuts no figure, from the fact that the land on which we made three bales per acre was still lower.

"3. Have never used kainit as a preventive of rust, but have used fertilizers containing kainit. Have never had the slightest trouble whenever and wherever *complete* fertilizers were used. Last year a piece of ground right through the center of a cotton patch to which *phosphate alone* was applied, rusted to fully as great an extent as that on either side of it, yet the yield was about 100 per cent. better than on that to which no phosphate was applied.

"4. New grounds are, in this section and in our experience, seldom, if ever, troubled with rust, especially if the ground is comparatively high and dry.

"5. Our experience and observation tends to confirm us in the opinion that as long as land is abundantly supplied with humus as in old fence rows, near barns, new ground, etc., in short, wherever the land from the presence of this same humus is loose, open, mellow and porous, such land will never suffer to any great extent from rust. On the contrary, whenever and wherever this humus is deficient and the land packs and bakes after every rain, the roots being thus deprived of air, the plant begins to suffer, the root first and finally the foliage."

From J. A. Peterkin, Fort Motte, S. C.:

"I have every foot of my land in oats that is subject to the so-called rust. There are several kinds of land that are subject to this trouble; viz.: a hill slope where the sand has collected near or adjoining a bottom. This will make healthy cotton if the weather is dry from the time the bolls form till it matures, but in wet seasons the soil does not dry out and air cannot enter except through the foliage, which becomes diseased, and then follows the death of the plant; the deep growing roots are first destroyed. Another class of land that will rust is a black or gray bottom with pipe-clay subsoil. A thin, hard crust forms on the surface, water is retained near the surface by the clay. Any character of rock that forms a pan like the clay causes the same effect. I have a neighbor who has succeeded in making good cotton on bottom land with this pipe-clay subsoil. He has it first thoroughly open drained, then tile drained every twenty feet. He uses stable manure, acid phosphate and kainit. I consider thorough drainage and fertilizers a remedy for the rust."

A careful reading of the above letters seems to justify the following conclusions:

1. This disease is largely confined to the older cotton growing States, and it prevails over considerable portions of North and South Carolina, Georgia, Alabama and Mississippi.

2. It is usually worse on old, worn, sandy lands, but it may appear on any kind of soil when the humus is greatly exhausted. In all such cases the building up of the general

fertility of the soil by plowing in vegetable matter and especially animal manures will do much to prevent rust. The application of kainit is often very beneficial.

3. Low wet lands and seepy hillsides are also subject to rust. In these cases better drainage, together with proper fertilizer, will give relief.

4. Sporadic cases of rust may be expected on almost any kind of soil in very unfavorable seasons.

The following experiments conducted in 1898 serve to still further corroborate these conclusions, and they also bring out a few other points of interest:

Experiments on the Station Farm.

Prof. Duggar kindly consented to plant some potash fertilizer tests with cotton on land known to be subject to rust. The place selected was on top of a dry, gravelly knoll. On September 4 these plots were carefully examined, and the following results noted: Plot 1. Some short point rows and an outside row unfertilized as a check; leaves practically all off. Plat 2. Four rows fertilized at rate of 50 pounds muriate of potash, 120 lbs cotton seed meal and 240 pounds acid phosphate; very good condition, an occasional rusted plant, but fully 90 per cent. of foliage green. Plot 3. Four rows; 1,000 pounds potash feldspar, 120 pounds cotton seed meal and 240 pounds acid phosphate; leaves practically all off; the feldspar seems to be entirely inert. Plot 4. Four rows; 120 pounds cotton seed meal, 240 pounds acid phosphate, no potash; leaves practically all off, perhaps 2 per cent. still green. Plot 5. Four rows; 60 pounds kainit, 120 pounds cotton seed meal, 240 pounds acid phosphate; about 10 per cent. still green, balance all off. Plot 6. Four rows; 100 pounds kainit; 120 pounds cotton seed meal, 240 pounds acid phosphate; about 50 per cent. of plants green, balance with leaves off. Plot 7. 200 pounds kainit, 120 pounds cotton seed meal, 240 pounds acid phosphate; about 70 per cent. of plants green. Plot 8. Check; about 2 per cent. green.

This experiment is interesting in showing the marked effect of potash fertilizers in holding the foliage and preventing rust on dry, thin soil, under the weather conditions of 1898. It also shows that applications of less than 100 pounds per acre of kainit did but little good, and that 50 pounds of muriate of potash was more effective than 200 pounds of kainit. It must be admitted that the soil conditions slightly favored the muriate plot, but later in the season the difference of rust in its favor became much more pronounced than at the time of this observation. This result is important as indicating that the muriate will be at least equally as effective as the kainit used in quantities proportionate to the actual potash content of each, a point that has not been previously determined. It also seems to indicate that it is the actual manurial value of the potash that is effective in preventing rust, rather than the supposed effect of these salts on the water-holding capacity, or surface tension of the soil, since the common salt and other impurities in the kainit would exert almost as much of this influence, pound per pound, as the potash.

The other cotton plots on the Station Farm were all on better soil and were but little injured by rust. On those that received muriate of potash and cotton seed meal the foliage was hardly so good as when a complete fertilizer was used. In the variety tests the short-limbed, rather dwarfish kinds seemed, as a rule, to suffer more than the rank-growing, longer-limbed varieties.

Observation on Residual Effect of Stable Manure on the Farm of Mr. Flanagan, near Auburn.

A field near the road was planted in watermelons in 1897. A large amount of stable manure was applied under the melon row. In 1898 this field was put in cotton, and the rows were so spaced that every third one came on the old melon row. All were fertilized and worked alike. On passing this field on September 5, it was noted that the row over the old melon row was rank and green, with no rust, while the two rows between were much smaller and were almost entirely bare of leaves.

EXPERIMENTS ON THE FARM OF MR. JAMES MOORE NEAR AUBURN.

The Experiment Station Farm lies near the dividing line between the red clays of the Piedmont region and the sandy lands of the lower levels to the southward. It is hardly typical of either class of soils. Through the kindness of Mr. James Moore of Auburn, it has been possible to try some cotton rust experiments on the typical sandy soil of Middle Alabama at his farm three miles south of Auburn. These experiments while on the same general line as the co-operative one suggested in the circular letter p. 289 were rather more extended and included differences in the preparation of the soil as well as the different use of fertilizers. Two series of plots were laid out in the fall in different fields and bands across each lot of plots were plowed and seeded to oats to test the effect of a winter cover in preserving the fertility of the soil. The soil was poor and as the oats were planted rather late they had made but little growth before being plowed down in the spring, so that this feature of the experiment was without result. Early in spring part of the oat bands and parts of the unseeded land were plowed with a turning plow followed in the same furrow by a scooter that loosened or subsoiled the ground to a depth of ten or twelve inches. The remainder of of the land was not broken but was laid off, fertilized and bedded in the way usual in these light sandy soils. During a rather severe spring drouth Mr. Moore thought that these subsoiled strips held moisture better than the unbroken land and that the plants grew off rather better. During the latter part of the season rains were seasonable and this slight advantage was lost. At harvest time there was no appreciable difference and it seemed to have no effect in preventing rust.

MOORE EXPERIMENT NO. 1.—The field selected for this set of plots was in corn and cow peas in 1897 and a large crop of pea vines was left to decay on the land. On March 25, 1898, plots 7½ rods long and 1 rod wide were laid off in this field crossing the bands that had been seeded to oats and those that had been subsoiled. Mr. Moore was using on his general crop about 100 pounds per acre of a "potash phosphate" guaranteed to carry 2 per cent. of potash. This was applied to all the experiment plots in the drill the same as to all the rest of his crop.

In addition the following were applied:

Plots 1 and 2—Stable manure, a large one-horse wagon load to each plot, broadcasted and covered by bedding up the rows.

Plots 3 and 4—Each 50 pounds of kainit.

Plots 5 and 6—Check.

Plot 7—50 pounds acid phosphate.

Plot 8—50 pounds acid phosphate and 25 pounds nitrate of soda. One end of this plot also received muriate of potash at the rate of 500 pounds per acre.

Plot 9—25 pounds nitrate of soda.

Plot 10—8 pounds nitrate of soda.

Plot 11—Check.

All were planted and cultivated alike throughout the season. Inspection on August 8 showed that, while the crop as a whole had made less growth than was expected from the large growth of peas the previous year, still it was almost entirely free from rust, and the foliage had a good healthy color. The stable manure and the nitrate of soda plots had decidedly outgrown the others, and the foliage was still greener and ranker. The heavy applications of kainit and of acid phosphate seemed to have had no effect whatever. There was nothing by which they could have been distinguished from the remainder of the field. On a second inspection September 5, the conditions were still much the same. The general crop was ripening and the foliage beginning to change color so that the stable manure and nitrate of soda plots stood out even more distinctly than before. The acid phosphate plot seemed quite mature and a larger proportion of bolls were opened than on the others. The phosphate and nitrate row was perhaps a little better than that which had only the 25 pounds of nitrate, but the difference was slight. The 25 pounds of nitrate gave a much better growth than the 8 pounds, though that plot was conspicuously better than the checks. The heavy application of kainit on plots 3 and 4 still showed no effect whatever. At this date there was a little spotting of the foliage in this field, but not enough anywhere to do material damage. The pronounced effect of the nitrogenous fertilizers and the lack of effect from the potash and phosphate in this field was a great surprise, as it was thought that the previous pea crop had furnished nearly nitrogen enough to supply the needs of the cotton crop. The general better tilth of the land on account of the pea crop at least served to ward off the rust, as many neighboring fields suffered badly, although the trouble was less serious than in 1897.

MOORE EXPERIMENT No. 2.—The land for this experiment was selected because it was very old and thin, and had the reputation of being more subject to rust than any other field on the farm. It was in cotton in 1897 and the crop was practically all ruined by rust. The fertilizers were not put down for this experiment till April 12. As in the other case all received Mr. Moore's "potash phosphate" at the rate of 100 pounds per acre. Here the rows were about 18 rods long, and the following plots were laid out:

Plot 1—Check.

Plot 2—Kainit at rate of 500 pounds per acre.

Ptot 3—Kainit at rate of 500 pounds per acre, acid phosphate at rate of 200 pounds per acre, and nitrate of soda at rate of 100 pounds per acre.

Plot 4—Check.

Plot 5—Kainit, 500 pounds per acre.

Plot 6—Check.

Plot 7—Muriate of potash, 125 pounds per acre.

Owing to a misunderstanding Mr. Moore had used all of his stable manure so that none was available for this test.

On August 8 the check rows were found to be very poor, plants only 12 to 18 inches high, and carrying very few bolls. The foliage was badly spotted and fully 10 per cent. of the plants had entirely lost their leaves.

In the kainit plots the plants were about twice as tall as in the check rows. They were slender and not much branched and the leaves, though healthy and not at all spotted, had a peculiar yellowish green cast, indicating lack of nitrogen. The muriate of potash plot was in exactly the same condition. It was impossible to note any difference between them. Both the muriate, kainit and check plots were found to be shedding the bolls of the top crop very badly.

Plot 3, with the complete fertilizer, was by far the best of the lot. The plants were tall and well branched, and were very heavily fruited. They were also setting a heavy top crop, with no sign of shedding the bolls. The foliage was green and luxuriant.

On September 5 the check rows were almost entirely bare of leaves, and the crop so poor as to be hardly worth picking. The kainit and muriate plots were still perfectly green and healthy. A few of the plants with the complete fertilizer were showing some spotted leaves, but the plot as a whole was in splendid condition, and was opening a crop that was estimated by good judges at fully a bale to the acre.

This experiment was very interesting as showing the marked effect of the potash fertilizers in preventing rust in this old worn-out, sandy land. It also fully corroborated the result on the Station Farm obtained with the muriate of potash. The same thing was noted again later in the season on, the farm of the District Agricultural School at Albertville where, in a fertilizer experiment, muriate and sulphate of potash were used in comparison with kainit. All three seemed to have a similar effect in preserving the foliage. It seems, therefore, safe to say that one pound of muriate of potash will equal four pounds of kainit in preventing rust. At most interior points the muriate will, therefore, be the cheaper of the two to use. The most unexpected result of this experiment was the getting so fine a crop from land of this particular character on the complete fertilizer plot by the use of commercial fertilizers alone. Like some of the sandy lands near the coast, this particular soil seemed to have a good water-holding capacity, and the rains were fairly seasonable. It can hardly be expected that this result could be duplicated in a season so unfavorable as that of 1897.

Experiment by Mr. J. P. Alvis, Auburn, Ala.

The soil was worn and sandy, much like that at Mr. Moore's, and it was known to be subject to rust. One plot was manured with hog manure in the row, another had kainit at the rate of 100 pounds per acre. The untreated portion of the field rusted badly. The hog manure plot was some better, though it, too, suffered from rust. The kainit plot was almost entirely free from rust, and remained green throughout the season. Mr. Alvis plans to use kainit on his entire crop next season.

Experiment by Mr. J. W. Eubank, Pine Level, Ala.

Plots fertilized as suggested in circular (p. 289). Soil sandy with yellow clay subsoil (See letter, p. 293). On September 5 Mr. Eubank reports the result of the first picking on September 2 and gives the following notes:

Treatment.	Condition.	Yield, First Picking, Sept. 2.
Plot 1. Stable manure	About 4 per cent. of plants show rust....	1,480 lbs. per acre.
Plot 2. Stable manure and kainit..........	No rust, leaves green.	480 lbs. per acre.
Plot 3. Kainit..........	No rust, leaves reddish and yellowish green.	360 lbs. per acre.
Plot 4. Check	All rusted, only 12 plants left with green leaves..........	240 lbs. per acre.

He adds that plot 1 was far in advance of the others throughout the season in growth and in maturity of fruit, and that all the plots seemed free from rust until the heavy rains early in August.

The final report on this interesting experiment has not yet been received. There can be no question, however, that in the later pickings plot 2 will show to better advantage. The effect of potash in retarding maturity is well known, and it is to this effect that its power in preventing rust is doubtless due. Maturity could have been hastened by the addition of acid phosphate.

Experiment by Mr. J. A. Evans, Therissa, Ga.

Mr. Evans used a compost consisting of one part acid phosphate to four parts of stable manure, putting down at the rate of 1,000 lbs per acre in the drill. On this compost, in the row before bedding, he scattered kainit in quantity ranging from 50 to 100 lbs per acre in certain spots most subject to rust. Owing to a storm that badly injured the cotton as it was opening he did not keep a record of the weights of cotton picked from these plots, but he states that he is satisfied that when as much as 100 lbs. per acre of kainit was used that the yield was fully doubled, and that when less amounts were used the improvement was less in proportion. Where no kainit was used the cotton stopped growing and died much earlier, and the foliage and stalks were at least one-third smaller. He considers the kainit not only a successful preventive of rust but a valuable fertilizer for his lands.

Mr. Evans induced a neighbor, Mr. James Williams, to test the kainit also. Mr. Williams used at the rate of 100 lbs. of kainit per acre on some spots very subject to rust, and Mr. Evans states that it more than doubled the yield.

This land was evidently in need of potash as a manure. In connection with the liberal application of compost and acid phosphate it made a complete fertilizer and that is undoubtedly the need of many of our southern soils.

Experiment by Mr. G. H. Turner, Burgess, Miss.

Mr. Turner reports as follows under date of November 1:

"The experiment spoken of was undertaken and carried through, but owing to peculiarities of the season the results are nil, as we have not had a particle of rust anywhere. Not only is this the case with us, but there has been a remarkable immunity from rust throughout this entire section. I do not know of a single farm infested with it this year, let it be ever so poverty stricken or ever so destitute of humus. There are other things that contribute toward an epidemic of rust besides the lack of either humus or chemical elements. The season has been exceptionally seasonable for uplands and altogether too wet for bottoms; yet we have the largest crop probably ever made in this section, bottom and top crop heavy, middle crop scattering."

Mr. Turner is undoubtedly right in stating that other things besides humus and chemical elements are connected with epidemics of rust. Favorably seasons may go far toward off-setting the ill effects of poor soils and again on the best of soils unfavorable seasons may produce sporadic outbreaks of the disease. When the sum of all the conditions is such that the cotton plant grows continuously and without interruption from one end of the season to the other there will be no rust. To produce a serious outbreak of the disease we must have, first, conditions that check the growth of the cotton and impair its vitality; and, second, weather conditions that favor the rapid growth of the fungus enemies that are connected with the disease. As the factors that go to constitute climatic conditions or "the seasons" are so largely beyond our control, it is only by ameliorating the condition of the soil that we can hope to cope with the disease, and even then our best efforts may sometimes be foiled by exceptionally unfavorable seasons.

Experiment on the Farm of the District Agricultural School at Abbeville, Ala. Undertaken by Prof. S. T. Slaton, the Agriculturist, and Reported on by His Successor, Prof. P. M. McIntyre.

Plot No. 1.—Stable manure in the drill.
Plot No. 2.—Stable manure broadcast.
Plot No. 3.—Kainit.
Plot No. 4.—Check.

Under date of October 13, Prof. McIntrye reports that plot 4 was very badly rusted and in fact had no leaves left on it. The other three plots all had plenty of foliage left but all had suffered to some extent. Plot 2, with manure applied broadcast, seemed to be in the best condition; plot 1 next and plot 3 next.

Experiment by C. C. L. Dill, Dillburg, Ala.

First picking reported October 3:

Plot 1.—1 load stable manure, 42 lbs. seed cotton.

Plot 2.—1 load stable manure and kainit, 54 lbs. seed cotton.

Plot 3.—Nothing, 20 lbs. seed cotton.

He says that when there was no kainit there was some rust, and the cotton was not so well fruited and did not stay green so long as when the kainit was used, though both the manured plots made fine cotton.

Experiment by Director G. W. Carver, of the Experiment Station of the Tuskegee Normal and Industrial Institute, Tuskegee, Ala.

The details were carried out exactly as suggested in the circular (p. 289). Report under date of October 6, as follows:

"Plot 1—Stable manure. Scarcely any rust, only a few plants showed signs of *Macrosporium* and *Cercospora*. It held its leaves well and fruited heavily. Stalks large and fine.

Plot 2—Stable manure and kainit. Only an occasional leaf affected with rust. Plants unusually fine and well fruited. One plant had a little *Ramularia*.

Plot 3—Kainit. Rusted badly in spots. Plants all pale and rather small. It had both *Macrosporium*, *Cercospora* and *Ramularia*. Plants not counted, but estimate fully one-third of plot affected.

Plot 4—Nearly every plant rusted and dropped its leaves. Plants very small, bolls inferior; did not see an average of four bolls to the stalk."

In this carefully conducted experiment the soil was evidently too poor to respond to the potash alone. It needed the complete fertilizer furnished by the stable manure as well as its beneficial mechanical effects.

Taking the view of the matter that seems to be forced on us by the evidence that has been given in such detail in the foregoing pages, and which has come from so many different sources, cotton rust simply becomes another argument, and a very potent one, too, in favor of diversifying our crops, of keeping more live stock, and of adopting some systematic rotation that will provide frequent crops of cow peas and other leguminous plants to aid in building up the fertility of our soils. All thoughtful people are agreed that the practice of growing nothing but cotton year after year has been the fruitful cause of many of the grave problems that now confront the Southern farmer. This better method that shall be conserving and adding to the fertility of our soil instead of rapidly depleting it, is demanded by every consideration of business prudence, and of justice to the generations that are to follow us. When these thin lands of the South shall be devoted two years out of every three to the growth of forage crops, including peas and other legumes, which, together with the cotton seed, shall be fed to live stock, thus producing an abundant supply of home-made manure, to be supplemented by the purchase of such mineral fertilizers as experience indicates as necessary, then will cotton rust largely disappear, together with most of the other agricultural ills that now confront us, and the "New South" will have indeed become a reality.

BULLETIN No. 100. DECEMBER, 1898.

ALABAMA

Agricultural Experiment Station

OF THE

AGRICULTURAL AND MECHANICAL COLLEGE,

AUBURN.

LAWNS, PASTURES AND HAY.

P. H. MELL.

BIRMINGHAM
ROBERTS & SON.
1898

*On leave of absence in South America.

LAWNS, PASTURES AND HAY.

So many inquiries have reached the Station during the past year from people in Alabama, concerning the methods for grass cultivation, and the grasses best suited for lawns and pastures, the author has deemed it wise to issue this bulletin conveying the information desired.

There is a bright outlook for the future when the farmers are seeking for instructions how to make pastures and cure hay. It is an indication that more milk and butter of a superior quality, and finer grades of beef, will soon be placed on the markets of the State by a larger number of farmers. The climate and soil of Alabama are so well adapted to grass cultivation, there is no excuse for any farmer buying hay from other sections of the country. If he will raise his own hay and keep in good condition a first-class pasture, there will be but little chance for introducing into his lands the seeds of injurious weeds, so often to be found in bales of hay shipped from distant sections of the United States. For instance, such an obnoxious plant as the Russian thistle has no doubt been scattered in many portions of the country through the forage purchased by farmers who have failed to produce on their own lands a sufficient amount of hay to supply the necessary food for their cattle.

Now that the serious problem is presenting itself to the consideration of the people: What can be done to induce the farmers to plant less 5-cent cotton, and to so diversify their crops as to make the farms self-sustaining? may not one solution be in the raising of cattle, which will result in turning much of the land into grass for pasturage and hay? This bulletin is, therefore, written with the hope that an impetus will be given in that direction, so that in the raising of fine breeds of cattle all over the State, the farms may be turned into paying institutions.

The Lawn.

A lawn cannot be successfully developed in one season, but it requires care in the selection of seed or sod and judicious labor in the preparation of the land. The first year is required to give the grass a firm hold on the soil, and even much of the second year is at times necessary to permit a uniform covering of the surface, particularly in those instances where the grass has been drilled or the sod set out in bunches.

The first matter of importance for consideration is the thorough preparation of the land. The character of soil best suited for the cultivation of grass is a sandy loam with a clay subsoil. The land should be well drained to prevent a too wet condition, which will result in sourness. Plow deep in the fall, after broadcasting an ample supply of stable manure or ground bone and cottonseed meal. If the land is not situated in a limestone region, and there is a deficiency of lime, this substance must also be broadcast before plowing. A liberal application of air-slaked lime, or land-plaster, should be made—at least, ten to twenty bushels per acre, where there is a deficiency. No definite rules, however, can be given as to the amount of lime required. The question depends entirely upon the character of the soil. In those portions of Alabama where marls are common the land for grass cultivation will be greatly improved by broadcasting the marl and ploughing in. In this case the application of lime will not be necessary, since this substance is one of the chief ingredients in the marl.

After plowing deep so that the soil will be thoroughly loosened, the harrow must be run over several times until the clods are broken, the earth finely pulverized, and the surface is rendered level. If the land is poor in humus or organic matter, and there is not a sufficient supply of stable manure available, it will be wise to first sow in peas, and turn them under before attempting to grow grass. When the grass has become well established it will be greatly improved by an occasional top-dressing with nitrate of soda and cottonseed meal. On small lawns old plastering from the walls of buildings, when well pulverized, makes an excellent top-dressing, when applied in December or January. The winter rains will soon beat the plaster into the soil around the roots of the plants. Wood ashes are also excellent fertilizers.

Immediately after the grass seeds are sown, the roller must be run over the lawn, so that the soil will be packed around the small seeds to insure germination. Care must be exercised, however, not to cover deeper than one eighth to one-quarter of an inch; otherwise the vitality will be exhausted before the young plants reach the surface of the ground. The roller is the best and most satisfactory way of covering the seeds. During the growing season, and just after the mowing, it will improve the lawn to run the roller over the grass occasionally. Early in the fall the mowing must be discontinued, so that the grass will recuperate for the winter's cold.

Selection of Seed and the Time for Sowing.

The heat of the summer's sun is so great and long-continued in many sections of the South, most of the grasses so popular in the northern portions of the country are destroyed, and their cultivation, except in shaded yards, becomes almost impossible. The summer months are also so often deficient in rainfall, it is important that provision should be made for the frequent watering of the lawn, if a green, vigorous condition is to be preserved. For these reasons it becomes necessary to select those grasses which will best stand the heat of the Southern sun, and will also live through the dry seasons. Among the number of the best lawn grasses suited to Alabama soils and climate may be mentioned the following. Only five species and one variety are given, because, in the opinion of the author, these are sufficient for general demands. The list will produce lawns of even texture, uniform sward and permanency:

Bermuda Grass (*Cynodon dactylon*, Pers).—This is purely a Southern grass in its habits and adaptability. It is, however, an introduced species, and does not mature its seeds except in the extreme South. It thrives best in the sun, and in a rich soil will grow rapidly, resulting in a beautiful, green sward. The growth is by underground stems, and after once obtaining hold in the land it will require but little care and attention, except the occasional fertilizing to keep the soil in a healthy condition for growth, and the regular sprinkling when the dryness of the atmosphere demands the application of water.

Bermuda grass is propagated by cutting into short pieces the underground stems and sowing them over the well-prepared soil and harrowing in; or by breaking up the turfs into small bunches and dropping them into holes made by means of a hoe, and covering them with earth. Where there is a large supply of the grass available, sodding may be resorted to, and this will insure a completed lawn in a much shorter period of time than secured by either one of the other methods. After the grass has been growing for some time, and weeds and other foreign, undesirable plants begin to show themselves, hand weeding must be resorted to. This will be quite laborious at first, but the beautiful and regular lawn resulting will more than repay the time and attention expended in eradicating the weeds.

St. Lucie Grass.—This is a variety of the Bermuda, and is very popular in many portions of Florida. A small plot has been cultivated for two years in the botanic garden of the Alabama Experiment Station, and it is proving to be an excellent grass for this latitude. It is not so tenacious in its hold on the soil as is the case with the Bermuda, and it can therefore be more easily eradicated if it is desirable to use the land for other crops. The blades are of a lighter tint of green, but in other respects it closely resembles Bermuda.

Carpet Grass (*Paspalum compressum*, (*Sw.*) Nees).—A creeping plant which throws up a slender flower branch and delights in a moist soil. As its name indicates, it covers the ground like a green carpet, and is exceptionally uniform in the sward it produces. It is a fine grass for low lands, and will even produce good results in rich uplands where moisture is not so abundant. It is growing successfully in a sandy soil on the grounds of the botanic garden, where other grasses have failed to yield good results. This grass is particularly well adapted to nearly all sections of South Alabama, and will grow with more or less success in most parts of the State. It can now be called one of the wild species of Alabama, since it is growing at will in Middle and Southern Alabama.

Kentucky Blue Grass (*Poa pratensis*, Linn).—It is a waste of time and money to place this grass in soils which are exposed to hot summer suns, because it can not stand successfully the continued heat. But in yards where there is ample shade produced by oaks, elms and other trees, excepting pines and cedars, it will thrive well and will produce a lawn not to be surpassed in beauty of color and texture by any other grasses. An advantage it has, that is one of special merit, is the green color it retains through most of the winter and the early, vigorous growth it puts on in the early spring before any other grasses are showing any life.

St. Augustine Grass (*Stenotaphrum dimidiatum*, Linn. Brongn).—In Charleston, S. C., and also in portions of Florida this grass is favorably thought of for lawns. It produces a larger blade than the preceding grasses. It readily takes root at the joints of the creeping stems and soon covers the surface with an even sward. This grass prefers the climate near the coast and will grow well in sandy soils. No experiments have been made with the St. Augustine grass at the Alabama Experiment Station, but the reports made to the author by reliable parties living in Jacksonville, Fla., and Charleston, S. C., satisfactorily established the plant as a desirable lawn grass for the coast region. It can be propagated by sets or cuttings by sowing the seeds in drills from which, after the first season, the sets may be taken and placed in the soil where the lawn is to be made.

The best time for sowing the seed of grass or planting the sod is in the late fall or in December. Favorable results, however, may be obtained sometimes by seeding in the early spring, provided the following summer is not too dry. The difficulty in spring planting consists in the inability of the young and tender plant to withstand the late spring and early summer heat before the roots have had time to penetrate deep into the soil and supply the needed moisture. On the other hand, when the seeding takes place in the fall or early winter the growth obtained by the plants gives them sufficient strength to withstand the heat of spring and summer, and the chances of surviving the first year's trials are decidedly greater than when the planting is postponed until spring.

Pastures and Grasses Suitable for Making Hay.

The preparation of the land for the establishment of a first-class pasture must be accomplished in the same manner as that given for making a lawn. Plow deep and thoroughly, fertilize with stable manure or ground bone, cottonseed meal and nitrate of soda. A good formula is as follows:

	PER ACRE.
Ground bone....................	300 to 400 lbs.
Cottonseed meal....	100 lbs.
Nitrate of soda.................	50 to 100 lbs.

The harrow must be run over the land in order to reduce the soil to an even condition and completely pulverize it. Sow the seed at the rate of 50 to 60 pounds per acre, and sow on a day when the air is in least commotion, so that there may be a uniform scattering of the seeds; otherwise the grass will come up in thick and thin patches, making an unsightly pasture. After the seed has been properly scattered run the roller over the land, or if a roller is not available, brush drawn over the field several times will cover the the seed. It is best to sow just before a rain, to insure germination.

In order to produce a pasture throughout most of the year, the species of grasses may be mixed which mature their seeds at different seasons of the year. For instance, barnyard grass is a summer species, and rescue grass gives a green sward late in the fall. Texas blue grass is a so-called winter grass, although it also produces one of the best grasses for summer grazing and for making hay. Mixing these grasses in proportions to furnish 50 to 60 pounds of seed per acre will give continued pasturage throughout most of the year. There is nothing better, however, than a field occupied alone by Texas blue grass or by Bermuda, to be used for either pasturing cattle or to be allowed to grow and cut for hay.

The following list of grasses contains the species which will be found amply sufficient for the demands of the cattle raiser and farmer in Alabama, both for pasturage and for making hay:

BERMUDA GRASS (*Cynodon dactylon*).

TEXAS BLUE GRASS (*Poa arachnifera*, Torr).—This grass is propagated by cuttings, or by seeds, or by sods. It stands the drought well, and will grow on any good soil which is in a well-drained condition. The name was given to this grass because it originated in Texas, but it is now well known in most sections of the South, and is becoming more and more popular as rapidly as its fine properties are understood. It is not incorrect to call it a winter grass, since it makes most of its growth in the winter months. When growing in a strong soil which has been thoroughly prepared this grass furnishes an excellent hay and will stand the trampling of cattle better probably than any other grass.

RESCUE GRASS (*Bromus unioloides*, Willd).—This may be also called a winter grass, since it obtains most of its growth in the winter months. If it is cut regularly and not allowed to go to seed it will continue green a considerable portion of the year, and will supply a fairly good pasture after most of the other grasses have died down.

ORCHARD GRASS (*Dactylis glomerata*, Linn).—For the extreme south this grass will be found not so sure as the others mentioned in this list. It will produce, however, in the middle and northern portions of Alabama, in good soil, from three to four tons of hay per acre.

BARNYARD GRASS (*Panicum crus-galli*, Linn).—This grass is so common, it will require no special mention in this connection. The farmers of this State are quite familiar with it. Barnyard grass is more suitable for feeding green to cattle than for making hay, because of its moist, succulent stems, which render it difficult to cure for hay.

TALL OR MEADOW FESCUE (*Festuca elatior*, Linn).—This is excellent for either pasture or for making hay, and will give a luxuriant growth on well-prepared rich soils.