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HYBRIDS FROM AMERICAN AND FOREIGN COTTONS.

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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 exceptionally 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 hybrids 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 these 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 hybridization 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 Affi (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			No. of plants per plot.	Per cent. of seed.	Per cent. of lint.	Length of fibre.	Diameter of fibre of millimeters.	Max-break- ing strain 1 strand grammes.	Min-break- ing strain 1 strand, grammes.	Average breaking strain 1 strand, grammes.	Character of twist.	Character of maturity.
		per plot.	Seed per plot.	Lint per plot.										
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 Sea Island	29.7	18.3	11.4	47	61.7	38.3	0.022	13.10	12.10	12.60	very good.	very good.	
71	Truitt x Cook	10.0	7.2	2.8	54	72.0	28.0	0.016	11.86	8.23	9.30	average.	average.	
70	Truitt x Peerless	60.7	40.7	20.0	113	67.1	32.9	0.014	12.35	9.68	11.02	excel.	excel.	
79	Wonderful x Peerless	17.9	31.4	16.5	135	65.6	34.4	0.021	15.38	12.79	14.09	excel.	very good.	
		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	0.024	10.46	5.14	7.16	fair.	medium.	
191	Bamieh	12.4	7.0	5.4	112	56.5	43.5	0.040	22.73	16.70	18.72	excel.	excel.	
187	Broach	7.6	5.4	2.2	39	71.0	29.0	0.032	15.60	5.81	9.41	fair.	fair.	
196	Deshi							0.024	15.35	7.48	10.53	good.	irregular.	
175	Goghara	13.3	9.2	4.1	44	69.2	30.8	0.024	15.02	10.07	11.74	excel.	excel.	
184	Herbucco	9.0	6.2	2.8	53	68.9	31.1	0.024	8.86	8.27	8.61	poor.	fair.	
180	Indrepur	8.1	5.6	2.5	59	69.1	30.9	0.024	11.88	8.10	10.54	good.	good.	
186	Jakko	4.5	3.2	1.3	56	71.0	29.0	0.016	15.84	8.25	12.06	irreg.	irregular.	
193	Manoah							0.032	18.75	10.20	13.93	good.	good.	
182	Mirzapore	5.3	4.0	1.3	58	75.5	24.5	0.016	7.79	6.91	7.35	poor.	fair.	
192	Mit Affi	23.5	13.6	9.9	105	57.8	42.2	0.048	12.61	10.34	11.47	excel.	excel.	
109	Narma	9.4	6.3	3.1	60	67.0	33.0	0.016	19.52	8.10	13.09	excel.	excel.	
173	Nadam	13.5	9.1	4.4	96	67.4	32.6	0.048	9.78	7.12	8.45	good.	fair.	
102	Nimari	5.5	4.0	1.5	50	72.7	27.3	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 3.5 warmer, and the mean minimum temperature was 2.6 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.

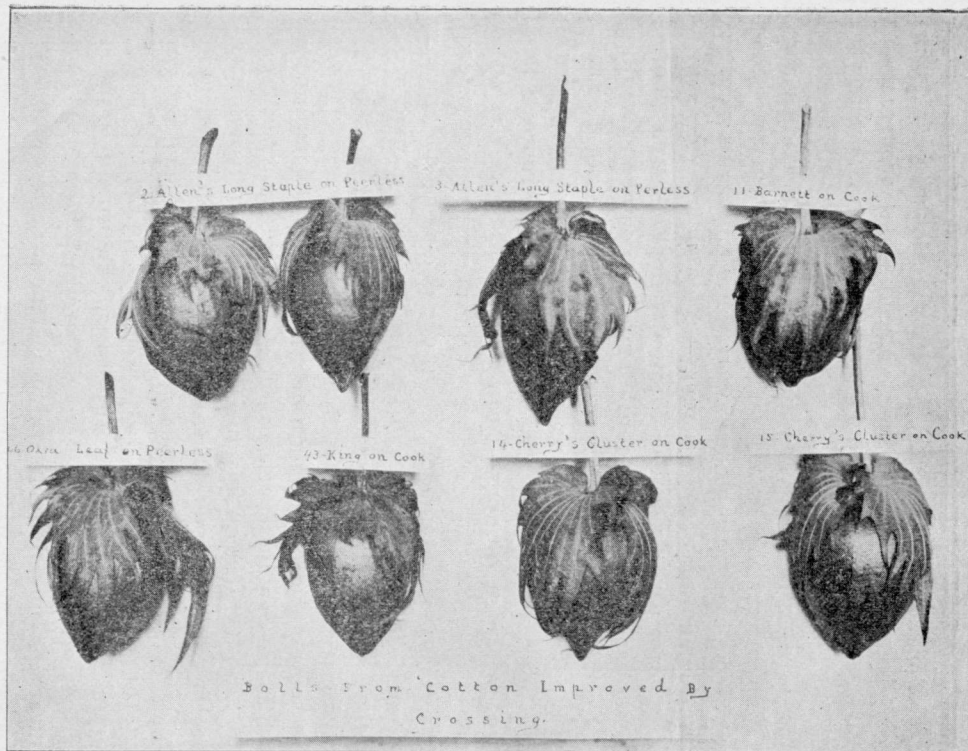


PLATE 1.

BOTANICAL CHARACTERISTICS OF AMERICAN PLANTS.

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 $\frac{1}{4}$ 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.

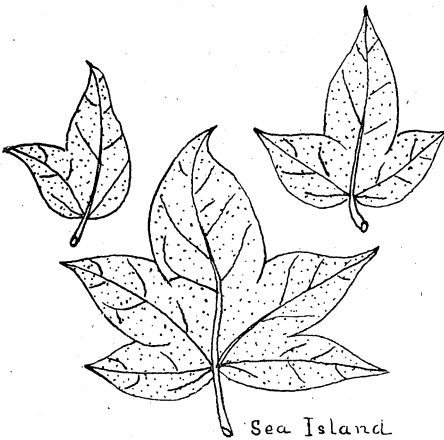
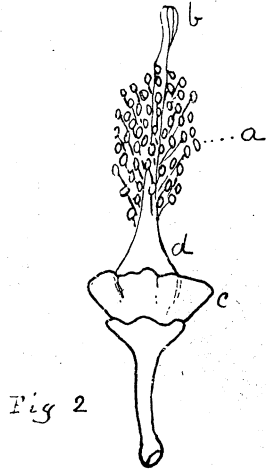


FIG. 1.

P. H. MELL DELSea 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.

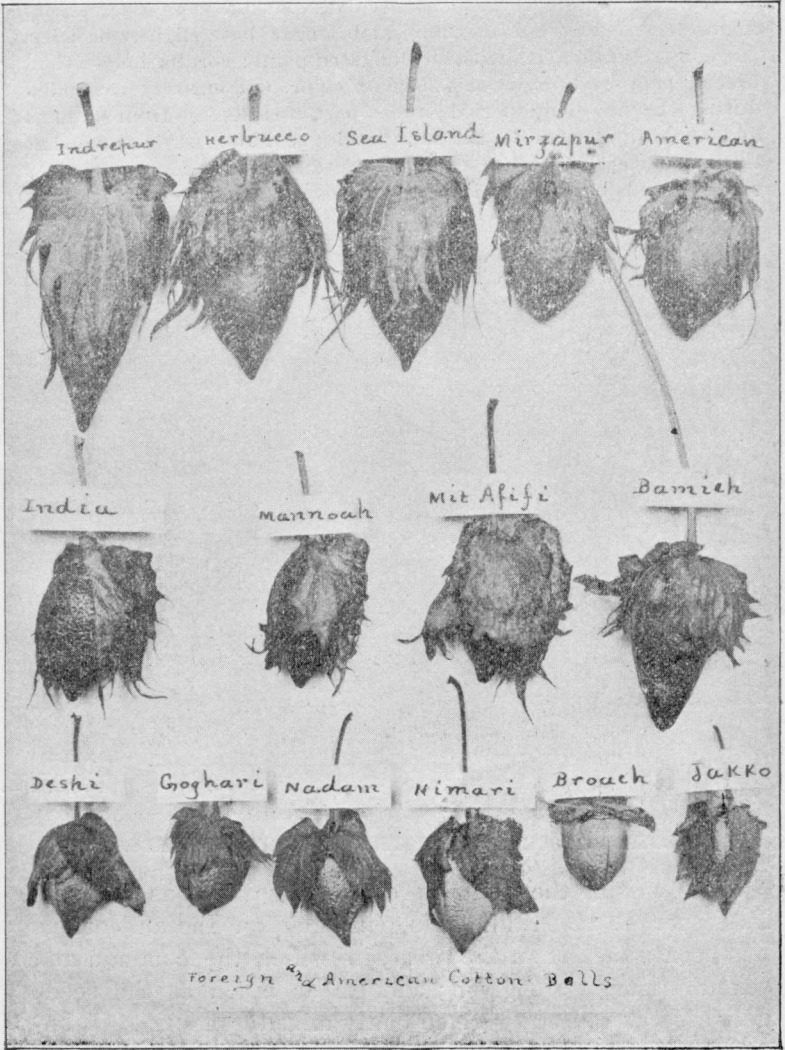


PLATE II.

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 petiole; bracts ovate cordate, with sharp cut teeth, general outline of bract leaf rotundate, bases united; corolla 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 Affi," are varieties of *G. marian-*

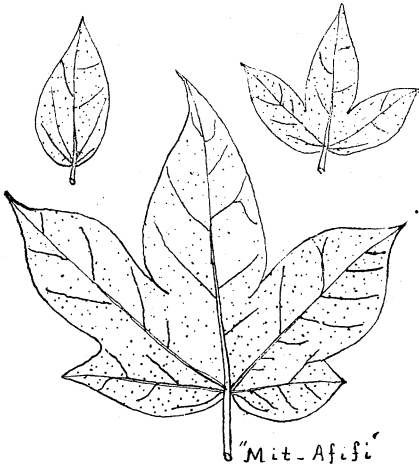


FIG. 3.

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 involucre 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 Affi	12.7	8.8	3.9	28	69.2	30.8	42	0.020	14.02	9.83	12.13
142	Affi 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 Affi	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 Affi	10.4	8.3	3.1	43	72.1	27.9	38	{ 0.032	9.83	6.28	7.72
171	Affi X Cherry's Cluster X Cook	12.0	8.8	3.2	43	73.4	26.6	48	{ 0.048	13.15	12.96	13.10
130	Wonderful X Peerless X Affi	13.0	9.3	3.7	56	72.0	28.0	38	{ 0.020	10.90	9.41	10.16
162	Affi X Allen's Staple X Peerless	12.2	8.6	3.6	120	70.5	29.5	44	{ 0.016	13.68	9.48	11.58
149	Truitt X Cook X Affi	10.5	7.5	3.0	43	71.4	28.6	44	{ 0.008	20.71	15.65	19.01
119	Allen's long Staple X Peerless X Affi	5.7	4.0	1.7	51	70.2	29.8	40	{ 0.016	13.50	11.16	12.33
148	Affi X Rust proof X Peerless	20.5	15.4	5.1	99	75.0	25.0	33	{ 0.024	21.40	19.17	20.29
163	Truitt X Peerless X Affi	7.5	5.4	2.1	54	72.0	28.0	32	{ 0.024	4.35	3.55	4.11
192	Affi	12.9	8.8	4.1	105	67.4	32.6	38	{ 0.032	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	{ 0.048	12.70	12.42	12.56
187	Broach	7.6	5.4	2.2	39	71.0	29.0	30	{ 0.016	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	{ 0.028	8.86	7.69	8.28
186	Jakko	4.5	3.2	1.3	56	71.0	29.0	47	{ 0.032	15.84	8.25	12.06
165	Barnett X Cook X Herbucco	17.2	11.9	5.3	61	69.2	30.8	36	{ 0.024	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	33	{ 0.016	9.57	3.97	7.12
184	Herbucco	9.0	6.2	2.8	53	63.9	31.1	32	{ 0.224	8.86	8.27	8.61
155	Petit Gulf X Peerless X Bamieh	17.7	12.0	5.7	64	68.0	32.0	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 grammes.	Min. breaking strain, 1 strand, in grammes. †	Average breaking strain, 1 strand, in grammes. †
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	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			
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	22.73	16.70	18.72
					42	69.0	31.0	42	{ 0.008			
141	Mannoh X Petit Gulf X Peerless.....	10.6	7.2	3.4					{ 0.016	10.30	9.73	10.01
118	Cherry's Cluster X Cook X Mannoh....	25.0	17.6	7.4	105	70.4	29.6	40	0.016			
147	Mannoh X Sea Island.....	9.0	6.4	2.6	42	71.1	28.9	42	0.020	11.96	7.01	9.42
146	Mannoh 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 Mannoh.....	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 Mannoh.....	4.0	3.0	1.0	42	75.0	25.0	31	0.024	9.25	8.70	7.98
193	Mannoh.....							32	0.032	18.75	10.20	13.93
181	Petit Gulf X Cook X Mirzapur.....	7.7	5.6	2.1	38	72.7	27.3	33	{ 0.016	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			
182	Mirzapur.....	5.3	4.0	1.3	58	75.5	24.5	32	0.016	7.79	6.91	7.35
182	Allen's Staple X Peerless X Nimari....	6.0	4.3	1.7	27	71.7	28.3	25	{ 0.016	8.77	7.55	8.16
102	Nimari.....	5.5	4.0	1.5	50	72.8	27.2	25	0.024			

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.

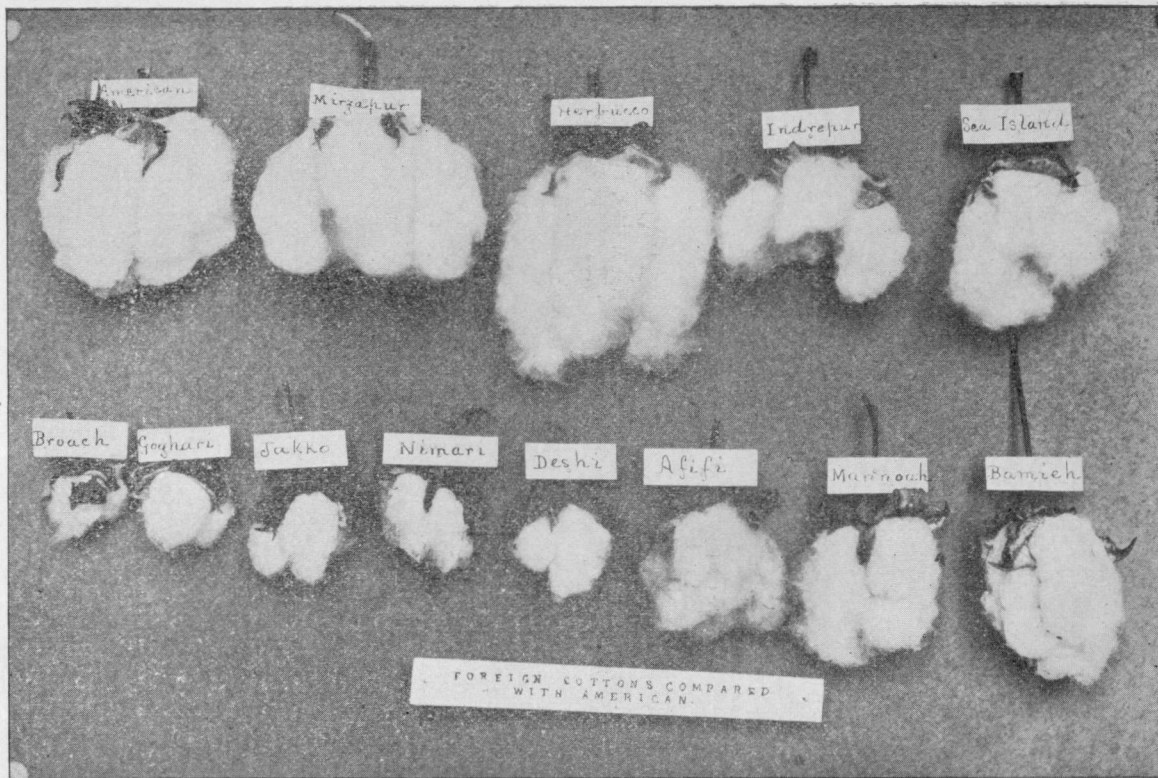


PLATE III.—Open bolls of American and Foreign Cottons. Reduced 1-6.

BOTANICAL CHARACTERISTICS OF THE HYBRIDS.

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 calyx cup.

Truitt x Cook x Affi (149).—One leaf is decided Affi type while others are decidedly Cook in shape (or *g. hirsutum*) and hairy surfaces some of the flowers are more like the Affi 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:

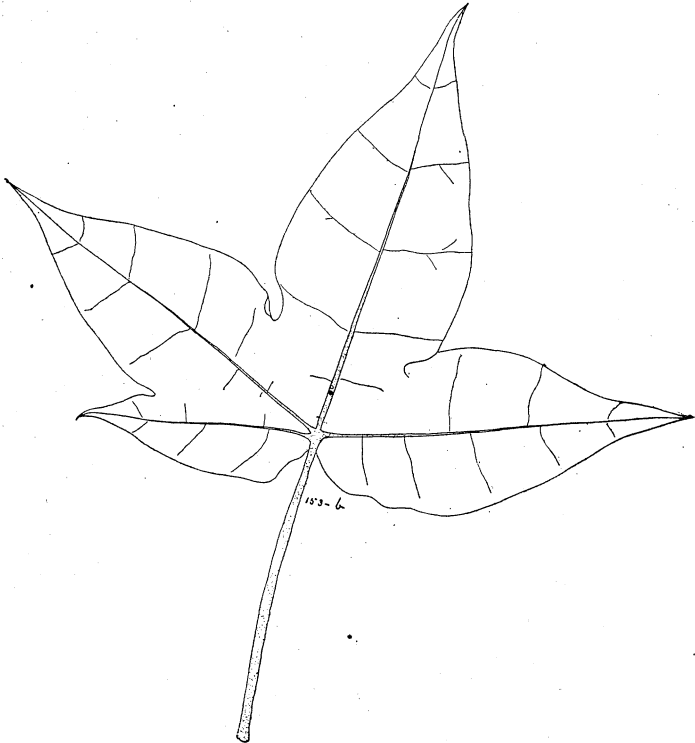


FIG. 5.—Leaf from Hybrid Petit Gulf X Cook X Bamieh.

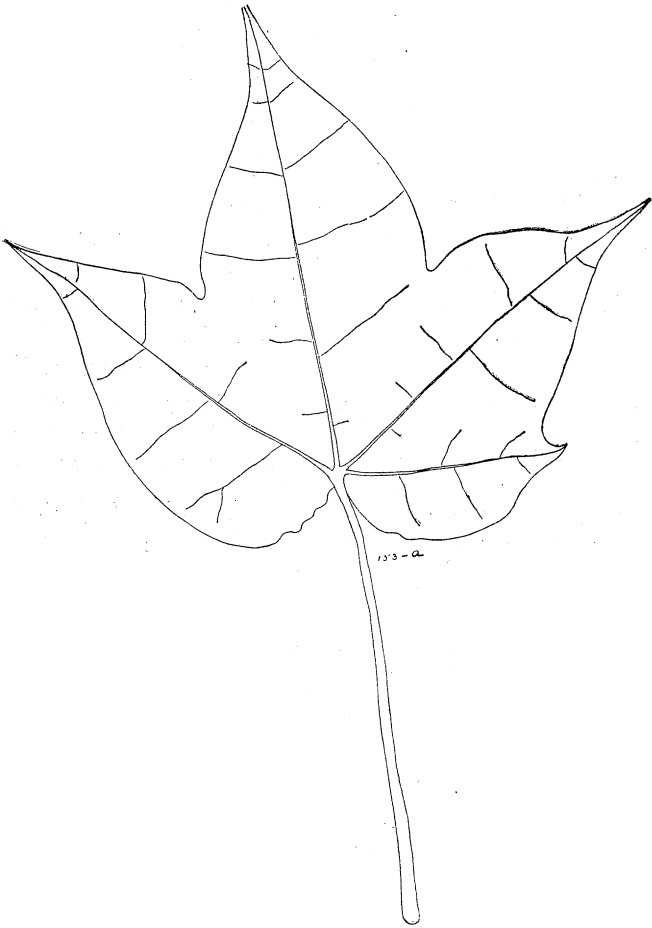


FIG. 6.—Leaf from Hybrid Petit Gulf X Cook X Bamieh.

Leaf (a) has five 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

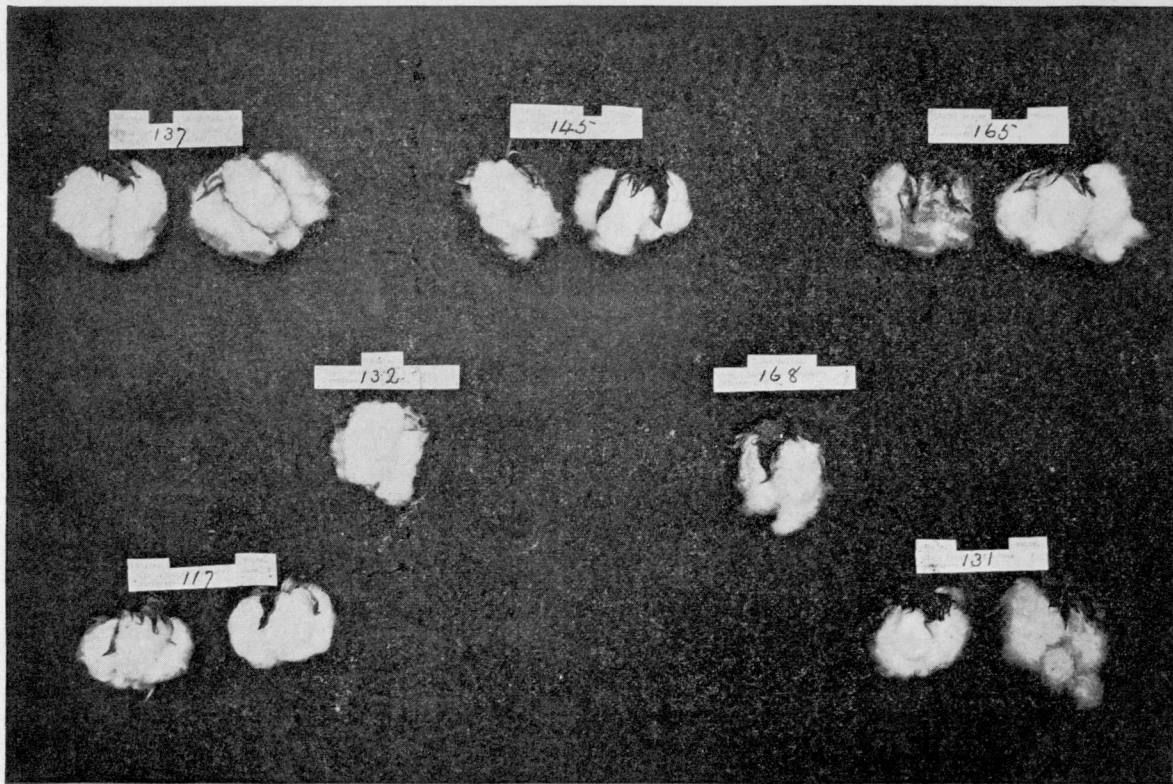


PLATE IV.—Open bolls of hybrids. The numbers containing two bolls, exhibit yellow and white fibre, features of each parent. Reduced 1-6.

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.

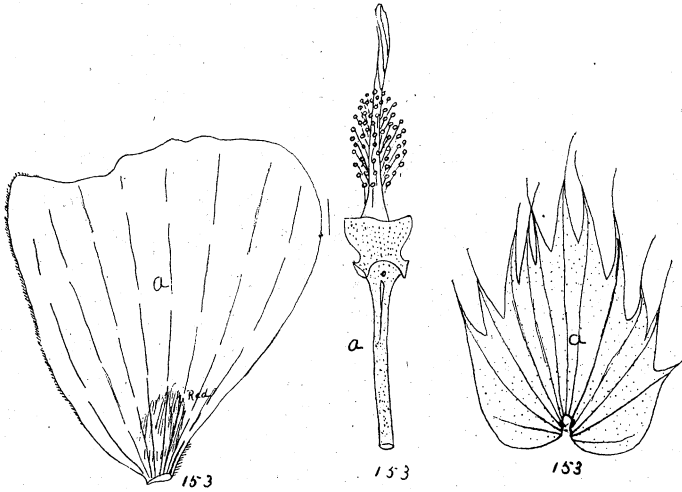


FIG. 7.—Parts of flower; Hybrid Petit Gulf X Cook X Bamieh.
(The number, 153. refers to experiment. See table, page 405.)

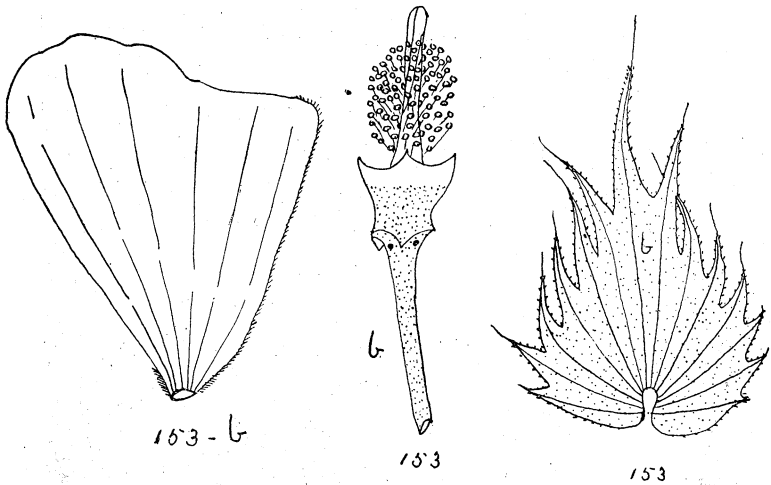


FIG. 8.—Parts of flower; Hybrid Petit Gulf X Cook X Bamieh.

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

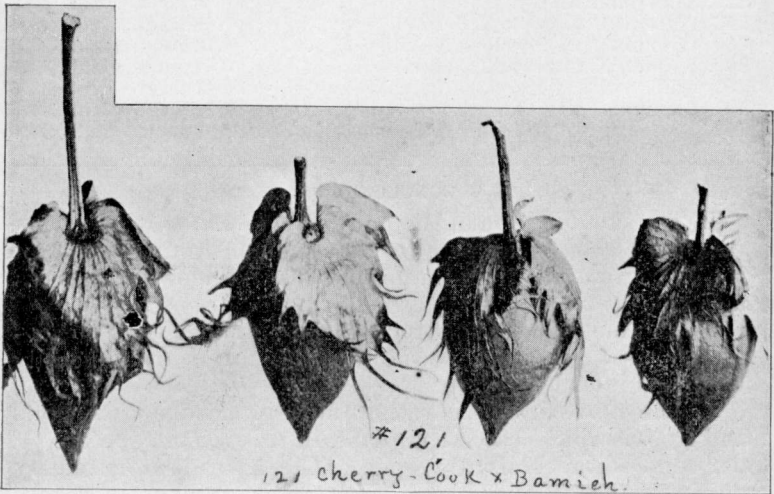


FIG. 9.—Bolls of Hybrid Cherry's Cluster X Cook X Bamieh 121.

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 Affi	19.0	Exel.	Exel.	28.6
171	Affi 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 Affi	12.13	Exel.	Exel.	30.8
153	Petit Gulf X Cook X Bamieh	10.88	Exel.	Exel.	28.4
130	Wonderful X Peerless X Affi	10.16	good.	good.	29.5
160	Bamieh X Cherry X Cook	11.58	good.	good.	30.5
192	Affi	11.47	Exel.	Exel.	32.6
191	Bamieh	18.72	Exel.	Exel.	33.8
141	Mannoh 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 Affi and Mannoh 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.