BULLETIN NO. 27. MAY, 1891.

AGRICULTURAL EXPERIMENT STATION,

OF THE

Agricultural and Mechanical College,

AUBURN, ALA.

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BLACK "RUST" of COTTON.

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Black "Rust" of Cotton.*

By Geo. F. Atkinson, Biologist.

Early in the past year I began the study of the fungus diseases of the cotton plant with the special object to determine the disease called "black rust." The first of August, 1890, one hundred circular letters were sent to different farmers of Alabama requesting specimens of cotton affected with the disease variously termed "rust," "red rust," "black rust," "frenching," etc.

From twenty-five to thirty replies were received including specimens marked "black rust," "red rust," "frenching" and "root rot." †

The disease has been very prevalent and destructive during the season and excellent opportunities were offered for studying it in the vicinity of Auburn, not only upon the Station farm, but on neighboring plantations.

July 22d, on one of my visits to the cotton field, I found the disease had made its appearance in full force in several spots, where fully one-half of the leaves of the plants had fallen off, the remainder being curled, dried, and blackened by a profuse development of dark hyphæ and spores of several fungi, so that by jarring a leaf the spores would float off in clouds like the smut

*The substance of this article was read in a paper by the author before the Botanical section of the American Association of Agricultural Colleges and Experiment Stations, Champaign, Ill., Nov. 1889. Later published in the *Botanical Gazette*, Vol. XVI., 3, Mar. 1891, pp. 61-65.

† An account of this disease was published in Bulletin No. 24, Dec. 1889. "A New Root-rot Disease of Cotton."

spores of some of the *Ustilagineæ*. Some of the plants showed still the earlier stages of the disease, and in other parts of the field were numerous opportunities to study the earlier stages. For two months my time was occupied in noting the external character, collecting material, examining the different fungi found and noting the relation of each species to the variety of external characters presented in the progress of the disease.

A Complex Disease.—The disease is a complex one, that is, it is not due to one organism, but to the combined effect of several microscopic plants called fungi, which grow within the leaves of the cotton plant, absorbing the living parts. Organisms that grow on or in plants or animals obtaining their own nourishment from their hosts are called parasites. So the microscopic plants causing diseases of other plants are called parasitic fungi. It is of great importance in speaking of them to apply some term defining this prominent character of parasitism for there are vast numbers of species of fungi, many which are not parasites growing also in plants, that is, they cannot grow on or in a living plant, but only on dead plants or dead parts of plants. Such fungi are called saprophytic fungi to distinguish them from the parasitic forms.

A number of persons prior to my own investigations have examined with the microscope the leaves of cotton affected with the "black rust" and have reported that fungi were present, some attributing to these fungi the cause of the disease. So far as I have been able to learn none of these persons have recorded what these fungi were which were seen, and it is quite probable that no determination was made. The fact alone that fungi are found on the leaves of diseased cotton plants affected with black "rust" is no argument in favor of their being the cause of the disease. The nature of these fungi must first be ascertained before one can predicate anything respecting their causal relation to the disease.

There are several ways in which their nature can be ascertained but even then it can be done only by one who is familiar with the accepted methods of research upon similar subjects, and has at his command the apparatus and literature required for accuracy; just as a trained chemist is the only person who can

accurately determine the chemical constitutents of substances capable of analysis.

Confusion of Names for the Disease.—It must be understood that in writing now of black "rust" of cotton, I refer only to the cases which have come under my own observation, either through personal inspection of diseased fields, or through specimens received from farmers. It may be possible that there are other diseases of cotton which are termed also "black rust" which I have not seen. It is unfortunate that the name "*rust*" was ever applied to any disease of cotton since the fungi commonly known as *rusts*, like wheat rust, oat rust, fig rust, etc., all belong to a group of plants called *Uredineæ*. No members of this group have ever been found on the cotton plant so far as recorded, so in that respect there is no *true rust* of cotton yet known. It would be very difficult, however, to bring any other name into popular use, and even if it were possible it would not be appropriate to introduce a new name until all the important complications of the disease shall have been studied. Therefore I shall at present use the term black "rust." I include in this term also what many farmers in Alabama call "red rust," which is but an early or arrested stage of black "rust."

In some cases when a cotton grower speaks of "red rust" he refers to the reddening of the leaves which is so common in worn out lands.

While in North and South Carolina my attention was called to this disease which was chiefly characterized by a reddening of the leaves not produced nor accompanied by any fungous growth. In most cases this seemed to be due to some condition of the soil which induces a hastened maturity of the plant and the development of erythrophyl in the cell sap of the leaves. In some cases, especially in North and South Carolina, the development of erythrophyl is induced by the irritation of mites as I have proved by infection experiments. From several places in both States cotton quite severely injured by mites has been sent me. An account of this was published in Bulletin No. 4 of the South Carolina Agricultural Experiment Station, January, 1889. These mites (*Tetranychus telarius*, Linn.) feed on a great variety of weeds

and other plants including clover. It would not be surprising if there would be found in this an explanation of the statement originating in North Carolina that carrying an armful of wilted clover across a cotton field, later the "red rust" could be traced spreading from the same course.

Other cotton growers do not speak of the peculiar reddening of the leaf which I have described as a rust of any kind, rightly saying it is due to some condition of the soil. When they speak of "red rust" they refer to leaves that do not have a healthy green color, there being a tinge of yellow, or even in some cases a tinge of red, accompanied also by dark circular spots on the leaves that are dead, the edges of the leaves usually being dead also. Such a leaf is represented in Plate I., the upper leaf in the figure, and the one at the left below. These are from photographs of diseased leaves.

Again by "black rust" the planter refers to the blackened condition of a whole or large part of the leaf, which ultimately falls off. This continues until the plant is entirely stripped of its leaves. This is only a more advanced or serious stage of the preceding kind of "rust." A leaf with black "rust" is represented at the right hand in the lower figure of Plate I.

A Fungus Disease.—The fungi commonly present and which play an important part in the disease are *Cercospora gossypina* Cooke, *Colletotrichum Gossypii* E. A. Southworth, *Macrosporium nigricantium* Atkinson, a species of *Alternaria* and a bacterial organism which sometimes produces a characteristic disease of the leaves.

The vegetive, or growing portion of the fungi concerned, consists of very minute thread-like bodies which grow on the inside of the leaf. At first the only external sign is the dead spots on the leaf. A little later fruiting threads (fertile hyphæ) grow through the epidermis of the leaf to the outside, and bear on their ends the germs, or spores, of the fungus. These fertile hyphæ and some of the spores are dark colored. Therefore when they appear on the leaf in great numbers they give it a more or less black color.

Difference Between Cotton-leaf Blight and Black "Rust."—Cer-

cospora gossypina is a fungus that has been long known as a parasite of the cotton plant. The first description of it was published by Cooke in Grevillea* from specimens distributed from South Carolina by Ravenel in Rav. Amer. Fungi, No. 593. A fuller description was published by Scribner in the report of the section of Vegetable Pathology.† The disease which it produces when alone is called "cotton-leaf blight." Professor Scribner says (l. c.) that it is quite distinct from the dreaded "cotton rust," and also that it is occasionally confounded with cotton rust. In view of the confusion existing in reference to the name cotton rust it is impossible to tell whether the disease referred to by Professor Scribner as cotton rust is the same as the disease I am writing of. However, some of the planters confuse the cotton leaf blight with the black "rust" as it is known to me for some of the specimens labelled "rust," "red rust" and in one case "black rust," were affected with nothing of a parasitic nature except Cercospora gossypina. This, however, is not so serious after all since all the specimens of black "rust" I have examined show evidences of the Cercospora. Cotton-leaf blight is characterized by irregular light brown or dirty white spots, often bordered by a dark or purple color. Many times the leaf is of a yellowish green color. Sometimes the spots have a blistered appearance, and are so close together as to give this appearance to a large part of the leaf, when it has often a rusty brown appearance. When, however, it is complicated with other fungi, the appearance of the leaf is totally changed.

Botanical Characters of the Fungi.—If the reader will turn to Plate II. and refer to figures 1, 2, and 3, there will be seen the clusters of fertile hyphæ of Cercospora as they appear when magnified under the microscope, projecting from the surface of the leaf. They are dark brown in color, toothed, geniculate, or nearly straight or curved in outline, as represented in figures 3, 2, and 1 respectively. They are produced abundantly on both sides of the leaf. The scars represented on the hyphæ at the angles, or "teeth," represent places where spores were formerly

*Vol. XII., 1883, September, p. 31.

†Department Agriculture, 1887, pp. 355 and 356. plate I.

attached. Also the scars on the ends of the hyphæ are the same. All the spores are borne at the ends of the hyphæ, but as one spore is formed the hypha grows out from the side of the end, elongates and produces another spore at its new end and so on. The different lenghts of the fertile hyphæ shown in the figures represent proportionately some of the variations which they are subject to dependent upon conditions of the weather. When the atmosphere is very humid and warm with frequent rains they grow very rapidly and are then quite long. The spores are colorless, or hyaline, only their outline and the transverse partitions, and the finely granular protoplasm can be seen. The spores are subject to the same variations in length that the hyphæ are. They are represented in 2^a, 3^a, etc. They are curved, or flexuous, and very slender, tapering toward the distal end. In figure 1 some are shown still attached to the hyphæ.* The measurements are as follows: Hyphæ .07— .45 mm x .007 mm. Spores. .07—.40 mm x .003—.0035 mm, 5—50 septate.

Colletotrichum Gossypii sometimes produces a distinct disease of the cotton plant and is then called "Anthracnose of cotton,"† As this is quite an important disease a separate bulletin is being prepared on it which I hope will be issued shortly after the appearance of this one. For that reason the fungus will not be described nor illustrated here. That it is an aggressive parasite has been proven by myself through inoculations of healthy plants.

Macrosporium nigricantium‡ is illustrated in Plate II., figure 4, *a*, *b*, and *c*. *b* and *c* represent the fertile hyphæ, *c* has a spore still attached to it. The other spores are free. At the place where the hyphæ arise from the mycelium in the leaf they are en-

*Hitherto the perfect (ascosporous) stage of Cercospora gossypina Cke. has not been discovered. I have found on dead leaves a sphæriaceous fungus which probably is the perfect stage. As studies on it are still in progress I reserve it for future publication.—G. F. A.

†During the past year E. A. Southworth, asst. Mycologist at Washington, D. C., and myself have each studied this disease independently. Specimens were received by Miss Southworth only on the bolls. Her account of the fungus was published in the Journal of Mycology. Vol. VI., No. 3, Jan. 1891.

I have found it not only on the bolls but on the leaves and stalks and have been able to make some interesting observations in the field. A paper on this subject was read by myself before the Amer. Asso. Ag. Colleges and Experiment Stations Champaign, Ill., Nov. 1890.

‡First described by the author in Bot. Gaz., Vol. XVI., Mar. 1891, p. 62.

larged as shown at the lower end in the figure. When a spore is being produced, as at *c*, the hypha becomes somewhat enlarged directly below it. When the spore falls away the hypha elongates at the end, the new growth arising from inside the enlargement, its contour being the same size as that of the hypha just below the enlargement. When the new growth first takes place it appears to be not connected with the enlargement but projecting through it. As the hypha ages this appearance usually is not present and the enlargement seems to taper above into the new growth. The new growth thus formed at the end of the hypha may bear a new spore, and so in favorable weather from two to eight or more spores may be borne on a single hypha, the point where the successive spores were borne being just at the upper end of the successive enlargements. The hyphæ are dark or olive brown and borne on both sides of the leaf. At the enlargements there is usually a darker band around the center. The hyphæ thus have a nodulose appearance, as in such species as *Macrosporium parasiticum* Thüm. The spores are olive brown,oblong, constricted in the middle,and stoutly rostrate at one side of the apex. As the young spore develops it is constricted in the middle before the first transverse partition is formed. This is formed in the constricted portion. Later other transverse, longitudinal and oblique septa are produced. The spore represented at *a* is a little larger proportionately than it should be, from the fact that the drawing was made after the spore had been sown in a cell culture and just prior to germination (when the drawing was made) it was considerably larger from imbibition of water. The fertile hyphæ are usually scattered, rarely in clusters of two or three.

Measurements. Hyphæ are .050—.140 mm long x .006—.007 mm in diameter. Conidia .018—.022 mm x .036—.050 mm.

The *Alternaria* is illustrated in Plate II. figure 5. The drawing is made from a water culture under the microscope, the spore *a* having been taken from among a number of others on a cotton leaf. Parts of several vegetive hyphæ are shown on the underside and at the left. These are the parts of the fungus which grow on the inside of the leaf. The fertile hyphæ are seen to produce in a concatenate manner the spores *b*. These spores as

well as the fertile hyphæ are dark brown in color, and in numbers serve to blacken the leaf.

The bacterial disease is often very widespread even when no evidences of the other fungi are to be found,but is mentioned here because frequently it is an accompaniment of the black "rust" and contributes materially to the aggravation of the disease. It is first manifested by a watery appearance in definite areolate spots which are bounded by the veinlets of the leaf. The spots are sometimes very numerous and frequently conjoined; often the disease follows one or more of the main ribs of the leaf being bounded on each side by an irregularly zigzag line. As the disease ages the spots become blackish and then light brown, frequently then bordered by a blackish color where the disease has extended somewhat centrifugally. The dead spots in the leaves sometimes break out leaving many perforations in the leaves with ragged edges, somewhat as results in cotton-leaf blight. The disease hastens the falling off of the leaves.

External Characters and Progress of the Disease.—During the entire season, from July to the close of October, of the thousands of leaves old and young that I examined, *Cercospora gossypina* has been an almost universal accompaniment, and has not been second in point of attack, except perhaps in rare cases. In many cases parallel or immediately succeeding attacks were made by the *Colletotrichum*. The *Macrosporium* as a rule follows closely the attack of the *Cercospora*, indeed sometimes seeming to be first to attack. In such cases possibly it attacked the spots diseased by *Cercospora* before the hyphæ and conidia of the latter were developed. The *Alternaria* usually succeeds the *Macrosporium*, though often seeming to be parallel with it. By its clusters of hyphæ and profusely developed concatenate spores in favorable weather the leaf is soon covered with a mass of spores giving a blackened appearance to the leaves.

My correspondents in Alabama generally use the term "black rust" when the disease progresses very rapidly and the development of the hyphæ of Cercospora and setæ of Colletotrichum, or the Macrosporium and Alternaria spores, is very profuse causing the leaves to appear black. When the disease progresses more

slowly, being checked by unfavorable weather, or is in the first stages the term "red rust" is generally used. In such cases the Macrosporium or Alternaria has extended centrifugally the spots attacked by the Cercospora, increasing their size, causing them to become more nearly circular, and marking the spots with concentric lines. Also the edges of the leaf are usually dead and dried, and curled either below or upward, being favorite places for the attack of either the Cercospora or Colletotrichum. The body of the leaf is still green, paled by different shades of a dull yellow or dull purple.

In some cases in the early stages of the disease the Colletotrichum severely attacks the upper part of the stem of the plant and petioles of the leaves, giving the stems a dark color from internal changes, to the leaves a scalded appearance and causing them to shrivel up and dry, much as if frost bitten.

Sometimes the development of the Cercospora may be so great and the attack of the other fungi so tardy as to give the appearance of black "rust" produced by it alone. Specimens of this kind were received from one of my correspondents at Eutaw, Ala. The conditions for the development of the Cercospora were so favorable that from one fourth to three fourths of the leaf surface was covered with a dense mass of the dark brown hyphæ, the remaining portion of the leaf being yellowish with numerous small points of attack. The hyphæ and conidia in such cases are very long.

Where other fungi, as Colletotrichum, Macrosporium and Alternaria are abundant, it is often very difficult to find the Cercospora on the leaf. By placing the leaves, freshly gathered, in moist chambers for ten to twelve hours I have never failed to get an abundance of Cercospora, even on the smallest, uppermost leaves of the plant. Sometimes the Macrosporium is the predominating fungus in the last stage of the disease, giving a black appearance to the entire leaf.

Cercospora and Colletotrichum are both active parasites, and I am convinced from a year's study of Cercospora gossypina that it is a more active and destructive parasite than has been formerly regarded. A diseased condition once started by such a fungus

opens the way for the rapid growth and great injury produced by such forms as Macrosporium and Alternaria. It is possible that the Macrosporium may infect the leaves unaided by other fungi. Inoculations of plants free from other forms must be made to determine this.

Cercospora gossypina sometimes produces a serious spot disease of the cotyledons. I first observed this on some young plants started on the horticultural grounds, in September, for experimental purposes. I am told that sometimes in cold seasons in May this spot disease is quite injurious along with "sore-shin." *

CURRENT THEORIES AS TO CAUSE.

Much speculation in agricultural papers has been indulged in regarding the cause of black "rust" of cotton. It would be almost impossible to collect and critically examine all that has been written upon the subject from a purely empirical, or as has been too often the case, from a subjective, standpoint. Some of the current theories, however, are worthy of consideration.

Physical Condition of Soil, Lack of Fertilizers.—Many hold that it is due to the physical condition of the soil, or to a lack of proper fertilization. It is quite likely that there are certain physical conditions of soil which are not so favorable to the healthy growth of the plant as others, and also that there are soils which lack proper and sufficient nutriment for a healthy growth. It is to be hoped that, since progress is being made by experimentation with fertilizers best adapted for the production of cotton on different soils, similar experiments will be made to test the efficacy of certain fertilizers in producing a plant that will be better able to resist the attacks of fungous parasites. Many of the statements currently made that certain fertilizers will surely prevent the "rust" are either without foundation in fact, or the "rust" referred to is not a diseased condition of the plant induced by fungous parasites. For example, the reddening of the leaves so commonly seen on worn out lands is usually nothing else than a

*A pycnidial form of some sphæriaceous fungus is also frequently an accompaniment of black "rust." It is probably *Phyllosticta gossypina* E. and M. Recent cultures in agar agar peptone broth seem to show that it is the pycnidial stage of an undescribed *Pleospora* which I have found on fallen leaves. —G. F. A.

physiological condition of the plant, which proper fertilizing will, to a great extent, remedy. It is usually in reference to such lands that we hear of the "fence-row" cotton which escapes the "rust." I have seen several cases during the past year where the "fence-row" cotton was affected with the black "rust" and injured just so severely as the cotton by its side in the field. In this case, however, the soil was all fertile. As yet we are far from knowing just what fertilizer to apply to prevent black "rust." Many cases have come under my immediate observation where good land was well fertilized and yet some of the cotton was very badly diseased. Some of my correspondents who formerly attributed the disease to the peculiar conditons of the soil, lack of fertilizers, etc., say that sometimes in the best soils and with careful fertilizing the disease appears in a very destructive form. The subject has not been inquired into in a satisfactory manner. It should be carefully tested by systematic experiments conducted as thoroughly as is done in determining the fertilizer best adapted to the growth and fruiting of the plant.*

Atmospheric Conditions.—Another theory very commonly held and frequently expressed is that black "rust" is due to "atmospheric conditions." It is an erroneous view, though arising from no fault of those who hold it, but from the fact that these fungous parasites are so small that no one can see them with the natural powers of vision, and so little known that but few people, comparatively speaking, understand how it is that an unseen organism can grow within a plant and kill it. It is true that, while the cause is not due directly to atmospheric conditions, certain conditions of the atmosphere favor the growth of the parasites. The fact is, there are certain temperature and other conditions of the atmosphere that are favorable to the growth of all organisms, even cotton itself. In the case of many plants these conditions vary, so that what is favorable for one plant is unfavorable for another. Long continued wet weather with a relatively high temperature is unfavorable to the growth and fruiting of cotton, but it *is* favorable to the growth of the parasites which produce black "rust."

*The rust frequently is much worse in spots so that large areas of an acre or more for experiment plats are not so reliable as narrow areas of about 4 row plats across an acre.

It is very reasonable to suppose that, if we had a physical condition of the soil perfectly suited to cotton culture, a fertilizer perfectly adapted to supply the plant with just the proper nutriment, and a climate perfectly regulated to run throughout the season in a manner most favorable to cotton, there would be very little damage from black "rust." But while we are approaching the day when we may know the best fertilizer to be applied to certain soils, and may possibly be able to change to some extent the physical conditions of unfavorable soils, we probably will never be able to control atmospheric conditions which are unfavorable to the growth of cotton and favorable to the growth of its parasites.

Fruiting Cotton More Subject to Disease.—Another theory which may contain a great deal of truth is, that only while cotton is fruiting is it subject to the disease, that barren stalks are never diseased. It is hardly necessary to call attention to the fact that if we avoid the fruiting of cotton, in order to prevent the black "rust," the main object of cotton culture is defeated. Since the above was written I have been informed by Mr. W. H. Lawson that frequently otherwise vigorous plants have been produced on parts of his farm which bore no fruit but were badly diseased by black rust.

The Power of the Plant to Resist Fungous Parasites.—The power which some of the lower organisms have, under favorable circumstances, of successfully resisting the attacks of fungous parasites has been demonstrated by direct observation under the microscope. In some of the higher animals observations of the blood taken from subjects inoculated by injection of the germs into the blood vessels demonstrates that also under favorable circumstances they may successfully resist the attack. From these direct proofs in a few organisms we are enabled to draw the inference that all animals and plants under favorable circumstances can resist the growth of many parasites inimical to their existence. Perhaps the most remarkable of the earlier experiments which demonstrate this power of animals over fungous diseases is the work of Metschnikoff.* The spores of one of the

*Ueber eine Sprosspilzkrankheit der Daphnien. Beitrag zur Lehre über den Kampf der Phagocyten gegen Krankheitserreger. Virch. Archiv. Bd. 96, 1884, pp. 177-195, 2 Taf. See Zopf; Die Pilze in morphologischer, physiologischer, biologischer und systematischer Beziehung, 1890, pp. 241 and 261-262.

sprouting fungi (yeast plants) first fed to crustaceans made their way through the alimentary canal into the blood. Certain of the blood corpuscles attack and completely surround a cell of the fungus, and excrete a fluid of the nature of an enzyme which acting upon the fungus cell first deforms and then destroys it. If only a few cells of the fungus entered the blood the action of the peculiar blood corpuscles was sufficient to prevent the growth of the fungus and resist the disease. If, however, numerous germs of the fungus were injected the blood corpuscles were incapable of destroying them all, so that the peculiar blood cells themselves were finally overpowered by the great number of fungus cells, which also excrete an enzyme to act on the corpuscles. Now the fungus was permitted to grow and to develop the disease.

While the higher plants do not have free amœboid cells which can act as the phagocytes, as they are called, in animals do, yet the protoplasm in a healthy condition and under favorable circumstances probably offers resistance to the growth of many fungous parasites. But where the germs of the fungns are very numerous and the plant is under unfavorable conditions of temperature, and these very conditions being favorable to the development of the parasites; the plant may not be able to resist the disease. This in fact is what experiments as well as observations prove in plants as well as in animals. Unfavorable changes in the weather alone sometimes render healthy animals and plants temporarily susceptible to parasitic diseases. Over such unfavorable conditions man has no control except in circumscribed areas. Therefore it has been found necessary in many cases to apply to perfectly healthy plants preventives of infectious diseases to tide them over unfavorable periods. Already in the case of the grape, apple, potatoes, the grains and other plants; substantial success has been met with in the treatment of diseases which every care given to soils and fertilizers cannot prevent.

Experiments.—During this season experiments will be conducted at the Experiment Station with a view to discover some preventive of the disease. Not only will direct applications be made to the plant of substances to check the growth of the spores, but certain fertilizers will be used in parallel experiments, and alternate areas or rows be left untreated as checks, so that some comparisons can be drawn.

The farmers themselves could do valuable work if they could make some careful tests with fertilizers on the coöperative plan. But if undertaken it should be systematically carried out.

Several alternations of treated and untreated rows should be arranged so as to avoid error. If this year should not be a favorable one for the disease experiments should be continued another year.

Object of the Bulletin.—The object of this bulletin is to present some tangible information in regard to the disease called black "rust," to describe it briefly and to give such illustrations of the leaves as will enable farmers to detect the disease and so prevent to a certain extent the confusion which now exists with cotton-leaf blight and some conditions of the leaf which are purely physiological or due to mites. It is hoped that farmers will read the bulletin carefully and preserve it to aid them in observing the diseases of cotton during the present year. I would consider it a great favor if the farmers would observe carefully to distinguish this disease from others and send me specimens of all the different diseased conditions of cotton leaves and bolls which they find. A half dozen or more leaves of each kind should be sent. They should be laid separately between sheets of paper and be supported on one side by stiff paper of some kind, so as to keep them from spoiling while they are in the mails. A great deal of aid can thus be given by farmers themselves in this important investigation. The leaves should be sent to me at Auburn, Ala.

I wish to express my thanks to the farmers who so kindly aided me the past year in sending specimens and notes on the disease. Their names are given below.

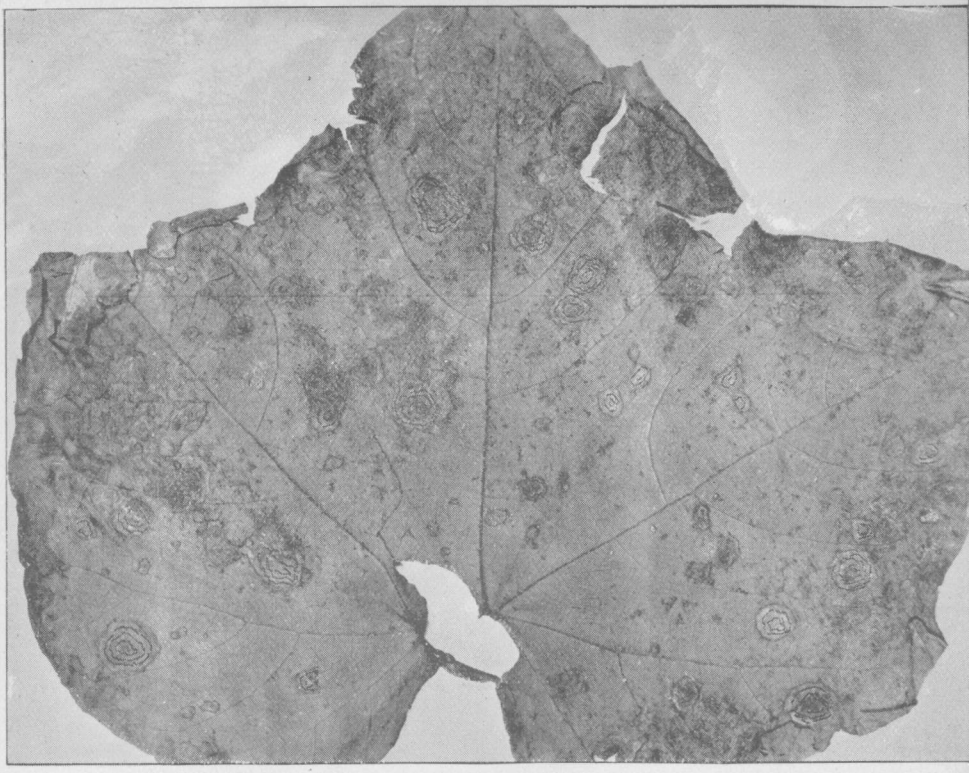
Hon. G. R. Banks, Tallassee; W. C. Barkin, Coats Bend; R. E. Browning, Pleasant Hill; S. M. Cathcart, Alberta; C. C. L. Dill, Dillborough; S. A. Driver, Augustin; J, W. Edmunds, Faunsdale; J. W. Eubank, Pine Level G. T. Green, Fayetteville; F. M. Kirksey, Eutaw; R. E. Mobley, West Greene; J. C. Mathews, Crittenden Mills; Rev. J. L. Moultrie, Union Springs; Prof. C. L. Newman, Athens; G. W. Rhodes, Saville; W. M. Trimble, Sandy Creek; J. V. Tutt, Belmont; A. Y. Smith, Prattville; O. D. Smith, Smith's Station; T. J. Waller, Auburn; Mr. Wright, Wright's Mills. Specimens were received twice from some of the gentlemen

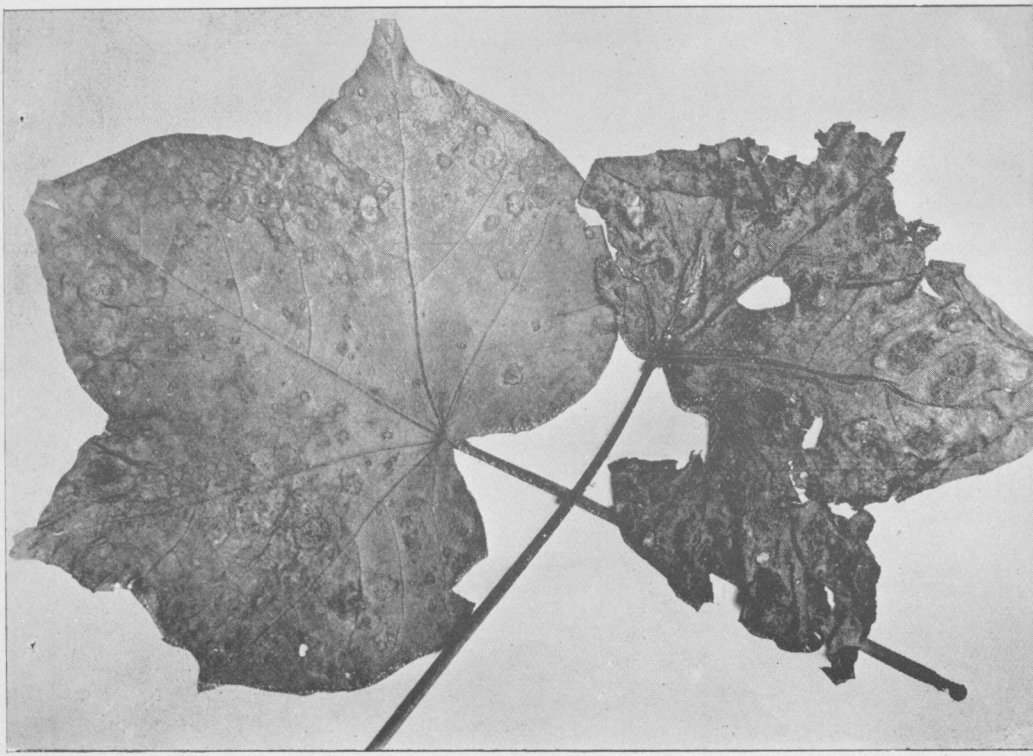
Explanation of Plate II. Figures 1, 2, 3, Cercospora gossypina Cooke, clusters of hyphæ, and few conidia; in figure 1 two conidia are still attached to the hyphæ.

Fig. 4 Macrosporium nigricantium Atkinson. *b* and *c* hyphæ. *c* bears a conidium

Fig. 5 Alternaria, *a* spore grown in water a culture, *b* chains of conidia.

All drawn with aid of camera lucida to same scale. Zeiss microscope, ocular 4, objective D used.





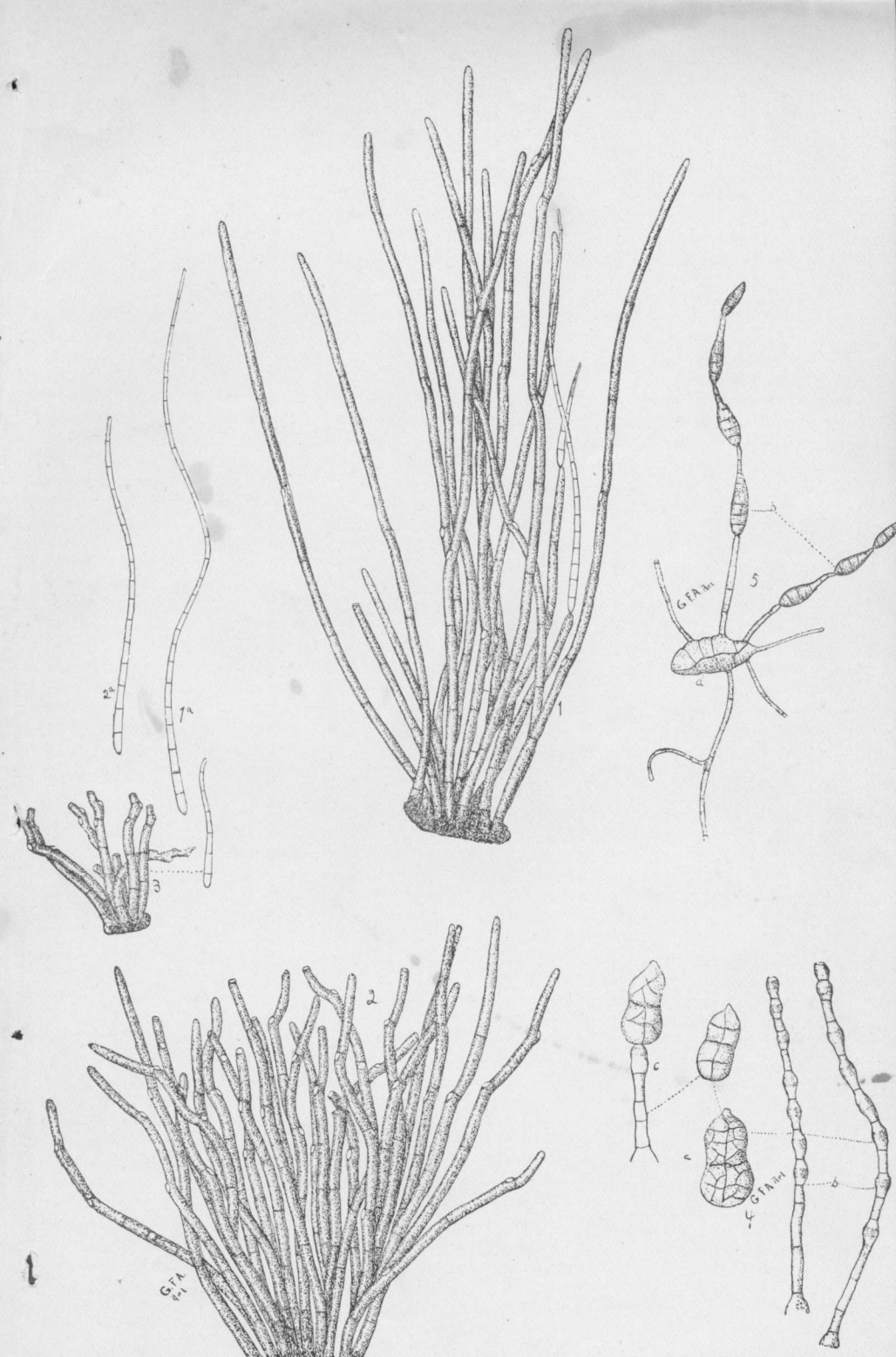


PLATE 2 ATKINSON, SOME FUNGI OF BLACK "RUST" ON COTTON.