Controlling the White Fly by its Natural Enemies—Report of Progress, and Other Observations.

By E. W. Berger,

(Entomologist, Florida Agricultural Experiment Station.)

Mr. President, Ladies and Gentlemen:

The mills of the investigator grind slowly. Whoever makes a business of investigating nature (coaxing as best he can her secrets from her) is treading unknown ground, or ground in regard to which he has only suggestive evidence, or no evidence at all, as to what he may find. Then also, a great part of his work generally consists in developing new methods as he progresses, although he may be guided by certain general principles. And then, at the best, his results are generally obtained point by point, and after long waiting. Thus it is with the whitefly investigations. This matter has been investigated before. Riley and Howard write:[1] "Our first acquaintance with the species was in June, 1878, when we found it occurring in profuse abundance on the leaves of the citrus trees in the orangery of this department. Some observations were made upon its life-history during that summer, and all of its stages were observed. During the following years we observed it in Florida, and it was studied by two of our agents, Mr. H. G. Hubbard at Crescent City, and the late Jos. Voyle at Gainesville." It was first referred to by its present scientific name (*Aleyrodes citri*) by Mr. Ashmead[2] in 1885. In 1893 Prof. H. A. Morgan[3] published a brief report of his observations upon this insect in Louisiana. He states that orange growers believe that it was brought into Louisiana on plants exhibited at the New Orleans Exposition in 1885. Later on Dr. H. J. Webber studied the pest in Florida, publishing his bulletin on the *Sooty Mold of the Orange* in 1897. Next came A. L. Quaintance and H. A. Gossard. Finally Dr. A. W. Morrill and E. W. Berger are risking a lance, and woe unto the white fly when they have finished with it (we hope).

1. INSECT LIFE, Volume V, No. 4, U. S. Department of Agriculture, 1893.

2. FLORIDA DISPATCH, New Series, Volume XI, November, 1885.

3. Special Bulletin of the Louisiana State Experiment Station, 1893.

WORK DONE UPON THE WHITEFLY.

The writer's investigations upon the whitefly have been continued chiefly with experiments for introducing the fungus parasites; together with some other observations and experiments

upon the ability of whitefly to survive on detached and partly dried leaves; the varieties or species of whitefly represented in the State which attack citrus seriously, the amount of honeydew excreted, and a few other points.

METHODS OF INTRODUCING THE FUNGUS PARASITES.

It has been repeatedly demonstrated that the red and yellow Aschersonias can be successfully introduced by spraying their spores (germs) suspended in water on to the under surface of white fly-infested leaves, or by pinning leaves having these fungi upon them to the under surface of the leaves of white fly-infested trees. Both methods are also applicable to the cinnamon and whitefringe fungi.

The spraying method is probably not generally applicable for introducing the brown fungus, and pinning fungus-bearing leaves is therefore recommended. This fungus has, however, been several times successfully started by spraying a mixture of water and fungus, obtained by agitating fungus-bearing leaves with water. A better way would be to scour the fungus from the leaves with a little sand and water. Use one to several leaves to a quart of water and strain the liquid if necessary.

EXPEIMENTS FOR INTRODUCING THE FUNGUS PARASITES OF WHITEFLY LARVAE.

Actual experiments and observations in the field have again demonstrated that the period of summer rains is a most favorable time in which to introduce the several fungus parasites of whitefly larvae. Introductions of the red and yellow fungi made during October and November were successful only to the extent of getting a small start of fungus, but were sufficient to insure a good spread of the same during the following summer. Thus, sprayings with spores of the red fungus in the R. S. Sheldon Grove at New Smyrna, on October 3, 1906, developed but a few pustules of the red by the first of December of the same year, and no more by the first week of May, 1907. The fungus spread, however, during the summer of 1907, so that by the fall of that year the trees sprayed had the foliage of many small branches literally dotted over with the red pustules, besides which the fungus had spread to perhaps all of the trees of the grove not sprayed with spores. This fungus will, no doubt, quite control the "fly" in this grove during the coming summer, and from there will spread over all the white-fly-infested citrus trees of New Smyrna. Why sprayings with spores of the red and yellow Aschersonias (fungi) made in the Ronnock groves at New Smyrna, at the same time (October 3, 1906), failed to produce a start of fungus can only be surmised; it may have been due to a more arid condition in these groves at that time, but more probably to poisoning of the spores by the use of an old spraying outfit previously used for spraying Bordeaux mixture. There being much less "fly" in these groves, of course, also lessened the chances of getting a start.

Sprayings with fungus spores made in the F. W. Edison grove at New Smyrna, on November 29, 1907, have given a promising start of red Ascheronia [trees examined April 23, 1908]; but other trees sprayed with spores at the same time in New Smyrna (some in the Ronnoc groves) show but a very poor start of

either the red or yellow Aschersonia after a period of five months (November 29, 1907, to April 23, 1908). Again, spore-spraying operations in some trees of Mr. B. F. Hampton's grove near Gainesville, made on October 6 and November 16, 1907, resulted in promising starts of both the red and yellow Aschersonias.

Spores of the red and yellow Aschersonias, together with some brown fungus material, scoured from the leaves with a little sand and water, were sprayed into some citrus trees at DeLand on January 17, 1908. Examination of the trees on April 20, 1908, revealed no certain growths of fungus. Introductions of the red Aschersonia made into thirteen trees on April 21 and 22, 1908, at the same place, by the spore-spraying method have produced an excellent growth of this fungus [trees examined June 17, 1908 and paper revised to this date]. In two trees, Mr. H. B. Stevens and the writer estimated that from 30 to 40 per cent. of the white fly larvae had become infected by the fungus and were dead. In two other trees the writer estimates [estimate was based on actual counts made upon leaves] that at least 50 per cent. were dead. Fungus introduced into two other trees by the leaf-pinning method resulted in only very poor growths of fungus; the growths of fungus produced by the spore-spraying method are estimated at from several hundred to perhaps a thousand times as great as those produced by the leaf-pinning method in the two trees referred to. At the time of introducing the fungus the spring brood of adult "flies" had about disappeared and larvae of the first, second and third stages were in abundance beneath the leaves. These spraying and leaf-pinning operations at DeLand on April 21 and 22 are regarded as of great significance; because they indicate so clearly that the *best time* in which to introduce the red Aschersonia by the spore-spraying method is when young larvae are abundant. It appears that young larvae are more easily infected than the older ones of the fourth stage and pupae. The fact that rains immediately followed or preceded the operations may also be of significance; the moisture favoring the germination of the spores. The comparatively very poor growths of fungus produced in the two trees into which leaves only had been pinned, are believed to indicate that the presence of an abundance of adult "flies" is necessary in order to obtain good growths of fungus by this method. [See: *The Whitefly Spreads the Fungi.*] What has been stated here for the red Aschersonia is also believed to hold good for the yellow Aschersonia; both are very similar in all their characters except color. The same principles, with one or two exceptions, probably apply to all the fungus parasites of the whitefly larvae.

The experiments enumerated demonstrate quite clearly that the red and yellow Aschersonias can be introduced in whitefly-infested trees during the fall months with fairly good success by the spore-spraying method, but leave us in doubt if we may ever be able to successfully introduce them during the winter and early spring months. Some other sprayings made at Gainesville with the red and yellow Aschersonias and the brown fungus during January and March indicate more clearly, however, that this may be impossible since not a single growth of fungus has so far resulted from any of these sprayings. The absence of the easily infected young lar-

vae at this time is believed to be the explanation. If the absence of young larvae is the explanation for the failures during January and March, this barren period is believed to also include December and February, since in neither one of those two months are there any but but a few [in December] young larvae. In other words, the barren period for introducing fungus will extend from December through March or until the young larvae of the spring brood of adults become abundant either in late March or in April. If larvae of the fourth stage and pupae are practically immune to the attacks of fungus as the January and March experiments indicate, then we may expect another barren period of a few weeks immediately preceding the appearance of the second brood of adult "flies" sometime in June or sometimes earlier. Preceding the appearance of the third brood of adults, there may also be a barren period, when the white-fly is in the fourth stage and pupae; but generally the separation of the second and third broods is not so well defined; larvae of all stages continuing to exist during the interval of the greatest abundance of adults. Some few trees in Mr. Wm. E. Heathcote's grove at St. Petersburg were sprayed on May 17, 1907, with spores of the red Aschersonia. A good growth of this fungus had developed from this spraying by the end of last summer, although in the beginning only a few fungus pustules could be found. This experiment clearly indicates that we can begin operations in May; and earlier as the DeLand experiments of April 21 and 22 have shown us. Better stated, the time to begin to introduce fungus in spring is when the young larvae of the spring brood of adult "flies" are becoming abundant (that is by the dozen) beneath the leaves.

Operations were begun last spring in Mr. Heathcote's grove for the main purpose of demonstrating what can be done in one season with the spore-spraying and leaf-pinning methods of introducing the fungi. The frost of the previous December together with the prevailing drought having defoliated so many citrus trees in sections where fungus had been abundant, that only small quantities of fungus could be obtained. However, continued efforts on the part of Mr. Heathcote, together with some supplies of fungus and aid from the writer, resulted in giving a wholesome sprinkling of the fungi, especially the red Aschersonia, together with some yellow Aschersonia and brown fungus, by the end of 1907. Mr. Heathcote has recently written, stating that the fungus does not appear to be as abundant in his grove this spring as it was last winter. This is quite what I expected, since it spreads but little if at all during the winter, and of course what has previously developed becomes weathered; besides some leaves drop, thus reducing the amount of fungus present in the trees.

It would be consuming an unnecessary amount of time were I to undertake to say something about all the experiments that I have started in different parts of the State. Suffice it to say that I have started spore-spraying and leaf-pinning operations for introducing fungus in the following places: Lake City, Leesburg, New Smyrna, Kissimmee, St. Petersburg, DeLand and Gainesville, in all seven localities. Taking a single grove or yard in which trees were treated in these several localities as the unit and also counting as separate experiments the differ-

ent times at which operations were begun in the same grove or yard, we have in all something like forty or fifty experiments made by the writer for introducing the fungi parasites of the white fly during the past two years.

TWO OTHER FUNGUS PARASITES.

Since appearing before you a year ago, two other fungus parasites of the whitefly larvae have been discovered in Florida. These are described by Professor H. S. Fawcett in *Press Bulletins* 68 and 76, Florida Agricultural Experiment Station, and are the whitefringe fungus (*Microcera sp.*) and the cinnamon fungus (*Verticillium. heterocladum*) respectively. The whitefringe fungus has been observed mainly at Sutherland, but specimens have been sent in from other parts of the State; so that it appears to be quite widely distributed. The cinnamon fungus has hitherto been mistaken for the brown fungus, and is probably as widely distributed as the latter, though not so abundantly. Both of these fungi being new discoveries, we are not prepared to make specific recommendations as to their efficiency in reducing the whitefly or as to the best methods for introducing them. Professor Fawcett, who has so far done about all of the work on the whitefringe and cinnamon fungi, succeeded in starting both of these upon whitefly larvae by spraying the spores of the fungi suspended in water. The cinnamon fungus has also been started by pinning leaves, and this method, no doubt is applicable to the whitefringe fungus.

SIX KNOWN FUNGI PARASITES.

Following is a list of the six known fungus parasites of whitefly larvae given in their order of discovery in Florida:

Red Aschersonia (*Aschersonia aleyrodis* Webber) 1893.

Brown Fungus (spores unknown) 1896.

Red-headed Scale Fungus (*Sphaerostilbe coccophila* Tul.) 1903 [?]

Yellow Aschersonia (*Aschersonia flavo-citrina* P. Henn.) 1906.

Whitefringe Fungus (*Microcera* sp.) 1907.

Cinnamon Fungus (*Verticillium heterocladum* Pensig) 1907.

The red-headed scale fungus has been observed upon white fly larvae only a few times and cannot be said to be of much significance in its relation to this insect. It is, however, a most efficient fungus parasite of scale insects in nearly every part of the State.

The following table gives the present distribution in Florida of the six fungus parasites of white fly larvae: R, Red Aschersonia; Y, Yellow Aschersonia; B, Brown Fungus; W, Whitefringe Fungus; C, Cinnamon Fungus; S, Red-headed Scale Fungus:

Altamont Springs		Y				
Alva	R		B			
Apopka	R			C i		
Bartow	R		B			
Bradentown	R		B	C		
Buckingham	R		B	C (?)		
Citra	R			C		
Ft. Myers	R		B	C (?)		
Gainesville	Ra	Ya		C b, c	W b	
Glen St. Mary	R					
Jacksonville	R					
Lake City	R	Ya, i	Ba, i			
Largo		Yd,i	B i		W	
Leesburg	Ra		Ba, i		W	S (1906)
McIntosh	Re			C e		
Manatee	R		B	C		
New Smyrna	Ra	Ya, i				
Orlando	R	Y	B	C (?)	W	S (1903)
Oneco	R		B	C (?)		
Oviedo	Rf	Y f				
Palmetto	R		B	C		
St. Augustine	R		B			
St. Petersburg	R h	Ya, i	Bh, i	C a, i	W	
Sarasota	R		B	C (?)		
Sutherland	R g, i				W	
Titusville (Mims)		Y			W	
Winter Park	R	Y	B			

a. Introduced by the writer.
b. Introduced by Prof. H. S. Fawcett.
c. Observed also on scales in forest by H. S. F.
d. Introduced by Mr. J. E. Kilgore.
e. Introduced by Mr. S. H. Gaitskill.
f. Introduced by Theo. G. Mead, about 1903.
g Introduced.
h. Introduced by Mr. Wm. E. Heathcote, Judge J. D. Bell and the writer.
i. Small quantities only.

*This table has been compiled from observations by the writer, corrected and added to by Dr. A. W. Morrill and Professor H. S. Fawcett.

THE WHITEFLY SPREADS THE FUNGI.

Observations made during the past year indicate that the whitefly itself is instrumental in distributing the fungi after once they have been started in a tree or grove. The adults, as they walk over the leaves, no doubt get many of the fungus spores attached to their feet, and as they fly away to other trees deposit them upon whitefly larvae; thus unknowingly carrying disease with them. Other insects, such as ants, and ordinary flies and beetles, may also be instrumental in disseminating the fungi. This probably accounts for the fact that pinning fungus-bearing leaves has not resulted in much success in starting the fungi during the cool and dry periods of the year, or when few or no adult whiteflies were about. It is therefore advised only to use the leaf-pinning

method for introducing the fungi during the period of summer rains or at other periods when abundant whiteflies are in the trees. Most excellent results have been obtained with the red and yellow Aschersonias by pinning fungus-bearing leaves during June, July and August. The spore-spraying method can be used at any time, but it will probably be difficult to start fungus in winter and early spring by any method. There are indications that larvae of the fourth stage and pupae (in which two stages the "fly" exists from about December until March and April) are not readily, if at all, infected with fungus.

PLAN OF CAMPAIGN.

The writer's plan of campaign, based upon experiments in the field, is as follows:—If a grove is thoroughly infested with whitefly, and sufficient "seed-fungus" is available, introduce fungus into all the trees; but if the supply of seed-fungus is limited, distribute it here and there throughout the grove, so that there will be a great many centers of infection from which the fungus can spread. It may be considered advisable to treat only a few trees in each row with fungus, and it may only be possible to treat some branches of each of these trees; but any scheme of distribution that will give the fungi a good chance to spread to all parts of a grove will suffice. Later on, when more seed-fungus is available, the trees or parts of trees not previously treated may be attended to. A second, and even a third or fourth treatment may be given to the trees in order to get the quickest possible dissemination of fungus. So long as only a few fungus pustules are visible on those leaves of a tree which bear the most fungus, it will be advisable to introduce more fungus, especially should an abundance of seed-fungus be readily available. The greater the amount of fungus growth which is successfully started in a grove by artificial means, the more rapid will be the destruction of the whitefly. Whiteflies have the habit of congregating on water-sprouts and other tender growth of citrus, consequently we should give particular attention to introducing the fungi into such parts of the trees. The work should be done methodically and not in a haphazard way.

The plan of campaign for a grove just becoming infested with whitefly; or only infested in part, would be to introduce fungus into all those trees sufficiently infested (that is, whitefly by the dozen on the leaves), and later on into other trees as soon as they become sufficiently infested. Incidentally, the trees should be fertilized a little more heavily.

"Seed-fungus" becomes abundant about midsummer and lasts until midwinter and later, although some can generally be obtained somewhere at all times. The best weather conditions for introducing fungus are met with from about June to the end of August. Since the period of summer rains is also the time when "seed-fungus" is abundant it is about the best time in which to introduce fungus. It is advisable, however, to introduce fungus at other times when "seed-fungus" is available, using only the spore-spraying method when young larvae are abundant and adults not plentiful but employing either one of the two methods (spore-spraying or leaf-pinning) during the warmer months, or when adult "flies" are swarming abundantly about the trees. It will, of course, be evident from a perusal of the preceding pages that it would probably be useless to try to introduce fungus from

December to April, or until young larvae become abundant immediately following the first brood of adults in spring.

It is best to use fresh fungus, although the writer has succeeded (during the rainy season) with fungus that had been collected and dried for a month.

For further particulars in regard to methods for introducing the fungi the reader is referred to Bulletin No. 88 and Press Bulletins 68, 76, 80, 82, and 88, Fla. Agr. Expt. Station.

Fungus can probably be obtained at the following places:—Manatee, Bradentown, Palmetto, Sarasota, Fort Myers, Buckingham, Orlando, Oviedo, Apopka, and Titusville.

OTHER OBSERVATIONS.

Whitefly Matures on Dead Leaves.—On November 20 and 21, 1907, Mr. R. Y. Winters, Assistant in Botany, and the writer made a very careful inspection of some of the trees at DeLand that had been defoliated the previous February, but in which the whitefly had reappeared during the summer. Careful inspection of the vegetation in the neighborhood of the infested trees revealed no plants infested with whitefly which could have acted as carriers during the period of defoliation of the citrus. (It does not necessarily follow, however, that such carriers did not exist.) But whitefly in abundance existed in the citrus and Cape jasmine that had been defoliated the previous February. Where had it come from? The writer finally decided to carefully examine the dead leaves accumulated under a certain Cape jasmine, especially any that had collected in small hollows near the trunk. Something like several pecks of such leaves were examined by Mr. Winters and the writer with the result that well matured larvae and pupae, apparently healthy and alive, were found on some leaves that were dead and brown, but had either retained or been supplied with enough moisture to keep them flexible. Finally, the writer found an adult specimen about half emerged from the pupa case on such a leaf. The specimen appeared fresh but inactive, and with a little effort was freed from its case and found to be undoubtedly alive, since it could move its legs and feelers.

In the afternoon Mr. Winters went to carefully inspect the fallen leaves of certain citrus trees, with similar results. Seemingly live and healthy pupae were found upon dead and dried leaves generally with enough moisture, however, to remain flexible. Some of these leaves were taken to the laboratory at the Experiment Station by Mr. Winters, and after a few days, live adults were found moving about under the bell jar. Two days later the writer found apparently live specimens of pupae on a few partly dried and curled leaves of citrus in another yard at DeLand. On January 17, some of the fallen leaves under the Cape jasmine above referred to were again examined, when semi-dried leaves with plump, live larvae were found, also a pupa on a leaf that was dried and brown. It was further observed on the Cape jasmine in question, and on two citrus trees (all of which had been defoliated in the preceding February) that the greater number of whitefly larvae were low down in the trees (about the lower third) and also that the empty pupae cases of preceding brood were on the lower leaves of the trees, possibly indicating that the "fly" came up from the ground.

When at DeLand on January 17 and 18, 1908, I brought back to Gainesville

several small twigs (with leaves) of the Cape jasmine before referred to, and well infested with whitefly. A portion of this material was placed in a small cloth sack and slightly buried at the foot of a large magnolia tree near the University. The magnolia was chosen because no citrus or jasmine was near at hand. On March 22 live adults were emerging and some of the leaves were still green.

Another portion of this material was placed under a bell jar (with open top and covered with cheese-cloth) on sand in the greenhouse. Live adults were obtained as before at the end of two months and a few of the leaves were still green. In both experiments, however, the larvae on the leaves which had turned dark or dried, soon died.

These observations leave no doubt in my mind that some whitefly can be carried through the winter on dead, partly dried and browned leaves, scattered under trees, especially when so placed that they do not dry sufficiently to crumble, although some of the leaves examined were quite dry. It was not possible to know how long these leaves had been in the condition in which we found them, and whether the larvae there could have matured; for when leaves are allowed to dry in the laboratory all larvae have been observed to die. In regard to the pupae there can be no doubt about their maturing, as one adult at least was caught in the act of emerging from its case while others developed into adults when taken to the laboratory, as previously stated. It is estimated that the leaves in question had fallen from the trees two weeks to two months previously, but they may have been older. The experiments with the fresh green jasmine leaves indicate furthermore, that it is possible for such leaves to become buried in the sand or otherwise protected, so that they remain green for at least two months, allowing whitefly larvae to mature upon them in time to infest the early new growth of the trees.

Extermination by Defoliation.—The previous observations and experiments indicate pretty clearly why the attempts at exterminating the white fly at DeLand in February, 1907, by defoliating the trees have failed, notwithstanding that precautions were taken to burn all the leaves. Some of the trees had been banked with earth, and as the "fly" appeared in greatest abundance in these trees after the defoliation, this again indicates the possible source of the re-infestation, since these banks of earth about the stems of the trees would be ideal places for preserving leaves, as the previously stated experiments show. That the defoliation of all the trees at DeLand at the time referred to was nevertheless useful can hardly be doubted, since it must have been at least equivalent to a season's spraying or fumigation in keeping the "fly" in check. The defoliation was completed after the partial defoliation by the December freeze of 1906, so that the burden of it was much less. I believe that defoliating whitefly-infested trees after a partial defoliation by a freeze may frequently be advisable, but doubt if the wholesale butchery of the trees at Marysville, California, of last year was advisable, and doubt, furthermore, if they will be successful in exterminating the white fly there unless they keep up the extreme vigilance now exercised for at least five or six years. No doubt the growers at Marysville, California, would have done better to have checked the "fly" as best they could dur-

ing last summer by spraying or fumigating, and then in winter have undertaken to exterminate it by fumigation in the citrus trees, and by destroying all of its other food plants possible. The injury in winter caused by even large overdoses of hydrocyanic acid gas would have been trivial in comparison to the injury done to the trees by cutting off their large limbs in order to get rid of the leaves.

Honeydew Excreted.—Leaves with an abundance of whitefly larvae were placed between glass plates, and it was found that the honeydew ejected by the insects was deposited in small drops on the glass above or below them, in some instances the liquid being precipitated upward a distance of 1-8 inch or more. Pupae ready to have the adult emerge secrete honeydew as well as larvae of all stages. A lot of larvae of perhaps the third and fourth stages of growth excreted at the rate of .0005 gram each in 48 hours. At this rate 1,000,000 larvae (in round numbers) could excrete one pound of honeydew in 48 hours, which would be at the rate of 15 pounds per month or 180 pounds per year. Since no doubt a large percentage of this sweet excretion is sugar (let us assume 50 per cent., since we have not had an opportunity to test it or have it tested), at this rate 100 trees of good size on an acre of ground would lose something like 50 barrels of sugar per year, allowing 1,000,000 whitefly larvae to a tree. These 50 barrels are the equivalent of 10,000 pounds, or 5 tons; at 5 cents per pound, this would amount to $500.00. Of course, this is not the actual loss per acre, since carbon, hydrogen and oxygen, the components of sugar, come from the air; but it does represent an unnecessary amount of work that the trees are required to do, granting that they bear a full crop besides, which they probably never do. This great amount of loss of sugar and water, however, does account for the insipid and dry fruit of whitefly-infested trees, and suggests the necessity of giving the trees an extra allowance of fertilizer and, of course, sufficient water.

Two Species.—Are there two species of white fly seriously affecting the citrus trees in Florida? The writer has several times observed that the eggs of the whitefly in certain localities in Florida had a different appearance from those in other localities. Last fall and winter, while Prof. H. S. Fawcett and Mr. R. Y. Winters were doing some work with the microscope under the writer's direction on the whitefly larvae and eggs, our attention became further directed to a peculiar delicate net-like covering to certain eggs. After examining material from different localities, I found that only whitefly eggs from certain localities had this covering, eggs from other localities being perfectly smooth and shiny. A like examination of eggs of this spring's brood from the same localities revealed the same differences, together with decided differences in the external structure of the larvae of the first stage. At the time of writing this no literature on the whitefly has been found which takes note of differences such as have just been stated.

It is true that Professor H. A. Morgan in his bulletin (previously cited) figures the reticulated type of egg for the whitefly in Louisiana in 1893, and in his description of the egg mentions "a film-like covering arranged in hexagons—;" but it is evident that he was not aware of the existence of two types of eggs represent-

ing two species of whitefly seriously affecting citrus. Professor Morgan gives the name of the whitefly observed by him in Louisiana (bulletin cited) as *Aleyrodes citrifolii*, giving for his authority Riley (unpublished manuscript). This is presumably the manuscript which was later published in *Insect Life* (previously cited), the name of the insect in the meantime being changed to *Aleyrodes citri*. The description in the article in *Insect Life* clearly refers to the species with smooth eggs, since it is expressly stated that the eggs are perfectly smooth, although sometimes pruinose, while the description of the larvae of the first stage also agrees with the character of the larvae which hatch from the smooth eggs, and not with those hatched from the reticulated eggs. At first it was thought that either *Aleyrodes aurantii* Maskell, *A. Marlatti* Quaintance, or *A. spinifera* Quaintance, reported on citrus from the N. W. Himalaya Mountains, Japan, and Java, respectively, might be the species in question. However, a careful comparison with the descriptions of these species has ruled them out, as well as many other species. The writer is therefore quite satisfied that the citrus whitefly of Florida with the reticulated egg is a new species, distinct from the citrus whitefly of Florida with the smooth egg (*Aleyrodes citri*); the differences in the eggs alone are considered sufficient to make the distinction. Careful comparisons have also revealed distinct differences between the pupae and perhaps also between the adults of the two species as well as between their eggs and newly-hatched larvae.

What is the significance of this discovery? The species with the reticulated egg is found at Clearwater, Largo and Sutherland on the West Coast, and at Mims, Titusville and Geneva on the East Coast. It also occurs at Orlando and probably in other localities. The species with smooth eggs is at present known to occur at St. Petersburg, Largo, DeLand, New Smyrna, Gainesville, Manatee County, Apopka, Chipley, Leesburg, Bay Ridge, Daytona, Jacksonville and other places. One conclusion immediately follows: that there have been at least two separate introductions of the whitefly into Florida; assuming, which is probable, that the whitefly of Florida is not a native here. It indicates, also, that the whitefly in the upper part of the Subpeninsula is not altogether an introduction from St. Petersburg as is generally believed, but has had its origin in part elsewhere, probably over at Safety Harbor. Whence came the "fly" at Safety Harbor cannot at present be told, but it is believed to have infested citrus trees there for many years. On the other hand, the whitefly at St. Petersburg, in all probability, has been brought from the Manatee Country. Further research may determine many important points of difference in the life history, effectiveness of the fungus and other parasites, spraying or fumigation in the control of each species.

[This paper was followed by a demonstration with stereopticon views illustrating the eggs and first stage larvae of the two species of white fly discussed, together with views of the fungus, parasites, lacewinged flies, and excretion of honeydew.]

DISCUSSION.

Dr. Inman—I would like to ask how much damage we are likely to do this fungus by spraying with insecticides.

Dr. Berger—That would depend

upon the nature of the insecticide. Kerosene and soap solution would do very little injury unless you keep the trees sprayed all the time. Of course, very caustic insecticides and those containing fungicides may do very much harm.

Dr. Inman—Thrip juice, which is a solution of arsenic—what about that?

Dr. Berger—I do not know the ingredients of thrip juice. I cannot answer definitely whether the arsenic will do harm or not, but probably not. I have never seen arsenic recommended as a fungicide.

Mr. Mote—How about the sulphur solution?

Dr. Berger—It may be very injurious to fungi if used too frequently. Of course, one spraying or dusting of the trees with sulphur will do very little damage, especially if the spraying is not too thorough and applied only to the parts of a tree affected. The Rex lime and sulphur solution is now recommended and sold as fungicide.

Mr.——How about the resin wash?

Dr. Berger—I imagine it would be injurious, because it is generally quite caustic, but one or two sprayings in winter will probably do little harm to the fungi.

Mr. Henderson—Do you know anything about the Gold Dust solution?

Dr. Berger—If Gold Dust is nothing but powdered soap, as I believe it is, it will do very little, if any, injury to the fungi.

Mr. Henderson—I also wish to say that I visited thirty or forty orchards in the state and in every one, but one, there was scale, somewhere. I introduced the fungus into all the orchards and so far as I know, the scale is dead in all of them. My experience has shown that the fungi is not only the cheapest but the best remedy for San Jose scale and orange scale. I believe that the black fungus is really more effective and stands more hardship and spreads more rapidly than the red. The application is very simple. You just tie a small piece of wood containing the fungi to about every tenth tree, and your work is done. It is much less trouble and expense to get the fungi and apply it than it is to spray one time. One man can go over about twenty acres in a day.

Prof. Rolfs—I might say, in opening this discussion, that to use the fungi requires courage and intelligence. I know the results of Mr. Henderson's experience must be especially gratifying to Mr. Hart, since he has been harping on that for fifteen years. It must be gratifying to him to see that a large number of citrus growers are coming around to see that the fungi are of invaluable assistance to them.

Mr. Warner—I would like to ask whether it is better to combat the rust mite with a spray or dust.

Mr. Skinner—The liquid spray just hits the outside of the tree, but the dust goes into the whole tree, and I think it is more effective. Besides, liquid spray is so unpleasant to use that ordinary labor will shirk their work to get through quicker. The lime is hard on their hands and faces and gets into their eyes and they don't like to use it.

Mr. Stevens—If you use the dust spray, try sulphur and no lime. It does not increase the scale at all. The liquid spray, in my judgment, injures the

fungi working on the spray, while the dust does not.

Mr. Painter—A good many complaints have come in the same as Mr. Skinner's, and one man told me he overcame that by giving his men olive oil with which to rub their faces and hands.

Mr. Longley—I don't think the sulphur solution brings scale. I spray with a sulphur solution and have been for a number of years, and in my case it killed the scale. I never have a scale even on the grapefruit, and we all know that it is a great breeder of scale.

Prof. Rolfs—I will say in connection with this subject that the lime in the dry spray is not necessary for it to be efficacious. It is pretty apt to kill the fungi and let the scale come out.

Mr. Longley—In order to keep the scale down and the rust mite down, I have found that unless you spray thoroughly you had better not spray at all. Consequently, it is necessary almost always to personally supervise it or do it yourself.

THE WHITE FLY INVESTIGATIONS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE.

By Dr. A. W. Morrill.

Mr. President, Ladies and Gentlemen:

I spoke to you last year on the subject of fumigation for the White Fly, describing the methods of procedure and discussing in a general way the results obtained up to that time. As most of you know, the present investigations of the Department of Agriculture have for their object a thoro study of all phases of the White Fly problem. Such work naturally divides itself into: first, studies of life history and habits; second, control by natural enemies, including parasitic insects and fungi, third, control by spraying or fumigation; fourth, studies of miscellaneous factors in their relation to White Fly damage and control.

The early history of the White Fly is rather obscure and its origin not positively known. The evidence at hand, however, seems to show the pest to have been an imported rather than a native species and much support has been given to this theory by its recent discovery in China. The first investigation of Citrus pests in Florida was by H. G. Hubbard, who was doubtless known to many of the present members of this society. As a special agent of the Division of Entomology of the U. S. Department of Agriculture he published in 1885 a valuable report entitled "Insects Affecting the Orange," based on three years' work begun in August 1881. In connection with the White Fly, it is interesting to note that at the time of Mr. Hubbard's investigations this insect gave no promise of developing into a pest, although its