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The White-fly or Plant-house Aleyrodes.

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THE WHITE-FLY OR PLANT-HOUSE ALEYRODES.

Aleyrodes vaporariorum Westw. ?

By W. E. Britton, *State Entomologist.*

For eight years the most serious insect pest affecting forcing-house tomatoes at the Station has been the "white-fly," "mealy-wing," or plant-house Aleyrodes. Were it impossible to hold the insect in check, the crop each winter would be nearly a total failure. Seemingly the species grows more and more abundant each succeeding year; at least the remedies need to be applied with greater persistence than formerly, and in spite of all the spraying and fumigating a goodly number of individuals survive.

The attacks of the white-fly are by no means confined to the tomato plant, but other forcing-house crops, especially cucumbers and lettuce, are sometimes seriously injured. There is a large number of florists' plants upon which the insect is known to live, and several of them are each year much damaged by its attacks. Nor are the depredations of this insect limited to plants under glass; on the contrary, it lives and multiplies on the out-door plants of the garden through the summer, frequently causing more or less injury. The white-fly has already been reported as injuring strawberry plants in Kentucky* and New York,† and we may expect similar accounts of it from other localities.

In 1901 the white-fly was sent to the Station from Bridgeport, where it was damaging aster and chrysanthemum plants. In July, 1902, specimens were received from Milford on strawberry leaves.

While on a vacation last month the writer observed that aster plants growing in a garden in Surry, N. H., were infested with this insect.

The original home of this Aleyrodes is unknown. Westwood states that it is supposed to have been carried into England on plants from Mexico. It may have been brought here

* Report of Kentucky Experiment Station for 1890, p. 37.

† Bulletin 190, Cornell Experiment Station, p. 155.

either from England or from Mexico. Quaintance states* that it has been received by the Entomologist at Washington from New Haven and Storrs, Connecticut; West Grove, Pa., and Goshen, Ind.

It also occurs in such widely separated regions as Michigan, Kentucky, New York, Massachusetts, New Hampshire, Ohio and the District of Columbia, which indicates that it is now thoroughly distributed throughout the northeastern portion of the United States.

The plates in this bulletin are from photographs made for the author by the late Mr. H. A. Doty. The text illustrations were engraved on wood by Mr. R. M. Sherman from the author's drawings.

Relationship to Other Insects.

The *Aleyrodidæ*, to which the white-fly belongs, are closely related to the *Coccidæ*, or scale-insects, being perhaps intermediate between them and the plant-lice, *Aphididæ*. They differ from the former in that both sexes are winged and motile, and from the latter in being fastened to the plant in the nymph stage. The larvæ or nymphs hatch from eggs deposited by the females on the under surface of leaves, and closely resemble several species of scale-insects.

Aleyrodid insects are not considered to be of very great economic importance. They are much more abundant in the tropics than in temperate regions. Many species occur on cultivated and wild plants, but are seldom abundant enough to be a serious menace to them. Signoret's monograph of the *Aleyrodidæ*, published in 1868, contains twenty-three species found in Europe.† Quaintance lists forty-two species‡ in America, but *A. citri* Riley & Howard, which is a serious pest of the orange and lemon groves of the Southern States, and this plant-house aleyrodes are without doubt the two most important species from the standpoint of the horticulturist.

* Bull. 8, Tech. Series, Division of Entomology, U. S. Department of Agriculture, p. 39.

† Annales de la Societé Entomologique de France, 1868, p. 387.

‡ Bull. 8, Tech. Series, Division of Entomology, U. S. Dept. of Agriculture.

How it Injures Plants.

The female lays eggs on the under sides of the leaves. Soon after the eggs hatch the young larvæ or nymphs attach themselves to the leaf and injure it by sucking out the sap for their nourishment throughout the period of larval growth. As each female deposits several eggs, and as only a short time is required for the complete cycle of development, successive generations finally cover the entire under surface of the leaf. The tissues collapse from the effects of this continuous pumping out of the life-juices of the plant, and the leaf shrivels and falls. As new leaves are formed at the top of the plant these in turn become infested, and later wither and die. If no efforts are made to destroy the pest, the entire plant may be dead before the end of the season, or if it be a vigorous grower like the tomato, may have a few green leaves at the top, with a bare stem from which the leaves have withered and dropped. In the greenhouses the insects usually become very abundant towards the end of the season, and the warm days of spring seem to favor their multiplication: this occurs in our tomato house nearly every year in spite of a weekly spraying which kills all adults with which the material comes in contact. As the season advances the plants in the garden become infested and the species keeps multiplying out of doors until cold weather approaches, when it again appears in the greenhouse, there to pass the following winter.

Though most of the feeding is done in the nymph stage, the adult is provided with mouthparts well fitted for sucking and probably injures plants to some extent. I have often seen adults resting on the lower surfaces of leaves with their beaks piercing the tissues. When disturbed they fly upward, and if abundant they literally fill the upper portion of the greenhouse. A sweet sticky substance called honeydew is exuded by the insects, and this covers the fruits and lower leaves of the plants during the latter part of the winter. A black fungus grows in the honeydew, giving the plants the appearance of having been covered with soot.

Food Plants.

Although in forcing-houses the white-fly has been most troublesome on tomato, cucumber and melon plants, and the florists must fight it persistently on *Ageratum, Lantana* and heliotrope,

I believe that it is able to live upon and may attack almost any kind of plant if the preferred ones are not at hand. Solanaceous plants (those belonging to the potato family) are favorites, and tobacco growing at the Station in 1901 was badly infested. Should this insect become established in the tobacco fields of Connecticut, it would doubtless prove a very troublesome pest.

The following list contains only those plants upon which I have observed the insect in its nymph stages: the adults have been found resting upon the leaves of a great many other kinds of plants.

Abutilon sp.
Hibiscus moscheutos.
Hibiscus rosa-sinensis.
Cucumber.
Squash.
Melon.
Potato.
Tomato.
Tobacco.
Strawberry.
Japan plum.
Currant.
Lettuce.
Bean.
Aster.
Coreopsis lanceolata.
Golden Glow (*Rudbeckia laciniata*).
Zinnia.
Lantana.
Verbena.
Heliotrope.
Calla lily.
Snapdragon.
Smilax.
Coleus.
Nasturtium (*Tropæolum*).
Chrysanthemum.
Ageratum mexicana.
Columbine.
Fuchsia.
Salvia.
Monarda.
Maurandya.
Grevillea robusta.
Tecoma radicans.
Erigeron philadelphicum.
Geranium.
Pelargonium.
Nutmeg (*Schinus molle*).
Oxalis.
Campanula sp.?
Parrot's Feather (*Myriophyllum proserpinacoides*).
Morning Glory.
Cigar plant (*Cuphea*).
Lavendula dentata.
Lilium superbum.
Solidago canadensis..
Phytolacca decandra.
Lonicera.
Platycodon.
Phlox.
Catalpa.
Hickory.
Berberis Thunbergi.
Rose.
Spiræa.
Rhodotypus kerrioides.
Spice bush.

Westwood found it on *Tecoma velutina, Gonolobus, Solanum,* and plants belonging to the *Bignoniæ* and *Aphelandræ.*

Habits and Life History.

The plant-house aleyrodes in all its stages is found on the under sides of the leaves and seldom anywhere else unless disturbed. The eggs are laid on the leaves, perhaps, when the plant is small, and as the new leaves are formed these become the ovipositing places. Thus the lower leaves of large and badly infested plants are usually completely covered on their under surfaces with the empty skins from which the adults have emerged. These leaves are the first to wither and drop. Those next higher up on the plant will show nymphs and pupæ; still higher we shall find younger and newly hatched nymphs, while on the upper leaves the adults will be mating and the females laying eggs. The process of ovipositing is an interesting one and was observed by the writer a few years ago in two cases on lettuce plants. The female first thrust her beak into the leaf, and depositing an egg, swung about with her beak still inserted and serving as a pivot, continuing to deposit eggs in a circle of about one millimeter in diameter. One of these circles contained six, while another had nine eggs. This peculiar egg-laying habit was observed many years ago by Réaumur in *Aleyrodes chelidonii* as cited by Westwood in the Gardener's Chronicle (1856, p. 852). But our species does not always lay eggs in this manner, for I have often found eggs deposited singly and scattered over the surface of the leaf. Davis has observed that on hairy plants like the *Ageratum* the eggs are deposited singly.

The eggs were light green or nearly white at first but soon changed to a dark color, and hatched in eleven days. The newly-hatched larva moves about for a short time, then becomes stationary and resembles a scale insect. It increases in size for a time and when fully grown changes to a yellowish color. Still more important changes are taking place inside. This is called the pupa stage. Finally the skin cracks open along the median line of the back, and transversely through the caret-shaped line, and the fully developed insect appears. It is pure white, much resembling a tiny moth, and it is entirely covered with particles of wax. The old pupa skins remain attached to the leaf for a long time. The adults fly about, mate and the female soon begins to lay eggs. It is not known how long the insects live

after reaching this stage. From the laying of the egg to the time that the adult comes forth requires a period of about five weeks. Plate I. shows nymphs and adults on a leaf.

It is not known whether the species can survive the winter out of doors in this climate, but in the cases coming under the writer's observation it has been carried through the cold weather on plants in greenhouses or dwellings.

Description.

Egg.—Length, 200μ to 250μ (.2 to .25 millimeter). Thickness, 90μ to 100μ (.09 to .1 millimeter) in thickest portion. Elongated ovate in shape. White or light green when first laid but soon (three days according to Davis) changing to a dark bluish-black. The large end is attached to the under surface of the leaf by means of a very short and slender thread-like stalk which is difficult to make out. Smooth and shiny or covered with minute granules of white wax. See fig. 1, and plate III. Eggs observed by the writer hatched in eleven days.

Fig. 1.—Eggs: × 36.

Fig. 2.—Newly-hatched nymph, ventral view: × 55.

Newly-hatched Nymph.—Length, about 252μ (.25 millimeter), width, about 101μ (.1 millimeter). Body thin, showing eyes, vasiform orifice, and caudal setæ or wax tubes. Ventral surface shows six poorly developed legs: eyes and antennæ are situated near anterior end of body. Mouthparts are in form of a sucking tube having its origin just in front of the forelegs. The segmentation is apparent in the abdominal region. See fig. 2.

Full-grown Nymph.—Length, about .75 millimeter. Width, about .5 millimeter though varying considerably in size. Thickness, about .28 millimeter. Greenish-white in color, dorsum mildly convex with several cross sutures indicative of

segmentation. One of these has the form of a broad and shallow caret (^) not far from the middle of the body. A median line from the point of this extends to the anterior end of the body, and it is along this line and across through the caret-shaped mark that the skin opens for the adult to emerge. A submarginal row of short, white, wax filaments or rods. Under the margin and extending perpendicularly from the horizontal plane of the body to the leaf is a wall of wax made up of narrow filaments side by side and adjoining each other. This wax fastens the insect to the leaf, and often breaks off in flakes when the nymph is removed and mounted in glycerine. Even when broken off this wall shows the parallel lines or striæ, and it is along these that it separates most readily.

In the fully matured nymph or so-called pupa, long waxen rods occur on the dorsum as follows—a pair close to anterior margin and a second pair a short distance back of the first. A third pair on the thoracic region. The fourth and fifth pairs are close together on the abdominal region just back of the caret-shaped cross-mark. The sixth pair is situated near the vasiform orifice and a seventh pair occurs near the posterior margin. These rods arise from distinct pores and vary greatly in length. The mature nymph is shown in figs. 3 and 4.

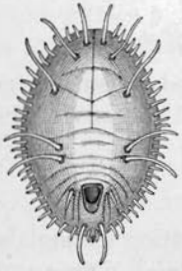


FIG. 3.—Mature nymph or pupa, dorsal view: × 36.

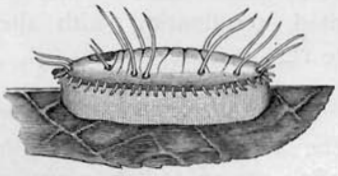


FIG. 4.—Lateral view of mature nymph: × 36.

Adult female.—Length, about 1.5 millimeters from head to ends of folded wings. Wing expanse of about 2.5 millimeters. Body plump and yellow in color, terminating in an ovipositor of three pieces. Four pure white wings extending beyond end of abdomen, each with a single median vein which in the fore wings is branched at the base; a row of papillæ or tubercles resembling

beads extends around the margin, and each papilla bears minute hairs. These are shown on Plate IV. Eyes brown, in two pairs, the upper ones slightly smaller than the lower, but with a larger number of facets. Antennæ six-jointed, the first joint short and thick, the second long, the others about equal in length and all but the first with many ring-like markings. Proboscis of three pieces arising from under the back side of the head and containing a groove in which are four bristle-like lancets. The lancets have a different origin from the proboscis, and arise from the front of the head. Each leg has two tarsal joints, the distal one being furnished with a pair of claws and a spine or bristle-like appendage. Wings, body and legs covered with a powdery white wax. See fig. 5.

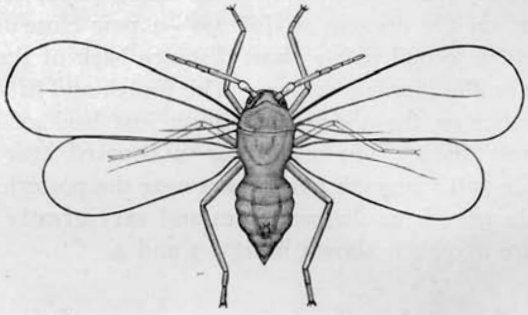


FIG. 5.—Adult female: × 36.

Adult male.—Like female, only the body is smaller and more pointed, terminating with the genital organs. Shown on plate II.

IDENTITY AND NAME OF THE INSECT.

The insect was first noticed at the Station during the winter of 1894–95, on tomato plants under glass. During 1895, the writer sent specimens to Prof. M. V. Slingerland of Cornell University, and later to Dr. L. O. Howard of Washington, both of whom reported it to be *Aleyrodes*, but that it was impossible to determine the species, for up to this time the *Aleyrodidæ* had received but little study in this country and few American species had been described. Prof. Garman, to whom specimens were sent, pronounced the Connecticut species identical with that which he had reported as attacking strawberry in Kentucky.

During the past year the writer has made several requests for authoritatively determined specimens from England, in order to settle once for all the identity of the insect. Prof. David Sharp of Cambridge very kindly sent some adults from the botanical garden at Cambridge, which presumably were *A. vaporariorum* Westw., but as Dr. Sharp makes no claim to a special knowledge of the group, the matter is still unsettled. Moreover the pupa case is needed to determine the species with certainty. The adults from England could not be distinguished from specimens taken in the Station greenhouses.

Garman and Packard, in the works of these authors mentioned on page 14, write of this insect under the name of *A. vaporarium*. Davis uses the name *vaporarium* in 1894 (Insect Life, Vol. VII, p. 174), but in 1896 (Special Bull. 2, Mich. Exp. Station) adopts Westwood's spelling. The difference in the spelling of the specific name is doubtless due to an oversight.

For the generic name some writers use the Greek spelling *Aleurodes,* meaning flour-like, which describes the waxy or mealy appearance of the insects. The present writer has preferred the original spelling as given by Latreille many years ago.

As Westwood's description fits our species very well, it is probable that the two are identical. Westwood described and figured the species in the Gardener's Chronicle for 1856, p. 852. As this is inaccessible to many, the description is here reproduced.

Westwood's Description of *A. vaporariorum.*

The New Aleyrodes of the Greenhouse.—During the past 12 months the greenhouses, both in the public gardens at Kew and in the gardens of the Horticultural Society at Chiswick, have been infested with a new pest, under the appearance of a very minute white four-winged insect, like a miniature moth, to which my attention was first directed by Sir William Hooker, and subsequently by Dr. Lindley. It especially attacks the leaves of Mexican species of *Gonolobus, Tecoma velutina, Bignoniæ, Aphelandræ, Solanums,* and other similar soft-leaved plants, and is supposed to have been imported with living plants or in the packings of *Orchidaceæ* from Mexico, in all cases attaching

itself to the under side of the leaf. Here it sits tranquilly with the tip of its short naked sucker or rostrum thrust into the leaf, but on passing the hand over the plants, quite a little white cloud of the insects is raised. They soon, however, settle again to renew their attacks, which are shortly followed by a discoloration and blackening, and subsequent drooping and falling of the leaves. The ordinary fumigations have been tried, and the winged insects, which are very delicate little creatures, are easily killed, but in a day or two a fresh brood of the perfect insects makes its appearance in as great numbers as before, and this continues to be the case after repeated fumigations. Nor is the placing of the plants out in the open air more successful in getting rid of the enemy, as Mr. Gordon pointed out to me a cluster of plants which had been in the open air for more than a fortnight, and which were swarming with the insects as thickly as those within doors.

The insect when seated with its four wings closed over its back is not larger than the head of a good-sized pin, and were it not for its beautiful clear white colour it would be seen with difficulty. A microscopical examination proves it to belong to the genus *Aleyrodes* (one of those aberrant groups allied to *Aphis* and *Coccus*), of which we possess in this country several native species, one (*A. Chelidonii*) found upon *Chelidonium majus*, and also on the common cabbage; another, first determined by Mr. Haliday, infests the common *Phillyrea*.

The body is soft and rather fleshy, the head distinct, with a pair of antennæ consisting of only six joints, the first large, the second long, and the four following short and slender; the eyes are four in number, each being small and round, the two on each side placed near each other; the rostrum short, fleshy, apparently two-jointed, emitting from its apex a fine-pointed (certainly compound) black seta, which is the real instrument by which the plants are wounded. The whole body, legs, and wings of the insect are covered with a white powdery secretion, analogous to the white floccose matter of the Apple-blight *Aphis*, the white mass in which the eggs of various species of *Coccus* are enveloped, and which is developed in many other Homopterous insects; the wings are of moderate size, rounded at the tips, with a single central strong rib; when at rest they are placed over the back roof-wise, and the legs are rather short and simple.

On examining some of the infested leaves I found them covered with great numbers of flat bodies of extremely delicate texture, fringed with long, straight, slender hairs (having a good deal of the appearance of some small species of mites); their number was greatest on the lower leaves of the plants, and I counted not fewer than 250 upon a single leaf of moderate size. They are of an oval, flattened form, the margin being very thin; the fore half of the body is occupied by two portions, which shut close by a straight slit along the middle of the back, but are generally seen more or less opened like the doors of a cupboard. These bodies are the envelopes of the pupæ of the Aleyrodes, which have already made their escape in the winged state, but with them were mixed many much smaller specimens of the insect destitute of the fine hairs and very transparent, of a very flat, oval figure, the middle and hinder half of the body exhibiting traces of the abdominal segments, with the anal apparatus placed at some distance from the hinder extremity of the body; the rostrum, very minute and conical, is seen at some distance from the anterior extremity, and around are seen several pairs of tubercles, which seem to represent the eyes, antennæ, and legs, and which are seen much more clearly in Professor Burmeister's figures of the young of *Aleyrodes Chelidonii*.

The present species, although very closely resembling *A. Chelidonii*, differs from it in its smaller size, in having only 6-jointed antennæ, in the want of the dusky spot on each wing, in the more suddenly angled rib in the middle of the fore-wings, and especially in the long straight rigid hairs with which the body of the pupa case is defended, and within which the insect lies concealed for several days, unaffected by external agents (except heat and cold), which circumstance explains the cause of the sudden reappearance of the insect so soon after fumigation. In consequence of its being only hitherto known in greenhouses it may be specifically named *Aleyrodes vaporariorum*. . . . . .

J. O. Westwood.

Bibliography.

1856. Westwood. Gardeners' Chronicle, p. 852. Original description and illustrations.

1868. Signoret. Ann. de la Soc. Ent. de France, p. 387. Description.

1871. Packard. American Naturalist, Vol. 4, p. 686. Illustrated. Brief mention as attacking strawberry and tomato.

1880. Riley. Amer. Ent. (Vol. 3), n. s., Vol. I., p. 129. A brief account of Aleyrodes on Oxalis.

1889. Packard. Guide to the Study of Insects, 9th ed., p. 526. Brief account, p. 712. Fig. on Plate XIV. Found on Strawberry at Amherst, Mass.

1891. Bailey. Cornell Exp. Station, Bull. 28, p. 58. Brief mention as attacking tomatoes in greenhouse.

1890. Riley. Insect Life, Vol. II., p. 339. Mentioned.

1891. Riley. Insect Life, Vol. III., p. 394. Troublesome in greenhouses, England.

1891. Garman. Agr. Science, Vol. V., p. 264. Brief description. Same account in An. Rep., Kent. Exp. Sta., 1890., p. 37-38. Numerous on Strawberry at Lexington, Kent.

1892. Riley. Insect Life, Vol. V., 17. Found on Strawberry in Dist. of Columbia.

1893. Webster. Rep. Ohio Exp. Sta., p. xxxv. Very abundant on Strawberry, but no serious injury resulted.

1894. Davis. Insect Life, Vol. VII., p. 174. Brief description. Troublesome in greenhouses in Michigan.

1895. Britton. Conn. Exp. Sta. Rep., p. 203. Brief description and illustrations.

1896. Davis. Mich. Exp. Sta., Miscellaneous Bull.,* p. 22. Description and illustrations.

1897. Britton. Garden and Forest, Vol. X., p. 194. Brief account. Illustrated.

1900. Britton. Conn. Exp. Sta. Rep., p. 311. Fumigating with hydrocyanic acid gas.

1900. Quaintance. U. S. Div. of Ent., Tech. series No. 8, pp. 16 and 39. Distribution and key to the species.

1901. Slingerland. Cornell Exp. Sta., Bull. 190, p. 155. Attacking strawberries in New York. Illustrations from Davis.

* This was issued as Special Bull. 2, and bears the date of November, 1896. Later it was found that the bulletin numbers had been duplicated and this was changed to Miscellaneous Bulletin.

REMEDIES.

Fumigating.—Fumigating with tobacco is the remedy that has been oftenest recommended for this insect, but the fumes from the burning of ordinary stems or dust do not kill any considerable number of the insects. Many are stupefied by the fumes and fall from the plants, but revive later and soon become as active as ever. During the past two or three years tobacco used in this way seems to have been less effective in destroying the adults than when the writer first employed it eight years ago. Where the adults are stupefied and fall to the ground, a copious watering of the surface of the soil will kill them in great numbers.

Fumigating with hydrocyanic acid gas to kill the white-fly was here first given a trial in 1900 and an account of the experiment was published in the Report of this Station for 1900, page 311. Three ounces of potassium cyanide for each one thousand cubic feet of space were used, and the house closed for thirty minutes. All insects were killed, but the tomato plants were more or less injured. Our experiments as well as those of others indicate that the tomato is more susceptible to the effects of the gas than most plants, and care must therefore be taken in fumigating tomato houses. Several trials were then made with two and one-half ounces for each thousand cubic feet of space and the results were similar. Some of the tomato plants were injured, but the insects were killed in all cases. One house which was old and not very tight allowed some of the fumes to escape, so that the plants were uninjured though the insects were all killed.

Dr. J. Fisher used one ounce of cyanide for each one thousand cubic feet of space and killed all the insects without injury to the tomato plants.*

Spraying.—In 1895, the writer used whale-oil soap solution (1 lb. of soap to 5 gallons of water) in the form of a spray on the under surface of the leaves to kill the nymphs. The result was successful, but on account of the disagreeable odor of whale-oil soap, it was discarded. Fir-tree oil (one-half pint in two gallons of water) gave excellent results when the plants were thoroughly sprayed with the solution. The adults and

* Johnson, Fumigation Methods, p. 136.

nymphs which were moistened by the spray were killed. The cost of the material, however, makes the treatment an expensive one and precludes its use on a large scale. Fir-tree oil has a pleasant odor and is not objectionable to use in a greenhouse of ornamental plants or even in a dwelling.

A fine spray of kerosene and water (15 per cent. kerosene) was then applied to the tomato plants on sunny days, by means of a "kerowater" pump, with good results in killing the insects.

But kerosene, like whale-oil soap, has an unpleasant odor, and occasionally causes a slight injury to the foliage. Even when not at first apparent, the leaves in some instances took on later a brown or reddish color not indicative of health, and some of these finally dropped.

Early in 1901, we began spraying the tomato plants with common soap and water, dissolving one pound of soap in eight gallons of water. This seemed to be the best, all things considered, of any of the sprays. Not only was it effectual in killing all adults and nymphs with which it came in contact, but it was both inexpensive and inodorous, and at first did not appear to cause the slightest injury to the plants. The soap was cut in thin slices, then dissolved in hot water, and cold water added to make the right proportions. The plants received one application each week for about three months, when some of the leaves finally exhibited signs of injury.

As the plants had never been sprinkled with water from the hose, and had received frequent applications of soap, the leaves finally became coated over with soap to such an extent as to seriously interfere with the normal processes of respiration. The lower leaves in some cases shriveled and dropped. A few sprayings cause no injury, and probably none would be done in any case if the plants are sprinkled freely with water to remove the excess of soap.

The chief difficulty with sprays of any kind is that it is impossible to reach all places where the insects are located. Many leaves are curled so that the spray cannot reach the under side, and there are always portions of plants which do not, on account of location perhaps, receive a thorough treatment; this permits the escape of a sufficient number of adults, or of nymphs which soon change to adults, to keep the house infected.

Summary.

1. The white-fly has been the worst insect pest of tomatoes and cucumbers under glass at the Station during the past eight years. Many florists' plants are also injured, and the insect has attacked strawberry and many other plants out of doors in summer. It has been received from several growers in Connecticut, and is widely distributed over the northeastern United States. Its original home is unknown.

2. The white-fly is closely related to the scale-insects, and to the plant lice. It resembles the former in its immature stages, but differs from it in that both sexes are winged when reaching the adult stage.

3. It injures plants by sucking the sap, from the under sides of the leaves. The lower leaves are the first to shrivel and drop. Most of the injury is caused by the nymphs or immature insects.

4. The nymphs of the white-fly have been found upon fifty-eight different kinds of plants in Connecticut.

5. About five weeks are required for the white-fly to pass through its life-stages, all of which are found on the under sides of the leaves. Eggs hatch in eleven days, and the young nymphs crawl for a short time, when they become stationary and secrete wax in long filaments. When the adults emerge, the pupa skins remain attached to the leaves. It is not yet known whether the species can survive the winter unprotected in this climate, but it is carried over on plants in greenhouses and dwellings.

6. It is thought to be identical with the European species *A. vaporariorum* of Westwood, but this has not yet been fully determined.

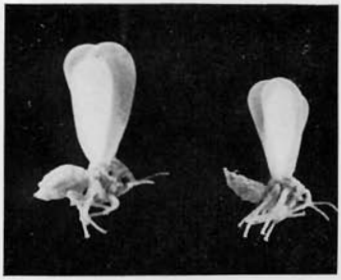
7. Fumigating with tobacco is not an effective remedy. Hydrocyanic acid gas (using two and one-half ounces of potassium cyanide for each one thousand cubic feet) killed the insects but injured tomato plants. Dr. Fisher used one ounce of cyanide and did not injure his plants, but killed all of the insects.

8. Spraying the under surfaces of the leaves with common laundry soap and water (one pound dissolved in eight gallons) proved to be a cheap and effective remedy. If applied frequently, however, the soap should be occasionally washed from the leaves by spraying them with clear water.

a. Nymphs: Enlarged about four times.

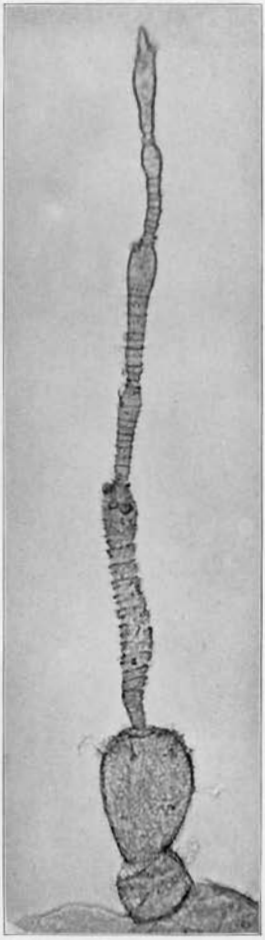
b. Adults and pupa skins. Enlarged four times.

THE WHITE-FLY ON TOBACCO LEAF.



a. Female and male : much enlarged.

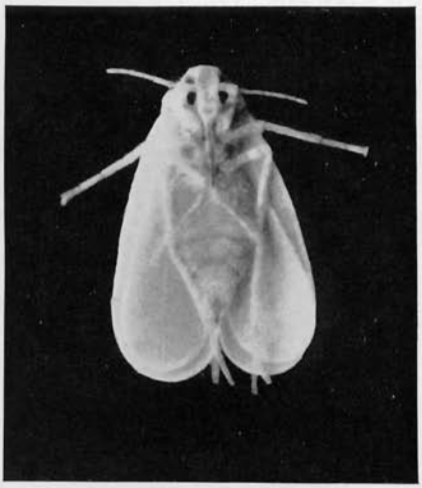
b. Nymphs and adults ; twice natural size.



c. Antenna, showing ring-like markings : much enlarged.

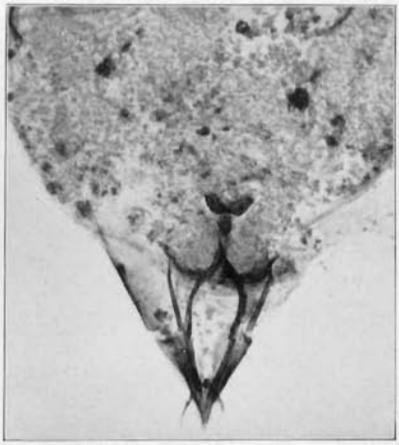
THE WHITE-FLY.

a. Egg, showing stalk : much enlarged.

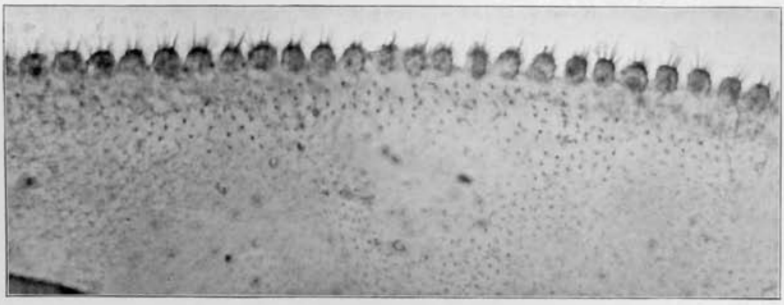


b. Adult female, ventral view, showing proboscis ; much enlarged.

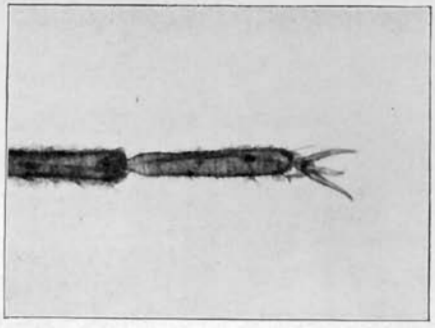
c. Genital organs of male : much enlarged.



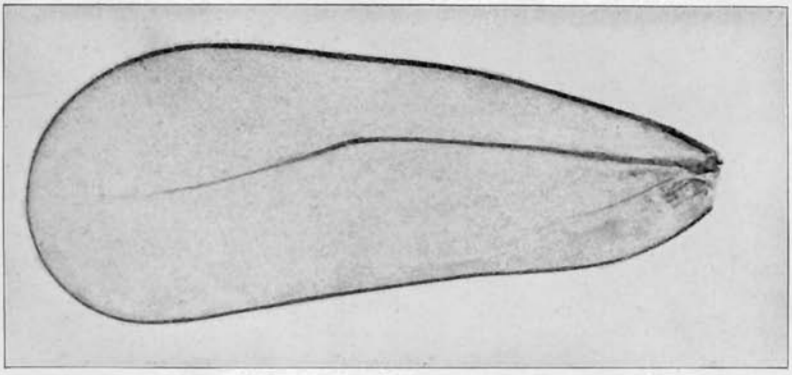
d. Ovipositor of female : much enlarged.



a. Edge of wing: much enlarged.



c. Foot: greatly enlarged.



b. Fore wing: greatly enlarged.

THE WHITE-FLY.