NOTES ON THE APHIDIDAE. (I.)

Observations on a Semi-aquatic Aphid, *Aphis aquaticus* n. sp.

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This species is a typical representative of the genus Aphis, and may be characterized as follows:

Winged viviparous female. Head broad, sparsely covered with hairs, two prominent hairs just above the median ocellus. Eyes black, prominent, the two lateral ocelli in proximity to the two compound eyes; ocular tubercle large. Antennae reaching slightly beyond thorax, joint I and II short, III nearly equal to IV and V taken together, slightly imbricated, the posterior margin bearing fifteen or more sensories. Joint IV slightly longer than V bearing three sensories and imbricated; V closely imbricated with two or three sensories near distal end; joint VI (including unguis or VII) longer than IV and V taken together; the unguis very long and slender, at the base of which is a group of six or seven sensories. Total length of antennae 1.6 mm.; length of I, 0.08 mm.; II, 0.08 mm.; III, 0.39 mm.; IV, 0.27 mm.; V, 0.23 mm.; VI, 0.14 mm.; VII, 0.46 mm. Beak stout, reaching third pair of coxae. Thorax well developed, the pro-thorax bearing a distinct lateral tubercle. Each thoracic segment has on the ventral side a pair of small wax glands. Wings long and narrow, with veins extending nearly to margin, the second branch of the cubital not occuring until near the end of that vein. Length of fore wing 3.1 mm.; width 1.1 mm.; length of hind wing 1.3 mm., width 0.5 mm. Legs long, slender, tibia provided with four more or less regular rows of long hairs. Femur and tibia covered with a fine pulverulence. Abdomen ovate, the second and eighth abdominal segments with distinct lateral tubercles above which is found a long bristle like hair. Honey-tubes 0.35 mm. long, nearly cylindrical or slightly vase-shaped. Cauda conical, provided with two pairs of long recurved hairs; outer margin serrated. Length 0.12 mm. Anal plate provided with six or eight pairs of long, curved hairs; outer margin of plate serrated. Color very variable, abdomen dark green, thorax lighter tinged with yellowish. Poorly fed individuals may be very light, while old specimens may be found of an almost uniform black color. Total length of body 1.95 mm. Wing expanse, 7 mm. Immature resembling adult except that the thoracic tubercle, wax glands and abdominal tubercles are much more prominent, while the cauda does not appear until the third molt.

Apterous viviparous female Head sparsely covered with hairs, eyes black, prominent. Antennae reaching nearly to the honey-tubes; joints I and II short, III but slightly longer than

IV which is imbricated, both being without sensories; V nearly as long as IV with one sensory near distal end; VI (including unguis) nearly as long as III, IV and V taken together, deeply imbricated. At the base of the unguis is a group of six or seven sensories as in the winged form. Total length of antennae 1.15 mm.; length of I, 0.06 mm.; II, 0.07 mm.; III, 0.22 mm.; IV, 0.18 mm.; V, 0.16 mm.; VI, 0.10 mm.; VII, 0.38 mm. Beak stout reaching third coxa. Thorax narrow, the pro-thorax bearing a lateral tubercle. On the sides of the thorax below the tubercle are three pairs of very distinct wax glands secreting a white flocculent material which covers the side and ventral portion of the thorax. Legs long and slender; tibia provided with four more or less regular rows of long hairs. Legs with the exception of the tarsus covered with a fine pulverulence. Abdomen large and swollen, the second and eighth abdominal segments with distinct lateral tubercles and bristles which project out above them. Honey-tubes slightly vase-shaped, 0.35 mm. long. Cauda 0.10 mm. long, which with the anal plate resemble the same structures in the winged form. Color, dark brownish or greenish black, but becoming a clear green under poor food conditions. Frequently forms will be found with three longitudinal black stripes down the abdomen. Older specimens may be nearly jet black in color. Total length of body, 2.10 mm.; width of abdomen 1.15 mm. Immature resembling adult but frequently lighter in color.

The circumstances which led to a special study of this form are as follows:

During the latter part of last September a number of aquaria at Ohio State University were partially filled with sediment and water plants of various kinds and set aside to wait the development of Protozoa and Hydra for class use. One large aquarium containing *Philotria canadensis* was placed just outside the window where it remained for some time until a thick growth of the *Philotria* developed, the tips of which projected slightly above the surface of the water.

On October 14 the aquarium was brought into the laboratory and great was my surprise to find the surface of the water and tips of the projecting *Philotria* covered with small black aphids which were apparently as much at home on the water as any other place. A careful search was made for a winged form which might have started the colony but none could be discovered. The only individuals present were dark brownish-black apterous females. At first I was led to believe that the presence of aphids on so strictly an aquatic plant as *Philotria* was purely accidental and that some chance migrant from an annual plant had fallen into the aquarium and having the ability to adapt itself to the new food plant at once began to reproduce. The off-spring

having nothing else to live on were forced to follow the example of the parent. However, after a detailed study of the adaptations of the insect to its semi-aquatic life I am convinced that it is a true semi-aquatic insect though not necessarily confined to *Philotria* but may feed on other aquatic plants. The colony was probably started by a winged migrant or by wingless forms brought in with *Philotria* or some other water plant.

The latter conclusion was strengthened by Mr. H. H. Severin, who reports that a similar aphid was very troublesome on aquatic plants in the green house at Wisconsin State University. Professor F. L. Landacre also says he has noted probably the same insect on various aquatic plants at Columbus several years ago. While doing some field work in Sandusky Bay a few years ago I noticed large colonies of aphids frequenting the lotus buds, but at present cannot say as to the identity of the two species.

One peculiarity which attracted my attention was the ease with which the aphids walked over the surface of the water, or were found half submerged in an attempt to feed on aquatic plants. An accurate examination of the forms showed that on either side of the thorax were located three pairs of wax glands. These glands resemble in all respects the thoracic or abdominal wax glands found in many other aphididae, but in every instance with which I am familiar the thoracic glands occur near a median dorsal line. Another fact which brings out this remarkable condition more forcibly is the relation of a small thoracic tubercle to the wax glands. In a great number of aphids a tubercle projects out from the sides of the thorax, but always below the wax glands when these are present. In this insect the glands lie below the tubercle and consequently on the ventral-lateral side. It is quite clear that this waxy secretion would be of the greatest value in keeping the insect from getting wet, as it not only projects out from the body, but is also powdered over the entire ventral portion of the thorax. While walking on the water this secretion is always in contact with the surface and serves as a float while the insect pushes itself along, moving quite as rapidly as on a dry surface.

In addition to this protection from the water the legs are covered with a fine pulverulence. This characteristic however is not at all peculiar to this species but is found on many other insects. On the sides of the seventh and eighth abdominal segments may always be found two tubercles directly above which small hair-like bristles project. These structures may be of value in determining the species. The number of sensories on the third joint of the antennae seem to be very inconstant, ranging from fourteen to eighteen. However, at the base of the unguis there is a fairly constant group of six or seven sensories both in the winged and wingless forms. The color cannot be relied upon as will be shown

later. In summing up the specific characters the three thoracic wax glands below the lateral tubercle, the two abdominal tubercles with their accompanying hairs, and the group of six or seven sensories at the base of the unguis ought to determine the species for the winged or wingless form.

A great deal of speculation has always existed as to the function of the honey-tubes. Repeatedly while observing the insect I noticed the honey-dew given off from the anal opening. A small drop of clear liquid would be extruded, and by means of the left foot the liquid would be thrown one or two inches. Therefore, in this particular instance I am quite certain the honey-dew is not extruded through the tubes. The honey-tubes always contain two structures. Running the entire length is a fine tube very much resembling a trachea. This could only be seen in freshly mounted specimens and could not be traced into the body of the insect. In addition to this the cavity of the honey-tube always contains a number of characteristic bodies, oval in shape, with clear centers. These bodies break down in certain mounting media and frequently form crystals. Since it is quite uncertain whether or not malphigian tubules exist, it is possible these bodies are the result of an excretory process. Both tubes and bodies have been observed by other workers, but I think as yet have not been explained.

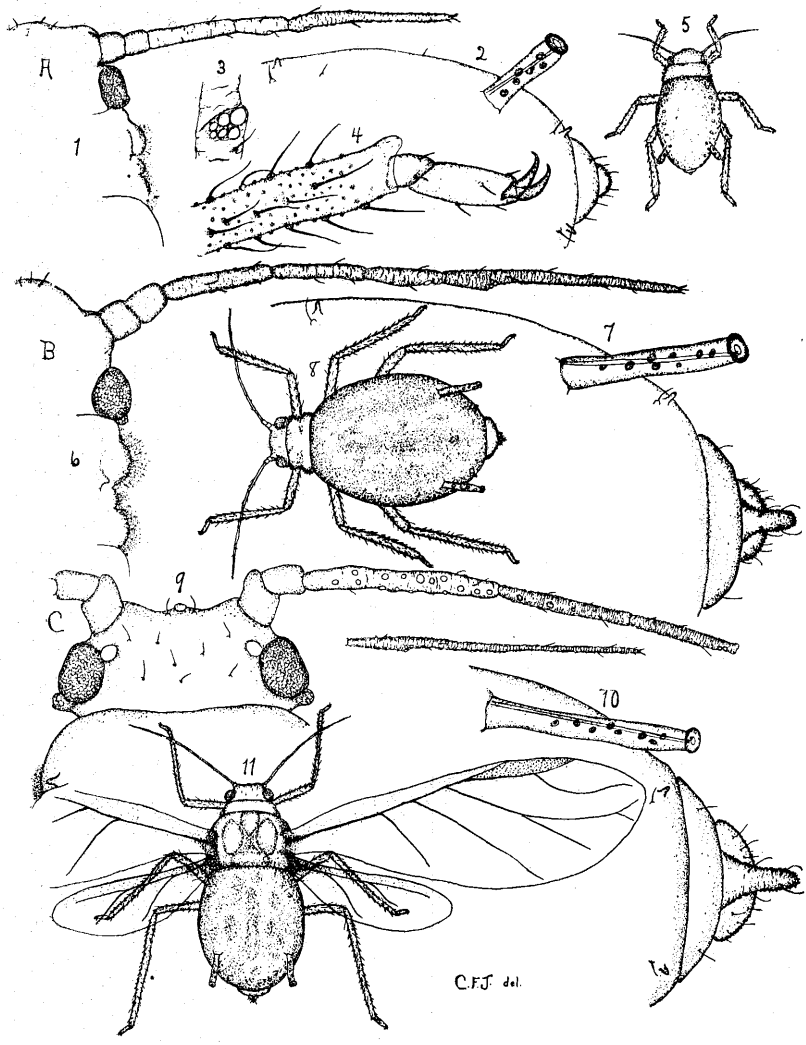
Two series of observations were carried on to determine the life history as well as the effect of food and other environmental changes on the species. The first set of observations was on the original colony which was not disturbed during the entire fall. As before stated when the aquarium was first brought into the laboratory it contained only wingless viviparous females or nymphs of the same. These were all very dark in color, varying from dark brownish black to nearly jet black. Being protected and in a warm room they multiplied at an enormous rate and in a few days every available leaf of the *Philotria* was occupied and soon began to die. No sooner had the food supply began to fail than a change was noted in the color of the aphids, especially the very young. In place of being dark in color they assumed a greenish tinge and before long individuals might be found of a light pea green color. In a short time nymphs of the winged form were noted which rapidly developed and either migrated to one of the other aquariums, or flew to the window to die in a few days from starvation. Four or five other aquaria were in the laboratory and contained *Philotria* which was soon covered with aphids after the first winged forms appeared. Strange to say no sexual forms could be discovered and that phase of their life history is yet unsolved. In a little over a week after the aquarium was brought into the laboratory it was nearly depleted of aphids owing to the lack of food. However, as soon as the

great number of aphids had died or migrated the *Philotria* began to grow again and soon furnished an abundance of food, the return of which was accompanied by the appearance of dark colored aphids. This cycle has been repeated about twice since the middle of October and has not been interfered with or controlled in the least.

In the second series of observations food and temperature were the best that could be provided. In order to have some uniform system of elimination (as all of the individuals of ten successive generations reared would amount to millions) the first individual of each brood was all that was kept. These invariably developed into dark, almost jet black apterous viviparous females. From observing this set of aphids the following points in the life history were noted: The insect requires about twelve days to reach maturity. The first molt occurs about fifty hours after birth; the second two hundred after birth; the third two hundred and thirty; and the fourth three hundred or about twelve days after birth, depending somewhat on the food conditions. For an hour or so before molting the insect crawls about seemingly seeking a dry place in which to molt, but returning at once to the food plant after molting. Immediately following the fourth molt the adult begins producing young which continues from ten to twelve days. This makes the entire life of the individual twenty to twenty-four days, although occasionally an aphid will live several days after it ceases reproducing. By the time the adult dies her young have begun to bear offspring. About five are brought forth every twenty-four hours. This makes fifty offspring for one individual, two thousand five hundred for the second generation and over six million for the fourth generation. This of course is only under the best food and climatic conditions. However, under normal, or even poor food conditions, at least twenty-five individuals from each female will reach maturity if not molested by parasites.

In summing up the effect of environment on the life cycle under the most favorable food conditions, dark, apterous, viviparous females constitute by far the majority of individuals produced, and it seems that the first offspring of a brood always develop into this form, although winged forms may be among the last offspring produced. Under poor food conditions but normal temperature by far the large majority of aphids are winged, the apterous individuals when present being very light in color or only showing faint markings of black. The character and number of the offspring under given conditions is practically the same in the winged or wingless forms, although probably more individuals are produced by the apterous female. Unfavorable food conditions do not call forth the sexual individuals and I

OHIO NATURALIST. *Plate XVII.*



JACKSON on "Notes of the Aphididae."

believe that their production is dependent on either climatic conditions or changes in the food plant. At present further experiments are being conducted along this line. So far as I am informed this species has never been described or the peculiar adaptations of its structure to its semi-aquatic life noted.

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NOTE.—Since this paper was written specimens have been received from Professor R. A. Harper, of Wisconsin State University which prove to be identical with this species. Professor Harper reports them very troublesome on a number of water plants in the University green house.

EXPLANATION OF PLATES.

A.—Nymph of apterous viviparous female before first molt.

Fig. 1. Dorsal outline of head and thorax, showing antennae, compound eye, thoracic tubercle, and the three thoracic wax glands. B. & L. 1 in.—$\frac{2}{3}$ in.

Fig. 2. Dorsal outline of the posterior region of abdomen showing honey-tube within which are small characteristic bodies and a fine tube which resmbles a trachea. Also the two abdominal tubercles, their accompanying hairs and the anal plate. B. & L. 1 in.—$\frac{2}{3}$ in.

Fig. 3. Sensory pits at base of unguis. B & L. 1 in.—$\frac{1}{6}$ in.

Fig. 4. Distal portion of tibia and tarsus, the former showing the regular arrangement of the long hairs, and also the pulverulent character of its surface. B. & L. 2 in.—$\frac{1}{6}$ in.

Fig. 5 Dorsal view of insect. B. & B. 2 in.—$\frac{2}{3}$ in. with lower lens removed.

B.—Drawings of the adult apterous viviparous female.

Fig. 6. Outline of head showing adult form of Fig. 1. B. & L. 1 in.—$\frac{2}{3}$ in.

Fig. 7. Outline of abdomen showing adult form of Fig. 2 with cauda developed. B. & L. 1 in.—$\frac{2}{3}$ in.

Fig. 8. Adult apterous viviparous female. B. & L. 2 in.—$\frac{2}{3}$ in. with lower lense removed.

C.—Drawing of adult winged vivipârous female.

Fig. 9. Outline of head showing ocelli and antennal sensories. B. & L. 1 in.—$\frac{2}{3}$ in.

Fig. 10. Abdomen of above. B. & L. 1 in.—$\frac{2}{3}$ in.

Fig. 11. Adult winged viviparous female. B. & L. 2 in.—$\frac{2}{3}$ in. with lower lense removed.

NOTE.—The above drawings were made with the use of the camera lucida at table distance. A Bausch and Lomb microscope was used with the combinations indicated.