LIFE-HISTORY OF SIPHANTA ACUTA (WALK.), THE LARGE GREEN PLANT-HOPPER.

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INTRODUCTION.

THE large green plant-hopper—*Siphanta acuta* (Walk.)—known in Hawaii, from its jumping-powers, as the "torpedo-bug," is probably, next to the cicadas, the most conspicuous homopterous insect in the Dominion. In this country it has not been studied, while elsewhere very little information has been recorded concerning its life-history and habits. Kirkaldy (1908, p. 161) mentions having partially studied the metamorphoses, and he gives a very clear drawing of the final nymphal instar, with a somewhat obscure one of the ova *in situ* (1907, pl. vi, figs. 17–20). Froggatt (*Australian Insects*, p. 359, no date) says that "its pale-green fluffy larvae feed upon the sap of many plants, and readily jump when touched."

ORIGIN AND DISTRIBUTION.

Siphanta acuta is one of the commonest fulgoroid Homoptera of New South Wales, and is found also in Queensland and Tasmania (Melichar). It has been introduced into Hawaii, where it feeds on guava, on *Acacia koa* and other trees, and on the coffee-plant, on which last it has become a pest of considerable importance. It was first recorded from New Zealand by Kirkaldy (1909, p. 81), who received specimens from Auckland. He suggested that it was probably introduced from Australia with the ornamental shrubs on which it feeds. The two centres of greatest abundance in this country are Nelson and Auckland, in both of which districts it is sometimes very common. It occurs at least as far north as Whangarei, and probably farther. In the more southerly portions of the North Island it is a rare insect.

SYNONYMY AND CLASSIFICATION.

Siphanta acuta was first described by Walker in 1850 from "New Holland," as a species of *Poeciloptera*. Kirkaldy in 1899 treated it as a new species, and erected for its reception a new genus, *Phalainesthes*. In 1902 it was correctly placed by Melichar in Stål's genus *Siphanta*. The synonymy therefore stands briefly as follows:—

Poeciloptera acuta Walk. 1850.
Phalainesthes schauinslandi Kirkaldy. 1899.
Siphanta acuta Melichar. 1902.

The genus *Siphanta* occurs throughout Australia, Tasmania, Java, St. Helena, and the Hawaiian Isles (introduced). It is placed in the family Flatidae, which consists of large-winged, often brightly coloured, moth-like forms, of which the introduced fireblight plant-hopper (*Sephena cinerea* Kirk.) is the only other representative in New Zealand. The Flatidae form one of the fourteen families into which the Fulgoroidea, a superfamily of the Auchenorrhynchous Homoptera, is divided.

LIFE-HISTORY.

The Egg.

Eggs have been found from December to February inclusive, and as late as the 25th May, but absence from the area where these plant-hoppers are numerous has prevented the record of definite dates. Eggs have been received at this laboratory during the above period, but the egg season may overlap at both ends. The eggs which were finally hatched and successfully reared were sent for identification by Mr. T. S. Skeates, of Auckland, all previous attempts at rearing having failed through ignorance of the exact conditions required. Once experience dictated the correct technique, further progress was much facilitated.

The eggs were found plentifully by the writer at Whangarei, glued to the leaves of lemons and of poor-man oranges. Each patch of eggs is roughly circular, with an average diameter of 6 millimetres and a greatest thickness of 1 millimetre, thinning at the sides to grade imperceptibly into the surface of the leaf. The eggs are packed fairly regularly, those nearer the centre being inclined more nearly to the vertical than those on the periphery, so that the whole egg-cushion is flatly dome-shaped. For about a sixth part of the circumference the sloping sides of the six or seven ova of the apparently last deposited row are fully visible. On the rest of the surface the mere tips of the eggs are seen embedded in the dark, semi-transparent material which glues them all into a solid cake, and fastens that cake to the leaf. The whole mass is surrounded by a thin, irregular edging of this adhesive substance, thus merging the outline of the dome into the surface of the leaf. The adhesive material projects in a reticulated pattern between the eggs, in places standing out as solid knobs and bumps. An examination of the underside of the egg-cushion shows that on five-sixths or so of the periphery, as indicated above, eighteen to twenty ova are arranged with their long axes parallel to the leaf-surface and their inner ends pointing towards the remaining sixth portion of the circumference, where the sloping row of seven to eight eggs evidently represents the last eggs laid. The centre of the under-surface of the mass consists of the very closely packed butts of those eggs which stand inclined nearer to the vertical though considerably far from it. Each egg-cushion contains approximately 90 to 110 eggs, the average length of each ovum being 1·2 millimetres.

First Instar.

The young, for some time after hatching, remain in a close group, squatting on and around the empty egg-cushion, which retains all its shape, though frequently a black fungus grows on the empty cases. These very young nymphs are, however, ready to hop with astonishing vigour at the smallest stimulus. Owing to the fact that the eggs of the brood which was eventually the only one reared with any success hatched in company with very young nymphs of uncertain age, in transit, it was not possible to isolate the first instar with absolute certainty. There is thus a very faint possibility that the instar described here is the second, our second the third, and so on; but the writer has every reason to believe, apart from absolute proof, that *all* the young nymphs isolated at the commencement of the rearing were really in their first stadium.

First instar (possibly second): Vertex elongate, tumescent. Pronotum laterally keeled, with indications of a longitudinal median keel which

continues down the mesonotum and metanotum. Mesonotum with a subparallel ridge on each side of disc. Segmentation of abdomen very pronounced; that of thorax indistinct dorsally. A bunch of white, waxy filaments on each side of sixth visible abdominal tergite, and a much longer tuft on each side of the extremity of the last apparent tergite, on each side of the anal segment. These filaments vary tremendously in length in different individuals (see below for a discussion of the use of these characteristic fulgorid appendages). Rostrum reaching almost to hind coxae. Frons elliptico-ovoid with a faint median longitudinal ridge. Colour very pale greenish-white, appendages transparent. Whole surface covered with fine white mealy powder, especially on the sides. The second and third visible abdominal terga with a triangular red spot at the middle of the cephalad border. A small roundish black spot at the caudal extremity of the lateral ridge on the disc of mesonotum—*i.e.*, on hind-border of mesonotum.

Length just before ecdysis, exclusive of caudal filaments, 2·4 mm.

Second Instar.

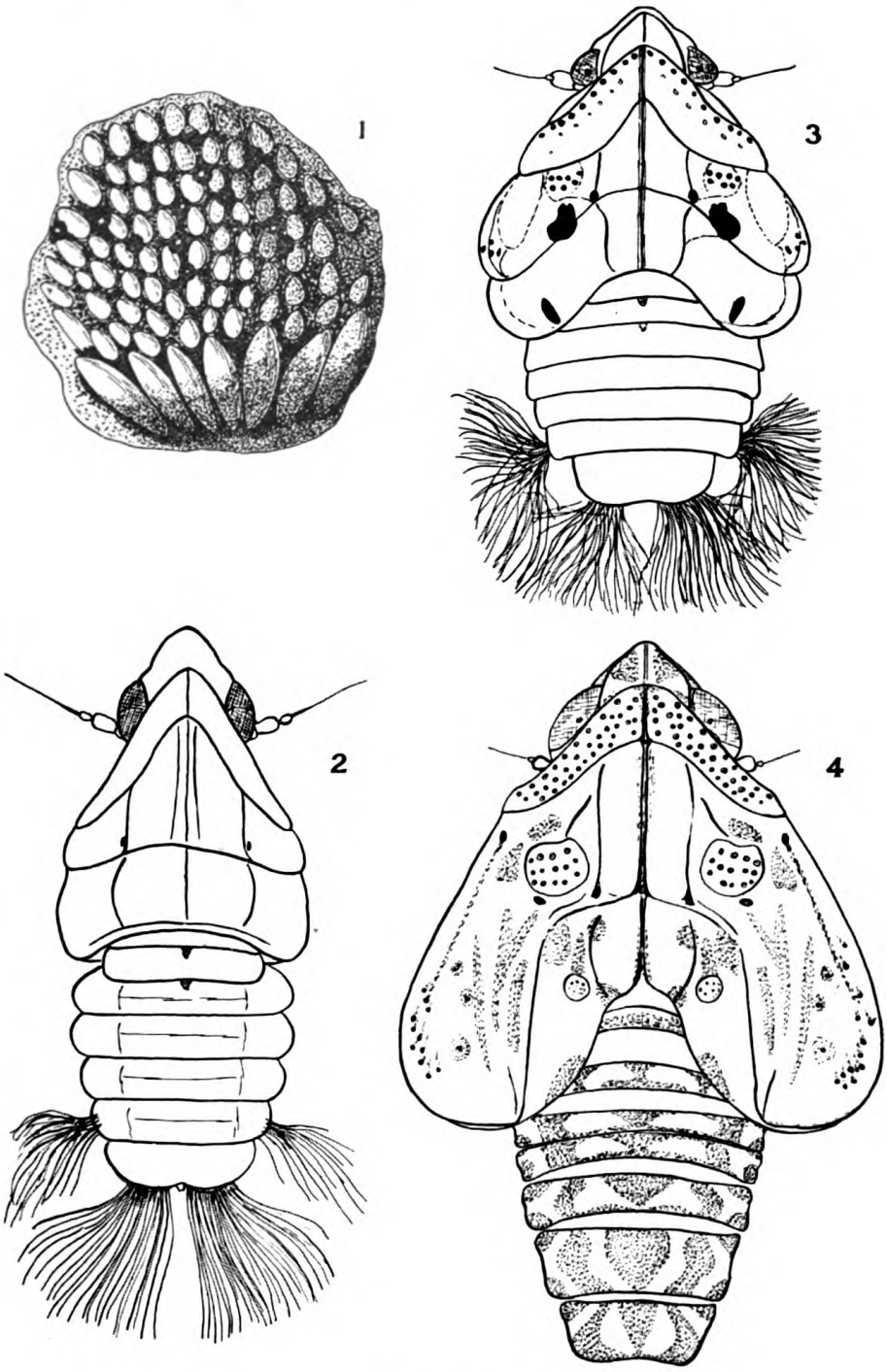
Head less produced, and slightly more tumescent. Median ridge of pronotum more distinct; disc having a tuberculate appearance owing to the number of specialized sensory organs. The apparent last abdominal segment very truncate but with a stronger growth of silky filaments. Rostrum reaching to and sometimes slightly beyond last coxae. Colour slightly more greenish. In addition to the spots in the first instar there is a black diffuse spot on each side of the disc of mesonotum lateral to the spots described above. There is a large and conspicuous oblong black spot almost at the apex of each posterior angle of the metanotum. Second joint of antenna more globose and larger in proportion.

Length, exclusive of caudal filaments, 3 mm.

Third Instar.

Whole insect much wider in proportion. Head not tumescent. Vertex flat, bordered by a keel, and bearing a median longitudinal keel. Second joint of antenna very much larger in proportion and swollen. Pronotum with the lateral keels very pronounced, meeting in front and diverging caudad, bordered by two parallel rows of the prominent cup-like sense-organs, about ten in front row and six in rear row on each side. Nota with a conspicuous median longitudinal bright-yellow ridge. A raised boss-like area on each side of disc of mesonotum has about six of the above-described sensory organs arranged in two rows. About eleven similar organs occur on the flat lateral expansions of the mesonotum. Colour pale green with less pruinosity than in the younger instars. Median streak of thorax bright yellow. Eyes whitish-transparent, with a black spot showing through. The six black spots of the second instar are present, much intensified and enlarged, especially the diffuse spots on the disc of mesonotum, which are now large, very clearly defined black blotches, like splashes of Indian ink; and in addition there is a clear black spot on each side of the anterior portion of mesonotum. The red spot on the second apparent abdominal tergum is intensified and very distinct; that on the third is, however, almost obsolete. The caudal filaments are tangled and very silky.

Length, excluding filaments, 3·6 mm.



Siphanta acuta.

FIG. 1.—Egg-cushion: dorsal view. × 7.
FIG. 2.—First instar nymph. × 28.
FIG. 3.—Third instar nymph. × 16.
FIG. 4.—Fifth instar. × 17. Caudal filaments omitted. Stippled areas red.

Fourth Instar.

Differs chiefly in colour from the preceding, but the following structural characters are either emphasized or different. Vertex depressed, with the thickened fore-border forming a rim. Prominences of pronotum (special sensory organs—Kirkaldy) very distinct. Pronotum sides almost parallel for some distance, but diverging finally caudad; a strong central longitudinal ridge. Mesonotum with the lateral granulated sensory area on each side sharply defined like a rounded superposed plaque; about a dozen sensory cups on each plaque; a prominent median longitudinal ridge; a longitudinal ridge on each side ending in distinct black spot and separating the granulated plaque on each side from the central ridge. Tegmen-sheaths reaching farther caudad and distinctly overlapping the wing-sheaths. Filaments as in preceding instar. Rostrum reaching slightly beyond hind coxae. Colour yellowish-green marked with red. Vertex with a large pinkish red spot on each side of disc; posterior portion of raised lateral border also reddish. Frons with a row of pinkish granulations down each side. Pronotum with the sensory organs ringed with red; the central ridge yellowish, except cephalad, where it is reddish. Mesonotum with the sensory cups, a few smudges on the tegmen-sheaths, and the cephalad terminations of the three discal longitudinal ridges reddish; a large jet-black spot on the posterior border immediately caudad of each granulated plaque, and a black dot at the caudal end of each discal lateral ridge; disc of mesonotum, between the two plaques, strongly suffused with canary-yellow. Metanotum tinged with yellowish; a curved ridge on each side of disc, two large diffuse spots lateral to this ridge on each side, and a small portion of the posterior border reddish; a jet-black spot on the inner posterior border of each wing-pad. Abdomen pale-greenish; a median longitudinal band, a small and a larger lateral splash, and most of the posterior margin of each segment red. Legs pinkish, the distal spines of hind tibia and hind basitarsus tipped with fuscous passing into black.

Length, excluding filaments, 4 mm.

This instar undergoes a gradual but very striking change about half-way through the stadium, before ecdysis into next instar. The red markings, though still visible under magnification as distinct areas, fade to an even paler (less yellowish) green than the rest of the body, so that to the naked eye the insect changes from red to pale green. The only red spots left are those primary ones (mere inconspicuous specks) possessed also by the previous instar. All the red which belongs peculiarly to the present instar is lost. This change is very gradual, taking about a fortnight under laboratory conditions (in one instance thirteen days). At the same time the abdomen elongates considerably, becoming frequently as long as head and nota together. This elongation occurs in all instars prior to ecdysis.

Fifth Instar.

Vertex shovel-shaped, depressed, with a raised rim. Pronotum with the sensory cups pinkish with black centres; central longitudinal ridge very distinct. Longitudinal ridge of mesonotum also very distinct; two curved lateral ridges lined with pink and followed by the round plaques containing apparently about fourteen sensory cups. Metanotum with a similar central longitudinal ridge, and a lateral one on each side followed by a red, slightly raised disc. The seven unmodified dorsal sclerites of

abdomen are apt to be separated by a space of intersegmental membrane, rather narrower than the sclerites themselves. Rostrum reaching slightly beyond hind coxae. Colour in the main reddish, owing to the large number of crowded pinkish markings, arranged as follows: Ground-colour greenish-white. Vertex with a pinkish spot on each side. Pronotum suffused with pink, especially fore-border. Tegminal pads with numerous longitudinal red stripes often terminating in distinct black dots as shown in the figure. Every dorsal sclerite of abdomen has a median triangular reddish patch with apex caudad, and a curved longitudinal band running from fore to hind border on each side. Segmental margins tend to be reddish. Two obscurely outlined reddish spots on the extreme edge of each tergite. Eyes greenish. Antennae pale-pinkish, flagella tipped with fuscous. Ventrally very pale greenish, except the frons, which is edged with reddish; the legs, which are suffused and edged with pink (spines black); and the tegmen and wing-pads, which project like a carapace and are thus visible from beneath. Caudal filaments shorter in proportion than in previous instars, and shining with a slight golden tinge. The lateral filaments of abdomen are small tufts.

Length, exclusive of filaments, 5 mm. Greatest width, 3·75 mm.

For some days (usually about three) after ecdysis the fifth instar is greenish without any tinge of red. The black spots of the nota and alar pads, and to a less extent the sensory cups of the pronotum, are alone conspicuous. Some of the more distinct red stripes of the fully coloured nymph are represented by pale-yellowish on the green ground-colour, while the median ridge of the nota is also yellowish, but still quite faint. The red colour is gained very slowly, the nymph being fully pink on about the fifth day after ecdysis, but not acquiring the maximum intensity of redness until the seventh or eighth day. Thereafter a very gradual further change takes place, once more to green—a green uniform and more vivid than that immediately after ecdysis. At the same time the abdomen lengthens and appears swollen, as the fifth instar nymph prepares for the final ecdysis.

Imago.

As there are no other species of the genus *Siphanta* in New Zealand so far recorded, the large green plant-hopper can be easily distinguished by its size (1 in. wing-expanse), very vivid green colour, triangular, broadly truncate tegmina or forewings, pink eyes, and pointed head. In repose the tegmina completely cover the body like the sides of a sloping roof. It would needlessly increase the length of this paper to give a full technical description of the imago.

Ecdysis.

A close examination of the process of ecdysis, or casting of the skin, is rewarded by the discovery of several peculiar features. As the time for ecdysis approaches the nymph's abdomen elongates and appears somewhat swollen, while in the fourth and fifth instars the colour changes from red to green. In the fifth instar also the alar pads become somewhat separated, partially exposing the hindwing pads beneath those of the tegmina. The insect becomes sluggish, leaves the stem which is its constant feeding-place and clings tenaciously to a leaf, usually the under-surface. From this position it refuses to stir at any stimulus whatever, evincing, indeed, when forced, considerable difficulty in loosening its hold. The actual emergence, for which these preparations take some time, occurs usually at night or early morning. The rupture of the old cuticle takes

place along the mid-dorsal line from the posterior of the metanotum cephalad to the frons, which is left intact, although the transverse split extends along each side of it between frons and eyes, to about half-way along the latter. The imprisoned nymph (or imago, as the case may be) appears and gradually disengages head and thorax. The motive force is not, however, apparent. There is much swelling and contracting alternately, each swell pushing back an almost infinitesimal portion of the slough, and it appears that these movements of the abdomen—which, as we have seen, swells and elongates before the commencement of ecdysis —are probably the sole force in extricating the nymph from the exuviae. It is almost analogous to the case of the Diptera; but here we have a whole abdomen acting the part of a ptilinum. The very tip of the abdomen is disengaged before the last claws are free, and the legs are packed fairly closely out of the way, beneath the body. In the case of the emergence of a fifth from a fourth instar, the newly-emerged fifth instar is a shining green, with no trace of the future pruinosity, and with a swollen, parallel-sided abdomen, longer, if anything, than the head and nota together. The points and spots which will eventually be red are visible at this early stage as paler areas, which seem to differ structurally —in fact, they appear possibly to represent points of muscle attachment to the exoskeleton. The abdomen commences to shrink almost immediately, and later is a very inconspicuous portion of the body. Filaments begin to appear about two hours after ecdysis, both caudally and laterally, but most conspicuously on the apparent penultimate segment.

Summary of Life-history.

The shortest period under autumn and winter laboratory conditions from egg to imago was eighty-five days, but I am satisfied that the conditions are so unnatural that this gives no criterion whatever of the length of the life-cycle in nature. These specimens were reared late in the season, on a strange food-plant, four hundred miles south of the region where the eggs were laid. The points of interest in this life-history are the intrastadial colour changes of the fourth and fifth instars (in the latter case a double change), and the method of extrication from the exuviae at ecdysis.

HABITS.

Although the younger instars frequently feed on the leaves the older instars invariably prefer the stem. Third, fourth, and fifth instars, when the spray of food plant is kept vertical, invariably keep an upright position on the stem itself, with their long axis parallel to that of the branch. They are very inactive, sitting for hours with their beaks applied to the stem. Occasionally an abdomen commences to vibrate — the vibrations pass gradually into an up-and-down thrashing—and at the moment of greatest amplitude of the movement, on the summit of an up-stroke, a perfectly spherical bead of honeydew, almost as big as the width of the abdomen at its tip, is exuded, and rapidly jerked away between the tufts of filaments which lie on each side of the anal extremity, and which are parted for the purpose. The younger instars are less forcible in this process, and frequently show a bead of honeydew held by the caudal filaments long after it has left the body. The honeydew is a dark bluish-green, sweetish, transparent liquid, which speedily grows a black fungus if allowed to accumulate on the floor of the breeding-vessel. Its colour may be due to a similar peculiarity in the sap of the food plant (in this case *Coprosma retusa*).

All the nymphs have a peculiar habit of swaying rhythmically from side to side—either when stationary or during the act of walking slowly. This movement, which swings the whole body clear of the surface, has been noted also in aradid nymphs, and is quite distinct from the abdominal wavings which accompany the ejection of honeydew.

The fifth instar nymphs can jump as far as 2 ft. The adult plant-hopper, if it jumps at all, almost always spreads its wings while in the air.

The older nymphs are often surrounded by a mealy halo of white pruinose material from the filaments, which are easily detachable. The formation of such circles, between which and the body itself of the insect is always a clear space, would be best explained by the supposition that the nymphs move round frequently without changing to a like extent the position of the rostrum. As mentioned above, the filaments are easily detachable, and yet I have seen a nymph carrying for as long as a day the recently cast skin entangled in these waxy tufts. This white waxy material forming the filaments is widespread throughout the Homoptera, but especially in Coccidae and Fulgoroidea. The filaments, if accidentally rubbed off, are soon replaced. Their function is problematical. It has been suggested that the mealy matter is protective. In other genera masses of it are used to envelop the eggs on deposition, while a species of *Myndus* in North America, according to Osborn, in the nymphal stadia lives below ground in crevices lined by the filamentous material from the abdominal tufts (Swezey).

The favourite food of this species in the north of this Island seems to be citrus-trees of various kinds, while in Nelson the ornamental shrubs of the gardens are favoured.

ENEMIES.

The eggs are parasitized in Hawaii by a minute hymenopteron, *Aphanomerus pusillus*. This egg-parasite, or a closely allied one, was emerging in large numbers from ova at Whangarei on the 25th May, when unhatched eggs, a very few nymphs of all ages, and one or two adult plant-hoppers were also observed. The steel-blue ladybird (*Orcus chalybeus*), which so efficiently keeps the northern citrus-orchards free from scale, devours the egg cushions wholesale—at least, when placed in contact with them in the orchard.

TECHNIQUE.

The nymphs were found to thrive in *closed* Petri dishes or large, wide tubes, in which the food plant finally selected on account of its succulence —*Coprosma retusa*—kept fresh for a week or more. When necessary the hoppers could be picked up, isolated, or transferred with a camel's-hair brush, from the point of which they apparently found it impossible to leap.

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