

STUDIES ON *Oliarus atkinsoni* Myers
(HEM. CIXIIDAE), VECTOR OF THE
"YELLOW-LEAF" DISEASE OF
Phormium tenax Forst.

I.—HABITS AND ENVIRONMENT, WITH A NOTE ON
NATURAL ENEMIES

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Summary

The habits and environment of the various stages in the life-cycle of *Oliarus atkinsoni* as studied at the Phormium Research Station, Paiaka, are described. Some information on natural enemies, which include spiders, a chelifer, a centipede, an entomophagous fungus, and possibly a bacterial disease, is appended.

INTRODUCTION

Experimental transmission work, commenced in 1949, incriminated *O. atkinsoni* as a vector of the yellow-leaf disease of *Phormium* (Cumber, 1952). The study of the life history of the bug has since been undertaken.

HABITS AND ENVIRONMENT OF *O. atkinsoni*

The Adult Stage

In the Paiaka area, the adults first appear on the upper portions of the *Phormium* bushes about mid-November, although some individuals may be present at the base of the plant for a fortnight before this date. They continue to be found up to mid-March. The appearance of adults in considerable numbers quite suddenly at the start of the flight season may be due in part to a favourable change in the weather, which brings forth those adults which have been sheltering among the leaf bases.

The number of adults increases rapidly as the season progresses, and in some areas it is not uncommon to see as many as thirty upon a single *Phormium* blade. They may be present upon either the upper or lower surfaces, although the lower surface appears to be preferred, and they feed anywhere from the basal sheathing portion to the tip. There does not appear to be any special preference for the blades of any definite age or, when feeding on bushes affected with the yellow-leaf disease, to select a green blade instead of a considerably yellowed one. In wet or windy weather, the adults seek the sheltered portions of the bushes.

Adults have been observed in copulation on the blades, where they lie adjacent to each other and facing in opposite directions. As a prelude to copulation, the male bug takes up position alongside and

level with the female and facing in the same direction (usually upwards). This lining-up often involves more than one male, and occasionally two males are seen on each side of the female, the five lying in a straight line across the blade. In areas where *Oliarus oppositus* Walk. and *O. atkinsoni* are both present on the *Phormium*, it has been observed that this preliminary lining-up may involve two individuals of different species, but copulation between two species has not been observed.

On yellowed leaves, the adults, which are a light powdery-grey, are easily discerned, although some measure of protection is afforded them if the blade is spotted with fungus patches or insect damage. When, however, they rest upon the grey bloom-covered ventral surface of a healthy blade, they are difficult to see.

When disturbed, the insect dodges around to the opposite side of the leaf or leaps into the air and takes wing for a short distance, but flights of more than six to eight feet are rarely seen. The insect appears to be able to withdraw its sucking mouthparts with great speed, due, no doubt, to the relative shallowness of the conducting vessels in the blade. The same speed could scarcely be visualized for nymphs feeding on primary roots, when penetration of the cortical zone and endoderm before entering the vascular tissue may involve 3 mm. to 4 mm. of tissue. Such urgency for withdrawal of mouthparts obviously is not necessary during the protected nymphal stages.

Short flights of about a foot without the usual leap into the air have been observed during hot weather, when bugs may fly from blade to blade.

During very wet weather, few adults are to be found upon the plants, for they take shelter amongst the dead basal material. Whether or not they disperse far from the plant on which they have fed as nymphs has yet to be shown, but during windy weather it would appear probable that some dispersal may occur.

The nocturnal habits of the bug have not been studied. The greatest numbers seem to appear on the upper portions of the bushes shortly after midday, at which time copulation is commonly observed.

About four days after the emergence of the adult, i.e., shortly after its first excursions to the aerial portions of the plant, the female recommences production of the white mealy substance which is produced during the nymphal stages. In the male adult, however, this substance is absent. There does not appear to be any obvious use for further secretion of this kind, whereas it still has a very real function to perform in the female. For about two weeks following her emergence, the pad of mealy substance increases in size, but never reaches the relative proportions obtained in the nymphal stages. The secreting segments (three posterior abdominal) are re-orientated so that the secreting surfaces are directed posteriorly.

Adults which have emerged from fifth instar nymphs in captivity have been kept alive on potted *Phormium* plants for four weeks. During

this period, only one batch of eggs per female was laid, although there was a regrowth of mealy substance following oviposition.

Oviposition

After an adult existence of approximately two weeks, the female is ready to lay her eggs, and for this purpose retires to the base of the plant. During these two weeks, she has accumulated a large pad of mealy substance, and her abdomen has become distended so that the yellow intersegmental membranes appear as stripes between the grey segments. She seeks out a dry spot between the leaf bases and there deposits her eggs (Fig. 1).



FIG. 1.—Leaf bases of a fan which has died following the previous harvesting. A blade has been removed to expose the white fluffy egg masses seen at extreme left. Nymphs about to emerge as adults often congregate between the leaf bases of dead fans.

Normally, insects belonging to this group implant their eggs within the tissues of the host plant. In *O. atkinsoni*, however, the rudimentary ovipositor could not perform such a task. However, adequate protection of eggs is provided for by the mealy fluff.

In preparation for the oviposition, a circular patch of the mealy substance is prepared upon the substrate. The spines of the hind legs (especially those on the tibiae and tarsi) are used to dislodge and tease out the fluff pad attached to the female. Soon oviposition commences, fifty to ninety ovoid eggs being placed amongst the fluff and held in position by more material, which is removed from each side of the pad and placed in position by the hind legs, oviposition and teasing-out of the mealy substance thus continuing together. The egg mass measures about 1 cm. in diameter.

The Nymphal Stages

The fluffy material surrounding the egg mass does not hinder the exit of the first instar nymphs, which push their way out some twelve weeks after the eggs are laid.

Sometimes, especially when the vicinity of the egg mass has become damp owing to falling vegetation and increase in cover by plants, etc., the nymphs remain in the vicinity of their egg mass for several months. Under such conditions, it often seems that they do not have access to rootlets of *Phormium* or to rootlets of other plants, and just what constitutes their source of nourishment at this stage is obscure. It is possible that their requirements are not very great at this stage owing to their relative inactivity during the winter months. Swezey (1907), describing the life-history of *Oliarus koana* Kirkaldy, expressed the

opinion that nourishment was probably obtained from the juice of decaying organic matter and from roots. In *O. atkinsoni*, the majority of the nymphs, especially from the second instar onwards (with the exception of the fifth instar nymphs just prior to emergence as adults), are to be found in the vicinity of living roots and rootlets on which they feed.

The growth habit of *Phormium* is such that the base of the plant tends to grow upwards or along the ground in typical monocotyledonous habit. As the plant grows, the new leaves and roots spring from a progressively higher level and trail a thick rhizome of fleshy storage tissue, which remains surrounded by the leaf-base remnants and decaying organic matter of previous years. Under conditions of periodical winter flooding, there is less tendency for plants to become perched on vertical rhizomes, for the decay of the basal material removes support. When drier conditions occur, however, large portions of the rhizome may remain vertical and sheathed with old leaf bases of previous seasons' growth. Through this dead basal material the roots, which arise from the level of the higher more recently dead leaves, pass on their way to the soil beneath. It is in this region that the nymphs soon take up their abode and form what may be termed "galleries."

The nymphal stages occupy the greater part of the two-year life-cycle. From the earliest stages, the nymphs produce copious quantities of a fine, filamentous, fluffy, white material which issues dorso-posteriorly from the three posterior abdominal segments, and projects upwards in tufts. This material is produced rapidly, and if removed may once more exceed the length of the nymph in a day or two. Consequently, it is continually being rubbed off on the walls of the material in which the nymphs shelter, and soon comes to line them, forming galleries. In well-established galleries, the walls are pure white, as though lined with fine fungal hyphae or webbing, and in some of the narrower recesses the nymphs may be found hidden among the strands of the substance. This material not only seals off the galleries from the predatory insects, spiders, and centipedes, etc., but also imparts a waterproofing to the walls, for it possesses great water-repelling properties.

Although the growth habit of the healthy plant provides that in the main only the thick unbranched primary roots are to be found in the immediate vicinity of the rhizome, often finer rootlets of some adjacent *Phormium* plant or fan make their way into the material and provide a suitable feeding source for the smaller nymphs.

One of the characteristics of plants affected with the yellow-leaf disease is that the branching of the primary roots commences at a much higher level or earlier stage than in the normal healthy plant, and this results in great numbers of fine roots ramifying through the dead basal material, which circumstance is most favourable for the successful development of the earlier nymphal stages. The older nymphs, however, favour thicker primary roots, and perhaps they are essential for the successful development of the bug.

It is possible that the galleries established about the base of the healthy plant may be responsible for dieback of roots, which sometimes appears to be extensive. Quite often, the new primary roots cease growth abruptly on entering the galleries (Fig. 2) and die back, leaving

a pale yellow gummy secretion which becomes a mass of tangled fungal hyphae in which innumerable nematodes are to be found. Transverse sections of the older primary roots which pass through the galleries occupied by the fifth instar nymphs show numerous feeding puncture traces of the nymphs radiating outwards from the central conducting elements through the cortex. These puncture traces appear to be sealed



FIG. 2.—Primary roots may cease growing abruptly on entering the nymphal galleries, where they blacken and die back (see arrows). A typical congregation of nymphs about to emerge as adults is shown where the old blade has been opened out on the left side of the picture.

off from the cortical cells through which they pass, and provide an excellent means of access to inner tissues for fungi. Many of these traces are soon invaded by secondary organisms, which spread longitudinally in the cortical zone, causing widespread decomposition. Such damage, however, does not appear to continue into the rhizome.

Emergence of the Adult

Towards the end of October, the fifth instar nymphs become noticeably more distended, and produce the mealy substance very copiously.

The eyes, which had remained relatively inconspicuous, now show a more general pigmentation. About this time, the nymphs forsake the deeper secluded galleries, which subsequently become covered with moulds, and climb upwards to take up new quarters in preparation for the final moult. It is probable that feeding during these last nymphal stages is not of importance, for often the new abode is a short distance from the plant. The nymphs form little fluffy nests in any of the drier material surrounding the base of the plant, and also between the still green sheaths of the blades which are in the process of dying. Nymphs are often found singly between the adjacent dead *Carex* blades, or in groups in the folds of old dry *Phormium* leaf. Particularly favoured are the fans which have dried following the previous harvesting of leaf (Fig. 1). The old fan consists of leaf bases, and often remains intact, nymphs congregating in considerable numbers between the leaf bases. These new galleries, in which the fluffy material forms a mass rather than a coating of the walls, protect both the nymph and the newly emerged adult during the hardening of the cuticle. When such galleries are opened, the occupants lie partly hidden by the fluffy material.

At the commencement of the moult, a split appears in the nymphal skin along the mid-dorsal thoracic region. The adult gradually emerges, being a light cream colour except for the strongly contrasting black eyes. The period from the first appearance of the split up to the emergence of the adult from the nymphal skin (except perhaps for the abdominal extremity, which rests in the old skin for a while) occupies approximately one hour. Soon the wings commence unfolding, and about two hours later are fully extended. At this stage, the adult is still very pale, and an approach to full pigmentation (black for the most part) is not seen for a further 24 hours.

Feeding does not recommence till three to four days after the final moult. It is probable that there is a relatively immobile period prior to moulting during which no food is taken. On 19th November, 1951, eleven adult bugs which had emerged that day were placed in a glass tube which contained leaves of a *Phormium* seedling, the roots of which had access to water. Adult feeding was not observed until 23rd November, 1951, a careful watch having been maintained in the intervening period. It is reasonable to expect such a period without feeding following each moult, for the feeding apparatus has to regain rigidity.

NATURAL ENEMIES

Predators

In the nymphal stages, especially during the period prior to the emergence of the adult, when nymphs leave their deep-seated galleries and seek the upper and drier portions of the basal material, several species of spiders, a chelifer, and a small centipede species have been observed feeding on the nymphs. In the adult stage, species of spiders which spin colonial webs in the *Phormium* bushes make *O. atkinsoni* one of their chief sources of food.

Discases

Both in the field and particularly in captivity, what may be a fungal or bacterial disease of nymphs occurs. Death is followed by a bloating and finally a general blackening.

Adults of *O. atkinsoni* and *O. oppositus* are also attacked by an entomophagous fungus. They are overcome by the disease while resting upon the *Phormium* blades and may be observed adhering to the substrate by a fluid or mixture of fluid and hyphae which has exuded from between the abdominal segments. The fungus appears externally, thrusting its aerial portions through in the regions of sutures and intersegmental membranes. If the insect is broken open at this stage, there is a central space with a light brown tinge to the hyphal material, due to spore formation.

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