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CRANEFLY LARVAE (DIPTERA: TIPULIDAE) LIVING IN JELLY MASSES

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Abstract.—The immature stages of the cranefly, *Limonia (Geranomyia) vitiella* Alexander, are found mostly on the leaves of *Pandanus* in moist habitats in the rain forest on the island of Viti Levu, Fiji. The larva lives within a tube of jelly on the upper leaf surface, emerging to feed on decaying and dead epiphylls, and associated microbes. When mature, it usually moves to the lower leaf surface where a larger mass of jelly is produced, within which it pupates. The jelly protects the immature stages against desiccation, and natural enemies. The species occurred patchily in both space and time.

Working in the forests of Guiana, Hingston (1932:342–3) found the 'pupa' (correctly pharate adult (Stewart and Pritchard, 1982)) of a cranefly (*Geranomyia*) suspended inside a globule of transparent jelly attached near the tip of a palm leaf. He noted that "its appearance was that of a large drop of water about to fall from the end of the palm leaf." The species was later described by Edwards (1934) as *Limonia (Geranomyia) gelatifex*, which is now considered to be a synonym of *Limonia (G.) recondita* Alexander (Alexander and Alexander, 1970). Hinton (1973) considered that the 'pupa' in its envelope of hygroscopic mucoprotein undoubtedly mimicked a drop of water. More recently, Grimaldi and Young (1992) found a *Geranomyia* sp. larva in a mass of jelly below a tree leaf in an old coffee plantation in Costa Rica. They bred a female adult, but were unable to identify it to species. They also briefly described and figured the larval head capsule.

Working in Fiji a few years ago, we found transparent masses of jelly somewhat resembling very large raindrops attached to pandanus leaves in the rain forest near Suva on the main island of Viti Levu. The majority of these jelly masses contained larvae or 'pupae' of a cranefly. Adults were bred, and identified by A. M. Hutson as *Limonia (Geranomyia) vitiella* Alexander. The species was previously known only from male and female type specimens also collected near Suva (Alexander, 1956), and is endemic to Fiji. Nothing is recorded of its habits. We report here some preliminary observations on the biology of the species made intermittently over the period 1984–1989.

OBSERVATIONS

The species was first found in humid valleys near streams in the rain forest near Wailoku, 10 km North of Suva (18°04′S, 178°26′E), and later at Colo-i-Suva a few km away (18°03′S, 178°28′E), and at Nabukavesi Creek (18°08′S, 178°13′E) in similar sites. Most larvae and 'pupae' were collected on the leaves of *Pandanus vitiensis*

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Table 1. Occurrence of immature stages of *Limonia* (*Geranomyia*) *vitiella* on upper and lower surfaces of *Pandanus* leaves.

	No. on *Pandanus* leaf	
	Upper surface	Lower surface
Larva Instars 1–3	11	0
Larva Instar 4	18	4
Pupa	0	2
Pharate adult	2	8

Martelli (Smith, 1979). Portions of these leaves were cut and brought back to the laboratory for observation, and to rear the immature stages. Leaf sections were kept in closed plastic boxes or in large plastic bags to avoid desiccation. Despite many attempts, rearing of the younger larvae proved difficult, and survival through more than two larval instars was not obtained. Final instar larvae, pupae and pharate adults could be reared through to the emergence of the nonpharate adult stage with fewer problems.

The majority of larvae were found on the upper surface (Table 1) of mature leaves of *P. vitiensis* which had a fairly thick growth of epiphylls (bryophytes and algae), rarely on younger leaves. The older larvae could usually be picked out by the jelly mass around them, but younger larvae were often concealed among the epiphylls. Field-collected pupae and pharate adults were more often found on the lower surface of the leaf (Table 1). The difference between larvae and pupae/pharate adults in the leaf surface selected is highly significant ($\chi^2 = 17.6$, $P < 0.001$). In the laboratory, no difference was found between upper and lower surfaces as a pupation site, possibly because of the lack of air movement in the containers in which the larvae were kept. Very occasionally, larvae occurred on the leaves of other (unidentified) species of angiosperm. One larva was found on the frond of a fern, and two hanging in jelly below a twig of *Piper* sp. overhanging a stream. Normally only one larva was found within a single jelly mass, but occasionally two were found at somewhat different stages of development (Fig. 1), one having presumably entered a jelly mass already available. No antagonistic interactions between the larvae were observed in this situation.

In all larval instars, the body normally has a covering of a transparent hygroscopic jelly-like substance, probably a mixture of mucoproteins, and thought to be secreted by the salivary glands. The covering of the early instar larvae is thin, and when they are kept in a saturated atmosphere, may apparently be absent. A thicker jelly covering is found in later instars, but a large jelly mass is made only by the mature larva before pupation. If the leaf becomes dry, the jelly is evident as a transparent tube around the larva. In such conditions, the larva becomes inert within the tube, but seems to be fairly resistant to desiccation. If provided with water, it revives and moves around again within a few minutes.

A larva may remain in one place for several days, apparently feeding around the ends of the tube, but more usually the larvae move around, particularly at night, to feed on the decaying and dead tissues of the epiphylls on the leaf surface, and on the microbial flora found there and on the leaf surface. Like most tipulid larvae

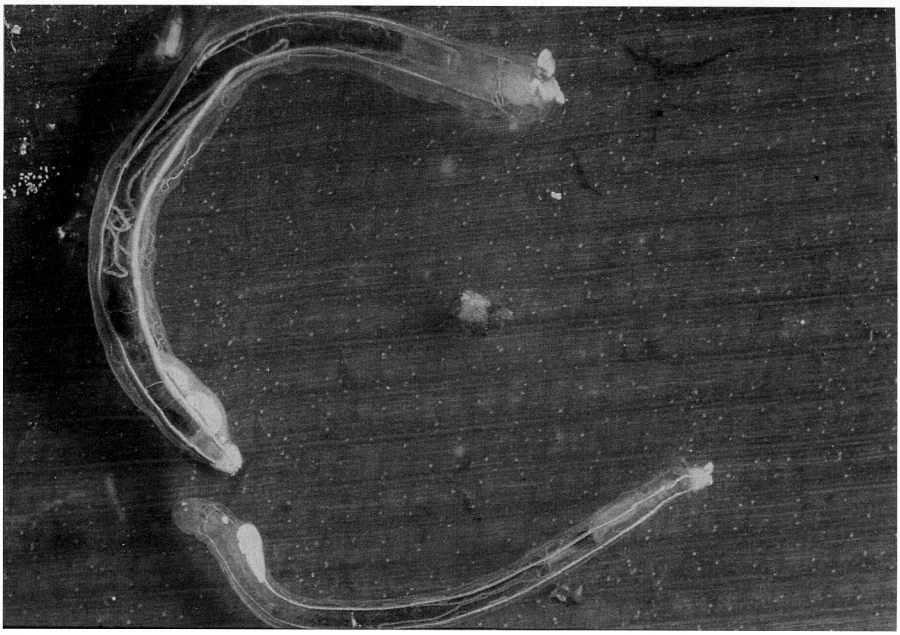

Fig. 1. Two larvae of *Limonia (Geranomyia) vitiella* at different stages of development within the same jelly mass on a leaf of *Pandanus vitiensis*.

(Pritchard, 1983), the larvae are saprophagous, and were not observed to eat the healthy tissues of either the epiphylls or the pandanus leaf. The only potential natural enemy observed was a dolichopodid larva (Diptera) among the epiphylls and detritus near the midrib of a *Pandanus* leaf.

The larva can respire in its jelly covering using the hind pair of spiracles. These normally remain at the air-jelly interphase allowing air to enter the tracheal system, but can be withdrawn from the surface if the larva is disturbed. The tracheae in the thoracic region are pink in colour, and the tracheal system is visible through the transparent tissues of the body wall, as are the gut and malpighian tubules (Fig. 1).

When fully grown, the larva usually moves to the underside of the leaf. It voids its gut, and then produces around itself a larger, thicker and more viscous mass of jelly measuring 1.0–1.5 cm across and 0.5–0.7 cm in thickness. The total length of larval life is not known. Larvae lived up to 3 weeks in the laboratory, during which time only one moult was observed. The larva spends less than one day as a pharate pupa before moulting the last larval skin, which remains in the jelly, to become a pharate adult within the pupal cuticle. The pharate adult stage is also very brief, no more than 2–3 days. The pharate adult is greenish in colour. It respires through prothoracic respiratory horns, which open at the surface of the jelly. It is fairly mobile within the jelly and can wriggle vigorously if disturbed. The nonpharate adult pushes its way partly out of the jelly before emerging from the pupal skin. Equal numbers of male and female adults (14:14) were bred.

In the laboratory, the adults fed on a dilute sugar solution, and may perhaps feed

on nectar or sugary exudates on plant surfaces in the field as do some other Limoninae (Pritchard, 1983). It was not possible to mate the fragile adults in the laboratory. Eggs have not been found, but are presumably laid among the epiphylls on the *Pandanus* leaves. The maximum length of life of a female adult in the laboratory was 6 days.

DISCUSSION

The species seems to be largely confined in its breeding sites to areas of *Pandanus* growing near the sides of streams in narrow, steep-sided valleys within the rain forest. In this situation, the humidity can remain high enough for the cranefly to complete its life cycle. However, *L.(G.) vitiella* is patchy in its occurrence in both time and space. During dry periods, it appeared to become locally extinct, and presumably recolonized from mountainous areas further from the coast with a more regular rainfall. However, it was absent from many apparently suitable sites even during prolonged wet weather. The localities where we found the species are presumably sink habitats unable to maintain viable populations without immigration from nearby source habitats (Pulliam, 1988; Holt, 1993). Human interference may also restrict its occurrence on a local scale. The mature leaves of *Pandanus* which form its main breeding site are often cut by the local Fijians for making mats of various kinds.

The larvae of *Geranomyia* are mostly aquatic, living in silken tubes, from which they can emerge to feed on exposed surfaces (Alexander and Malloch, 1920; Oldroyd, 1964). The larva of *L.(G.) vitiella* is far more terrestrial in its habits. It has to remain on the exposed upper surface of the leaf because that is where its food is. Epiphylls do not grow on the lower surface. Tipulid larvae are generally very susceptible to desiccation (Pritchard, 1983), and the jelly around the larva clearly helps to protect it from drying out. It is also protected by the epiphylls, which retain water longer than the bare leaf surface, and provide a microhabitat that stays humid provided that rain is not too infrequent. At this stage, the larva can still move away from dry conditions, at least over distances of a few cm. It was noted that larvae tended to move into the groove along the midrib of the leaf. This groove accumulates detritus falling from the trees above, and remains moist longer than other parts of the leaf. The inability of the pupa and pharate adult to move to moister areas probably explains the move of the mature larva to the lower side of the leaf, and the production of a much larger and thicker jelly mass. Below the leaf, they are better protected from the desiccating effect of the sun. The jelly mass also provides protection from predators and parasitoids. The jelly provides a physical barrier to attack, and the greenish pharate adult may also be less visible within it (Grimaldi and Young, 1992). Hinton's (1973) suggestion that the 'pupa' mimics a raindrop—which presumes natural selection of individuals that produce jelly masses more closely resembling raindrops—seems improbable. The resemblance is likely to be fortultous. Besides the records given above, jelly production is known to occur in one mycophagous species of *Limonia* (Grimaldi and Young, 1992), and these authors suggest that production may be widespread in limoniine tipulids, although in small quantities. Outside the family Tipulidae, Smith (1989) notes the larva of a mycetophilid (?*Epicypta* sp.) which lives under a jelly-like 'blob' on rotten wood.

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