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SHORT COMMUNICATIONS

A NOTE ON PHOTOTACTIC BEHAVIOR AND ON PHORETIC ASSOCIATIONS IN LARVAE OF *MECISTOGASTER ORNATA* RAMBUR FROM NORTHERN COSTA RICA (ZYGOPTERA: PSEUDOSTIGMATIDAE)

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A larva was found covered with algae on the dorsal side of the head, thorax, abdomen and caudal gills. The larvae showed a phototactic behavior, using the caudal gills to follow a gradient of light, which also corresponded to a gradient of oxygen. Larval Chironomidae were found between the wing cases and over the algae of the gills. Relationships between odonates and chironomids are discussed.

INTRODUCTION

The neotropical family Pseudostigmatidae is represented in Costa Rica by three genera: *Mecistogaster* (3 species), *Megaloprepus* (1 species) and *Pseudostigma* (2 species). The three species of *Mecistogaster* are: *M. modesta, M. linearis* and *M. ornata* (CALVERT, 1917; PAULSON, 1982; STOUT, 1983). Commonly referred to as "helicopter damselflies" they are among the largest living insects and the largest Odonata. *Mecistogaster* contains the smallest species in the family while the type genus, *Pseudostigma,* has the largest species in Costa Rica. The larvae of *Mecistogaster* have been reported from epiphytic tank bromeliads (CALVERT, 1917; MAY, 1979; CORBET, 1983), tree cavities (MAY, 1979; MACHADO & MARTINEZ, 1982; CORBET, 1983; FINCKE, 1984), and even sugarcane stalks (L.K. Gloyd *in* STOUT, 1983) but they are rarely found. Published observations on living larvae are very scarce (CALVERT, 1911, 1917; FINCKE, 1984, 1992).

We found larvae of *Mecistogaster ornata* living in tree holes of fallen trees on

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the Pacific slope of Volcán Orosi, in northwestern Costa Rica. The collection site was located at 550 m.a.s.l. in a forested transitional area between the semi-deciduous dry forest of low elevations and the mostly evergreen volcano slopes. In this transition zone we find "rainforest" type conditions, but with a prolonged (3 to 4 months) nearly rainless dry season (JANZEN, 1986; de la Rosa, unpublished). Adult *Mecistogaster* were found flying along animal and human trails, stream corridors, and in sunny gaps left by tree falls. They seem more abundant in this area from July through October, although they have been collected at other times as well (Dr G. Pritchard, pers. comm.).

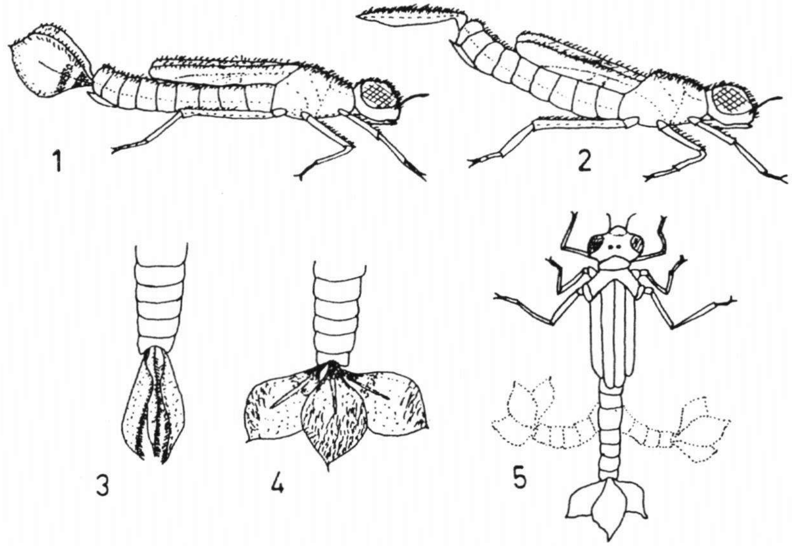
The larvae referred to in this paper were found in the water-filled folds along the trunk of a fallen tree, containing masses of leaves and other organic matter. Each of the two largest holes contained approximately 2 liters of water. Also collected from these holes were intermediate instars of *Megaloprepus caeruleatus*, two intermediate instars of *Orthemis ferruginea*, and Chironomidae and Culicidae larvae. The falling of the tree created a gap in the canopy which allowed sunlight to reach the surface of the holes for a few hours a day. Throughout the dry season (December through April) the holes are dry. Filamentous algae grow abundantly inside these holes during the wet season and cover the sides of the holes and the surfaces of leaves and other detritus closest to the surface. Temperature in the holes range from 23 to 26°C during the day. Periodically the contents of the holes are disturbed by coatimundis (*Nasua narica*), monkeys and other animals, presumably looking for insects or other food within.

This paper reports on behavioral observations supplementing those made by FINCKE (1984, 1992), on the first algal association with Pseudostigmatidae larvae, and the first observation of phoretic chironomids recorded for *Mecistogaster ornata*.

RESULTS AND DISCUSSION

PHOTOTACTIC BEHAVIOR

On 8 July 1991 we collected one teneral adult with its larval exuviae near one of the tree holes. The exuviae showed a heavy algal growth (a layer of up to 1 mm thick) on one surface of each of the caudal gills. The head, thorax, abdomen and legs of the exuviae were also covered with algae on their dorsal portions (Fig. 1). On the same day we collected from the same tree hole two more live Pseudostigmatidae larvae: a final instar *M. ornata* and an intermediate instar *M. caeruleatus*, identified by the presence of a white mark on the tip of each caudal gill characteristic of this species (FINCKE, 1984). They were placed in a container in the laboratory with some organic material collected from the tree hole and stream water. The *M. ornata* larva was also covered with a growth of algae, including one surface of each of the three caudal gills. The *M. caeruleatus* larva had only a scant growth of algae mostly on the dorsal portions of the head, thorax and legs, with no algae growing on the caudal gills. Both larvae, at rest, lay on the bottom of the pan, partially under leaves, with all three gills positioned horizontally along the axis of the body (Fig. 1). Occasionally the larvae would shake the gills laterally several times, creating small current of water around them.



Figs 1-5. *Mecistogaster ornata* Rambur, various aspects of larval biology and behavior: (1) larva at rest, lateral view, showing algal growth over dorsal portions of head, thorax, abdomen, legs and on caudal gills; – (2) larva, lateral view, with the gills exposed to light; – (3) caudal gills, dorsal view, at rest; – (4) ditto, when exposed to light; – (5) lateral "search" movements, performed by larvae when light was moved to another section of the container.

For better observation we placed the live larvae in the container under a dissecting microscope. When the strong light of the fiber optic illuminator hit the *M. ornata* larva, it opened the three caudal gills and placed them with the flat side horizontal against the surface of the water (Fig. 2) effectively exposing to the light all three algae-covered surface of the gills (all three gills had algae growing only on one side, and this side was the one exposed to the light source, Figs 3-4). We moved the light spot to another area of the container, and the larva, after performing several lateral movements of the exposed gills (bending laterally the abdomen and making nearly 180° turns of the gill complex, Fig. 5), followed a straight path leading with the opened gills, towards the light, and again positioned the gills in the area where the light was strongest. We repeated this procedure several times with similar results. The *M. caeruleatus* larva did not react this way to the light, remaining hidden under the leaves, or swimming around the pad with undulating movements typical of the genus (FINCKE, 1992).

The tree holes where these larvae were found were choked with organic matter and relatively warm, so one would expect low oxygen concentrations during most of the day and night, but when sunlight hits the hole, photosynthesis by filamentous algae could increase local concentrations of oxygen.

The *Mecistogaster* behavior pattern suggests that the algae-covered larva is following a light gradient and thereby placing itself and positioning its gills in the higher oxygen concentrations found when the light hits the algae within the tree hole, including the algae growing on the larva surface.

PHORETIC ASSOCIATES

The larval exuviae and the large living larva of *Mecistogaster* were both found to carry chironomid larvae. The exuviae, found outside the hole near the teneral adult, had 8 Orthocladiinae larvae and 1 Tanypodinae larva still attached to the caudal gill surfaces, within the algal growth. The orthoclad larvae could have been using the algae for food (examination of their gut content revealed small amounts of mixed detritus, some of which could have been fragments of filamentous algae), as a site of attachment, or for transportation. The tanypod larva, typically predatory when larger, was probably a second instar and did not have any food in its gut. It is likely that these associations were accidental, as were those reported by CORBET (1962), ROSENBERG (1972) and WHITE & FOX (1979) and a consequence of a limited locomotion of the terminal instar *Mecistogaster* and the small size of the habitat, which would increase the likelihood of the larvae coming into contact with the odonate.

The live *Mecistogaster* larva had one final instar *Polypedilum* sp. (Chironomini) living inside a tube built between the odonate's left wing pads. There were other larvae of *Polypedilum* in other areas of the tree holes inside similar tubes built within the detritus or on the sides of the holes. The bright red chironomid had built the tube out of fine debris and algal strands, and it performed typical Chironomini undulating movements within the tube. These movements create a strong water current through the tube to aid respiration (BRYCE & HOBART, 1972) and filter feeding activities (OLIVER, 1971). Zygopteran larvae exchange gases, especially oxygen, through the body integument (PENNAK, 1978) including the wing pads in low-oxygen situations. One of the first reactions of zygopteran larvae to low oxygen levels is to open or separate the wing pads, thereby increasing the surface area exposed for gas exchange (CORBET, 1962). The presence of a chironomid in this location could benefit the odonate in creating a water current past the wing pad area thus aiding oxygen exchange. Gut content examination of *Polypedilum* larva revealed a mixed amount of detritus, fungal hyphae, algae, and insect parts (typically collector/filter feeder food). It is possible that the *Polypedilum* larva located itself within the wing pads by accident, as suggested by CORBET (1962) for *Simulium* (Diptera, Simuliidae) on *Zygonyx* (Libellulidae). *Polypedilum* larvae, when taken out of their tubes, rapidly seek other shelter, which may include a motionless larva of *Mecistogaster*. *Polypedilum* has also been reported as phoretic on other Odonata, in particular *Zygonyx iris* (Libellulidae) (DUDGEON, 1989). He suggested that *Polypedilum*, a collector, could be feeding on the detritus accumulated within the odonate wing pads but that the benefits of associating with a higher predator in a community (specially one in a confined habitat such as a tree hole) could enhance the survival of the chironomids and thus maintain the phoretic relationship. Odonates, specially late instars, have been reported to carry chironomids, other Diptera, and even Trichoptera as phoretic associates (CORBET, 1962; DUDGEON, 1989; ROSENBERG, 1972; WHITE & FOX, 1979). In most cases the phoretic associates have been found on other substrates near the odonate as well. Given that both Anisoptera and Zygoptera final instars spend long times motionless on their preferred substrates it is likely that this habit would account in itself for most of the phoretic associations found in nature. Nevertheless, there are advantages in associating with a top predator (BENEDICT & FISHER, 1972; GOTCEITAS & MACKAY, 1980; STEFFAN, 1967; WHITE & FOX, 1979; WHITE et al, 1980; WIENS et al, 1975; TRACY & HAZELWOOD, 1983; SVENSON, 1976; FURNISH et al, 1981; HILSENHOFF, 1968; DE LA ROSA, 1992), and these can not be discounted. The tolerance of *Mecistogaster* larvae to colonization by these chironomids would also encourage these phoretic relationships to develop.

The small still-water habitat of a tree hole and the species that live within it are amenable to experimentation to resolve some of these questions.

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