

**TERRESTRIAL LARVAE OF ODONATA FROM NEW CALEDONIA
(ZYGOPTERA: MEGAPODAGRIONIDAE; ANISOPTERA:
SYNTHEMISTIDAE)**

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Received September 9, 1982 / Revised and Accepted April 27, 1983

The terrestrial damselfly larva from New Caledonia described by LIPPITT WILLEY (1955, *Psyche* 62: 137-144) is identified as *Caledargiolestes uniseriis* (Ris), and the larval habitat is described. Larvae of *Synthemis miranda* Selys and of an undescribed *Synthemis* species have been reared from similar terrestrial and semi-terrestrial habitats. Larvae previously identified by supposition as *C. uniseriis* and *S. miranda* prove not to be those species.

INTRODUCTION

LIPPITT WILLEY (1955) described from New Caledonia a unique specimen of a damselfly larva found amongst material extracted from soil and litter samples collected at hillside sites remote from any stream or standing water. Basing her views on its morphology and the habitat from which it was collected, she ascribed to the larva a terrestrial or burrowing mode of life. The larva was conjectured to be one of the four megapodagrionid species then known from New Caledonia. No further specimens were known when LIEFTINCK (1975, 1976) revised the New Caledonian Odonata.

The identity of the terrestrial damselfly larva is not the sole outstanding problem in the New Caledonia Odonata, and in yet other respects our knowledge of the odonate larval stages is deficient. LIEFTINCK (1975) identified 40 adult taxa from the island, but only 22 larval taxa were represented in the material he examined, and only in one instance had an adult been preserved with its larval exuviae (LIEFTINCK, 1976). Other incongruities in the Synthemistidae are particularly intriguing. Although only six *Synthemis* species

have been described from New Caledonia, LIEFTINCK (1976) recognised at least seven, and possibly eight, larval synthemistid taxa within his material. He considered it noteworthy that two major limnological expeditions had collected abundant *Synthemis fenella* Campion larvae whereas the more robust larvae of the other six or seven synthemistid taxa were each represented by only one or two specimens.

In November-December 1981, and in November 1982, a series of larvae, matching that described by LIPPITT WILLEY 1955, was collected from several New Caledonian locations, and observations on the larval habitat and behaviour are here presented. Similar observations are included on the larvae of two synthemistid taxa which were found with the zygopteran larvae. The distinctive habitats involved may shed some light on the question why so few larvae of the larger synthemistid species have been collected in the past.

LARVAL HABITAT

Zygopteran larvae, matching that described by LIPPITT WILLEY (1955), were found together with larvae of two synthemistid taxa at three hillside sites alongside a stream which crosses Route Territoriale 5, 1 km southeast of Col d'Amieu (21°40' 165°50'E). Each site was within the dense shade of rainforest 400-500 m upstream from the road. A female *Caledargiolestes uniseries* (Ris) ovipositing onto bare rock drew attention to site 1, a steep rockface moistened by a spring-fed hillside seepage. Shallow pockets of water collected in diagonal fracture lines across the rockface, and dead leaves were strewn across the surface which otherwise lacked vegetation. Site 2 was a spring-fed seepage over rock and soil supporting a well developed understorey of small trees, shrubs and ferns. At each of these sites, synthemistid larvae were found partly or completely immersed in pockets of water under leaves but the zygopteran larvae were usually clinging to the underside of moist leaves, or on moist rockfaces, and I found none in the water pockets.

The greatest number of synthemistid larvae was found amongst moist leaf litter at site 3, the bed of a small gully or rain channel at an altitude of about 380 m. At this altitude, rain can be expected at any time in New Caledonia, and a saturated atmosphere probably pertains within the leaf litter throughout the year. Site 3 is not spring-fed, it depends on direct rainfall for its moisture, and its limited catchment ensures that any flow is ephemeral. When the site was revisited on 8 November 1982 during heavy rain which had persisted overnight, there was no obvious flow in the catchment. Larvae at site 3 were located by washing leaf litter in a 3 mm mesh net and sorting the residue in water in a white tray. To quantify the larval distribution, one sample representing all of the leaf litter from an estimated 0.1 m² was examined separately, yielding 13 synthemistid larvae with headwidths from 1.2 mm to 6.2 mm, and 2 of the zygopteran larvae. The coarse

mesh might have failed to retain small larvae; only two synthemistids of the smallest size were taken.

Sites 1-3 combined yielded 41 larvae and 12 final-instar exuviae of the zygopteran species, 39 larvae corresponding to the unidentified synthemistid species C of LIEFTINCK (1976), and one larva matching his unidentified species B male. It is not known which of three sites yielded the species B larva.

Two more of the zygopteran larvae were collected from the undersurface of moist leaves in a small spring-fed seepage (site 4) on the banks of the Thi River in Forêt de Thi (22° 11'S 166° 32'E). This seepage is on the edge of rainforest but the situation is more exposed than sites 1-3. No evidence of burrowing by any of the species was found at the four sites.

REARING EXPERIMENTS

Ten of the final-instar (F-0) zygopteran larvae collected in 1981 were placed together in a covered glass aquarium. A few dead leaves in a thin film of water were included for cover, and leafless twigs were propped up as emergence supports. Live arthropods extracted from leaf litter were offered as food. The larvae spaced themselves on the bottom of the tank, on the underside of leaves, or on the emergence supports both in and out of the water film, and also wandered up and across the vertical sides of the aquarium. On a horizontal surface they raised the body from the ground and walked with the caudal lamellae angled away from the substrate. Three of them, all males, metamorphosed to the adult in December 1981, enabling the identification of the species as *C. uniseries*. One male and three females were reared from the larvae collected in 1982.

Larvae of *C. uniseries* were never observed to swim; they only crawled about their containers. Penultimate and earlier instar larvae, kept in shallow, water-filled containers, captured and ate aquatic insects given to them as food, mainly larvae of the mosquito *Opifex fuscus* Hutton.

Two early instar larvae taken in 1982 were kept for 17 weeks in 55 mm high, 47 mm diameter transparent plastic pots containing water to a depth of about 10 mm. A small square of synthetic mesh was provided on the bottom of each pot for the larvae to cling to. These larvae ate the mosquito larvae they were given as food, but were as frequently out of the water as in it, either on the sides of the containers, or underneath the opaque plastic lids. The two larvae were transferred later to containers identical to those previously used but with about 10 mm of plaster of Paris in the bottom. The plaster of Paris was kept moist to maintain a saturated atmosphere in the container, and a square of synthetic mesh was placed on the moist surface. The larvae were fed small arthropods, mainly mites, extracted from leaf litter, and were given vestigial-winged *Drosophila melanogaster* occasionally. During a period of 5 weeks, the larvae were not once seen on the sides or lids of their containers.

Sixteen of the species C final-instar larvae taken in 1981 were placed in water about 10 mm deep in individual containers, each with a stick as an emergence support. They were fed tubificid worms and various aquatic insect larvae, mainly mosquitoes. In water, they used rectal propulsion to move when disturbed. They left the water freely, particularly at night. Those seen climbing and descending the emergence supports did so awkwardly, sidling crabwise. A pharate male, which failed to emerge completely on 7 December 1981, was dissected from its exuviae to identify the species as *Synthemis miranda* Selys. Nine *S. miranda* females completed emergence, between 19 December 1981 and 23 March 1982. The remaining final-instar larvae, 4 females and 2 males, died.

Penultimate and earlier instar larvae of *S. miranda*, collected on 5 December 1981, left the water and their containers as readily as F-0 larvae when supports were available. Only three of these larvae survived to emerge as adults; two taken in instar F-1, and the other in instar F-3. They moulted to instar F-0 in March, May, and August 1982 respectively, and emerged as adults, all females, within 15 days of each other between 21 January and 4 February 1983. These three larvae were denied the opportunity to leave the water for most of their time in captivity. Emergence supports were placed in their containers some weeks before they were expected to emerge, but none of these insects, conditioned to a fully aquatic existence, was observed out of water until the day of transformation to the adult. All 12 *S. miranda* females were of the one colour form, their wings coloured to near the level of the arculus, or a little beyond it.

The species B synthemistid larva was treated in the same way as the other final-instar synthemistids. It was less active and was never seen to leave the water until the adult male emerged on 26 February 1982. This proved to be an undescribed species in the *Synthemis montaguei/campioni* facies. All of the synthemistid adults emerged after dark and before dawn, but their transformation was not witnessed.

Voucher specimens of *C. uniseriis* and *S. miranda*, with their exuviae, have been deposited with the Bishop Museum, Honolulu, Hawaii, and the Australian National Insect Collection, C.S.I.R.O., Canberra, Australia. The specimen of the new species of *Synthemis* and its exuviae will be lodged in the British Museum (Natural History), London.

DISCUSSION

Some slight confusion exists within the accepted definitions of the terms "terrestrial" and "aquatic". Several dictionaries, the *Concise Oxford English Dictionary* for example, define "terrestrial" as "living on the ground, as opposed to aquatic, arboreal, or aerial", but introduce conflict by interpreting "aquatic" as "growing or living in or near water". For my purposes, I accept "aquatic" only as growing or living in water, but even with this definition, there remains ambiguity in deciding whether some larval Odonata are terrestrial, semi-terrestrial, semi-aquatic, aquatic, or amphibious.

Normally-aquatic larvae in a number of species of Odonata are known to

make forays out of water, particularly, but not exclusively, in the few days before emergence (CORBET, 1962). At least one New Caledonian species may be in this category. Over a period of 14 weeks before it emerged I observed a final-instar larva of the megapodagrionid *Caledopteryx sarasini* (Ris) out of water frequently, sometimes for several days in succession.

Laboratory experiments have shown that several Australian Odonata, including *Synthemis eustalacta* (Burm.) and *Synthemis leachi* Sel., have larvae which can survive in an inactive state if free water is withdrawn (TILLYARD, 1910a, 1910b; WATSON, 1967, 1981, 1982b), and it seems likely that larvae of other Australian species — aeshnids of *Telephlebia* spp. and the megapodagrionids *Podopteryx selysi* (Förster) and those of the *Argiolestes pusillus* complex — have a similar capacity to withstand a drought (TILLYARD, 1916; WATSON, 1967, 1977, 1981, 1982b; WATSON & DYCE, 1978; WATSON & THEISCHINGER, 1980). An unidentified gomphomacromiine corduliid species and the coenagrionid *Megalagrion oahuense* (Blackb.) are known to have fully terrestrial larvae (WILLIAMS, 1936; WATSON, 1982a, 1982b), and the aeshnid *Antipodophlebia asthenes* (Till.) is possibly in this category (WATSON & THEISCHINGER, 1980).

It has been shown that *C. uniseriis* larvae remain active and feed in the absence of free water although the reason that they then cease to climb is not clear. The need to rear the other New Caledonian specimens for identification precluded rigorous desiccation experiments, hence the extent to which the two synthemistid species are terrestrial remains debatable. The spring-fed seepages at sites 1, 2, and 4 constitute specialised aquatic habitats similar to those favoured by species with semi-terrestrial (or semi-aquatic) tendencies such as *Tachopteryx thoreyi* (Hag.), *Megalagrion hawaiiense* (McLach.), and *Megalagrion oceanicum* (McLach.) (DUNKLE, 1981; WILLIAMS, 1936). In contrast, site 3 is a terrestrial habitat resembling the rain channel larval abode of *M. oahuense*, a species considered fully terrestrial (WILLIAMS, 1936). The range of instars of *C. uniseriis* and *S. miranda* at site 3 indicates that those species thrive rather than survive in a situation frequently lacking free water, and that they are normally terrestrial, although the rearing experiments also permit the view that they are amphibious. The behaviour of the species B larva in captivity suggests that the species is more dependent on immersion.

LIEFTINCK (1976) has described seven, or possibly eight, larval synthemistid taxa from New Caledonia, and I have since collected an additional taxon, the larva of *Synthemis ariadne* Lieft., which will be described elsewhere. Six adult taxa have been described, the species B larva has proved to be a new species, and an additional species, intermediate in size between *S. ariadne* and *S. miranda*, is now known (D.A.L. Davies, pers. comm.). It remains to be seen if the species B female larva of LIEFTINCK (1976) corresponds to the species B male. The rearing experiments reveal that the unidentified species C larva of LIEFTINCK

(1976) is *S. miranda*, not the larva he earlier associated with that species by supposition (LIEFTINCK, 1971, 1976). Similarly, the larva identified as *C. uniseriis* by supposition (LIEFTINCK, 1976) is not that species. Neither of the misidentified larvae can yet be determined to species. I have reared to emergence a final-instar larva of *S. fenella* confirming the identification which LIEFTINCK (1971, 1976) made by supposition. This brings to four the number of synthemistids from New Caledonia which can be reconciled with certainty with their adults.

ACKNOWLEDGEMENTS

With my collecting companions D.A.L. DAVIES (Cambridge) and J.R. GREHAN (Victoria University of Wellington), I am grateful for the support accorded our expedition by the Office de la Recherche Scientifique et Technique Outre-Mer, Nouméa, and particularly to Dr J. GUTIERREZ of that institution for his many kindnesses. I also thank the Director, Service des Eaux et Forêts, Nouméa, for facilitating our entry to areas under his control, and Mr and Mrs M. BRINON for their hospitality at Forêt de Thi. GORDON McPHERSON, who represents the Missouri Botanical Gardens in New Caledonia, gave me invaluable aid in November 1982. DIANA E. BENNETT (Victoria University of Wellington) assisted with larval maintenance.

Grants from the New Zealand Entomological Society and the Internal Research Committee (V.U.W.) to J.R. Grehan and W.J. Winstanley assisted the research.

I am grateful to G.W. GIBBS, Victoria University of Wellington, and to J.A.L. WATSON, C.S.I.R.O., Canberra, Australia, for comments on the manuscript, and to S.J. BROOKS, British Museum (Natural History), London, for comparing material against type specimens.

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