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SHORT COMMUNICATIONS

A DENDROLIMNETIC DRAGONFLY FROM SULAWESI (ANISOPTERA: LIBELLULIDAE)[1]

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The occurrence of larvae of the libellulid dragonfly, *Lyriothemis cleis* Brauer in water-filled treeholes in the Domoga-Bone National Park, Sulawesi Utara, Indonesia, is recorded. Early and final instar larvae are described and figured for the first time. The role of the species within the treehole community is discussed and observations compared with cognate results for other species of Odonata.

INTRODUCTION

Some 50 species of Odonata are recorded worldwide, which breed in plant-held waters ("phytotelmata") (CORBET, 1983). Almost without exception these are tropical species and the habitats used range over four of the five principal types of phytotelmata — axil-waters, bromeliad "tanks", bamboo internodes and water-filled treeholes (KITCHING & PIMM, 1985). Not unexpectedly most of the species involved are Zygoptera but about 10 records of Anisoptera are collated by CORBET (1983), largely from the Oriental region and (with one exception — an aeshnid) from the family Libellulidae.

The libellulid genus *Lyriothemis* Brauer contains a number of Oriental species, the breeding habits and life-histories of which are largely unknown (LIEFTINCK, 1954; RIS, 1909). The species *magnificata* (Sel.) was recorded by LIEFTINCK (1954) as breeding in treeholes and bamboo stumps and LIEN & MATSUKI (1979) describe larvae of *tricolor* Ris from similar situations. These last authors also record *L. elegantissima* Sel. from open marshes and impounded ditches. The association suggested by LIEFTINCK (1954) between *L. selva* Ris and "old *Nepenthes* pitchers" remains to be confirmed.

[1] This is contribution No. 14 from Project Wallace.

I had the privilege, recently, to participate in the Indonesian Institute of Science and the Royal Entomological Society of London's "Project Wallace" — a major entomological expedition to the Dumoga-Bone National Park of Sulawesi Utara in Indonesia. During a two-month sojourn in the area I investigated the community of animals living in phytotelmata in the region. As part of this work I collected and reared to the adult stage, a treehole-breeding *Lyriothemis*, subsequently identified by Dr J.A.L. Watson as *L. cleis* Br. In this short paper I present my general observations on the species and give brief descriptions of both an early and a final instar larva. This description complements those of LIEN & MATSUKI (1979) of *L. elegantissima* and *L. tricolor*.

THE NATURAL HISTORY OF *LYRIOTHEMIS CLEIS*

I found four larvae of this species, one of which I was able to rear to an adult male. All four individuals were from rot holes (sensu KITCHING, 1971) in the stumps of trees, principally palms. All sites examined were in the area of the Dumoga-Bone National Park (0°34'N 123°54'E) at 211 m altitude in the area designated "blue" in the Expedition's Survey (unpublished Result). Many such treeholes were examined and a summary of the physico-chemical characteristics of the sites is presented in Table I. All the palm holes were the products of human activity associated with the clearing of a survey line. The one non-palm hole was by far the largest site in terms of water-holding capacity and was the product of earlier storm damage. In this case the species of tree could not be determined. All the sites were within rain forest with a virtually closed canopy overhead. Many water-filled bamboo internodes in the same stretch of forest were also examined as part of my wider researches and, although a rich infauna was found, no dragonfly larvae were encountered in them.

In the treeholes, the *L. cleis* larvae occurred among the leafy detritus which was found at the bottom of each of the water-filled habitat units. Although few larvae

Table I

Physical and chemical characteristics of water-filled treeholes in the Dumoga-Bone National Park, Sulawesi Utara

Site	Principal diameters at rim (m)	Maximum depth to rim (m)	Height from ground to rim (m)	pH	Conductivity ($\mu S\ cm^{-1}$)
Palm stumps					
1	0.025 x 0.025	0.015	0.80	6.0	652
2	0.025 x 0.015	0.020	0.80	6.5	1572
3	0.030 x 0.030	0.040	0.80	7.0	1330
4	0.012 x 0.012	0.025	0.80	6.0	—
5	—	—	—	6.0	597
6	—	—	—	6.0	1231
Other stump hole	0.800 x 0.600*	0.30*	2.50*	6.5	2358

* Approximations only

— No records taken

were found I do not believe the species to be rare but rather that my usual sampling methods, designed for other smaller, less active organisms, were inappropriate for this species. An account of the full complement of metazoan animals present will be published in due course as will a putative food-web for the community. In the laboratory the *Lyriothemis* larvae fed avidly on all the insects with which they were enclosed including the larval stages of scirtid beetles and mosquitoes (the most abundant of the treehole fauna) as well as the very large larvae of a treehole tipulid belonging to the genus *Tipulodina*. Accordingly, and in accordance with a priori expectations I suggest that the larvae act as top predators within the treehole food web. This coincides also with the assessment by LIEN & MATSUKI (1979) of the role of larvae of *L. tricolor* in the bamboo-internode community.

THE LARVA OF *LYRIOTHEMIS CLEIS*

In the following descriptions I use CORBET's (1953) terminology for labial chàracters.

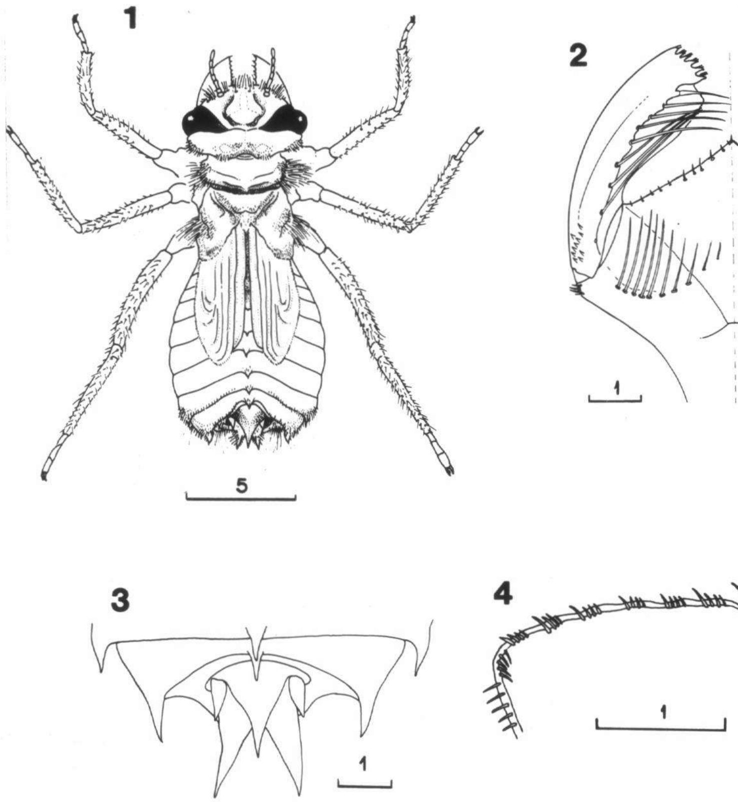
FINAL INSTAR
Figures 1-4

Larvae of characteristic libellulid form with expanded, moderately flattened abdomen, mud-brown in colour with no distinct patterning; notably hirsute on legs, thorax, frons, and, distally, on the abdomen. Legs long and relatively slender, the metathoracic pair extending substantially beyond the end of the abdomen. Labial palps large, clearly visible from above when retracted, extending back to just behind the prothoracic coxae when retracted. Abdominal segments 4-9 with a single, backwardly directed spine situated centrally on the posterior margin of each (Fig. 1). Details of posterior end as in Figure 3.

Palpal setae as in Figure 2. Distal margin of palp as in Figure 4. Each palp with a cluster of spiniform setae basally and with the distal margin having about eight crenellations, more or less regular in shape and without the beak-like modification of the innermost one seen in the earlier instar (cf. below), each crenation bearing four associated short spiniform setae (Fig. 4). Premental setae 10 & 10; a row of short spiniform setae along the distal margin of the median lobe and four spiniform setae clustered laterally at the outer points of articulation of the palps.

EARLY INSTAR
Figures 5-8

Like the final instar in general facies although with the labial palps much less visible from above. Generally hairy and pale brown. Posterior end as in Figure 7.

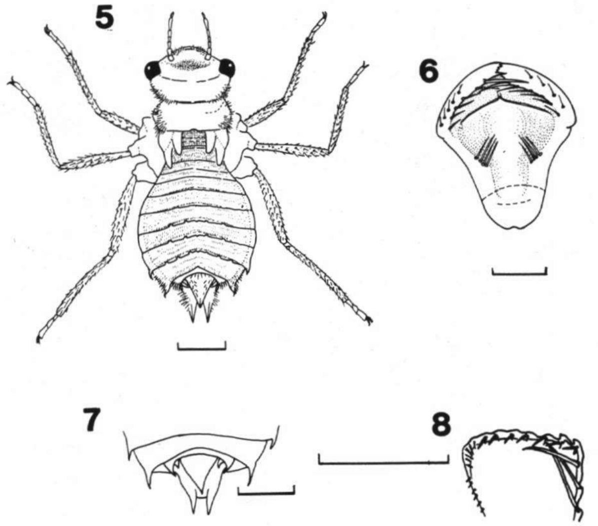


Figs 1-4. Final-instar larva of *Lyriothemis cleis* Br.: (1) general dorsal view; — (2) labium, dorsal view; — (3) detail of posterior end of larvae, dorsal view, spines and setae omitted; — (4) labium, detail of distal margin of palp, flattened out. — Scale bars in millimetres as indicated.

Labial palps and prementum (Fig. 6) with fewer setae than in the final instar Palpal setae 5 & 5, long and inwardly directed, with abbreviated parallel rows of very short setae external to them. The distal crenations form a distinct claw (the end hook) at the inner end (Fig. 8). Detail of the distal margin as in Figure 8. Premental setae 4 & 4.

DISCUSSION

The mature larvae of *L. cleis* can be readily distinguished from those of the two species described by LIEN & MATSUKI (1979). *L. tricolor* is easily distinguished from the other two species having only 4-5 pairs of premental setae and 8 setae in



Figs 5-8. Early-instar larva of *Lyriothemis cleis* Br.: (5) general dorsal view; — (6) labium, dorsal view; — (7) detail of posterior end of larva, dorsal view, spines and setae omitted; — (8) labium, detail of distal margin of palp, flattened out. — All scale bars indicate one millimetre.

each lateral row on the palp. The comparable numbers for *L. elegantissima* are 10-11 and 9 respectively; and for *L. cleis* 10 and 7 respectively. In addition the basal cluster of short spiniform setae on the palps of *cleis* appear to be absent in *elegantissima*. Differences in abdominal shape and the shape of the labial palp itself are also evident.

My findings raise several points of special biological interest mostly relating to comments made recently about odonates in phytotelmata by other authors. Firstly, however, the degree of specialisation of the species with respect to its breeding sites deserves comment. The larva of *L. cleis* was not previously known, and I found larvae nowhere but in treeholes. They were not found in bamboo stumps or (from a nearby site) in the pitchers of *Nepenthes*. I did not examine several other classes of aquatic habitat in the area and, given LIEFTINCK's (1954) record of the congeneric *L. magnificata* (Sel.) from "miniature leaf--bottomed pools" as well as from treeholes and bamboo stumps, this makes provisional any claim that *L. cleis* is restricted to treeholes. Nevertheless an extensive collection of adult odonates made by Mr A. Harman over the same period in the same stretch of forest (which did contain small ground pools) contained but three specimens of this species. The frequency of treeholes in the area together with the species' absence from other phytotelmata makes it very likely that this is indeed a species confined to water-filled treeholes.

Several authors have referred to the special oviposition behavior of phytotelm odonates (CORBET, 1962, 1983, 1984; CORBET & McCRAE, 1981). It has been implied that the predominance of Zygoptera among the list of these odonates probably reflects the endophytic oviposition habit of the suborder coupled with their generally smaller size, facilitating oviposition in plant crevices (Westfall, in CORBET, 1984). My observations of *L. cleis*, an anisopteran, do not negate this conjecture. However, all sites in which I encountered larvae were fully exposed, relatively large stump holes offering no difficulties of access even to a completely exophytic ovipositer. Indeed the absence of the species from bamboo stumps and from water-filled bamboo sections used as artificial oviposition sites for phytotelm insects in the Sulawesi forest, may be because these present insuperable difficulties to ovipositing females of this species. Balanced against this are the observations of LIEN & MATSUKI (1979) who found *L. tricolor* in bamboo stumps.

Lastly the rarity of *L. cleis* adults in large ground zone collections of Odonata made in the Sulawesi forest bears comment. Even though the stump holes I studied were in the ground and shrub layers (sensu ELTON, 1966) it is possible that the adults are canopy dwellers returning but briefly to the lower layers of the forest in order to oviposit. Certainly studies of water-filled treeholes high in the canopy would be of great interest although the sampling of these presents substantial logistical problems and, in any case, they are probably rare.

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