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SHORT COMMUNICATIONS

LARVAE OF *HADROTHEMIS SCABRIFRONS* (RIS) IN A TREE CAVITY IN EAST AFRICA (ANISOPTERA: LIBELLULIDAE)

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Two large larvae of *H. scabrifrons* and 2 smaller larvae probably of this species have been found in a water-containing cavity in a tree root in lowland rainforest near the Kenya coast. Conventional collecting methods may result in large Odonata being under-represented in collections from tree holes. The oviposition behaviour of Anisoptera occupying tree holes is probably unusual and merits study.

INTRODUCTION

About 16 genera and perhaps up to 43 species of Odonata have so far been recorded in the pre-imaginal stage from phytotelmata, i.e. small water bodies found in or upon plants (cf. CORBET, 1981). Phytotelmata occupied by Odonata are mainly epiphytic or terricolous bromeliads, terrestrial plants such as *Astelia, Freycinetia* and *Pandanus*, bamboo stumps and tree holes. That tree holes form only a small proportion of the phytotelmata from which Odonata have been recorded may reflect both sampling effort and sampling effectiveness. It is probably significant that the tree hole-dwelling species of *Lyriothemis* (in Malaysia and Taiwan) also occupy bamboo stumps (LIEFTINCK, 1954; LIEN & MATSUKI, 1979), a habitat in which, because of its greater accessibility, such Odonata are more likely to be detected. In Africa, bamboos of large stem diameter are not indigenous; however, when

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large (exotic) bamboo stumps were exposed in forest in Uganda, larvae of Anisoptera (*Hadrothemis camarensis* (Kirby)) appeared in 3% of them — mainly at ground level but sometimes up to a height of about 9 m (CORBET, 1961).

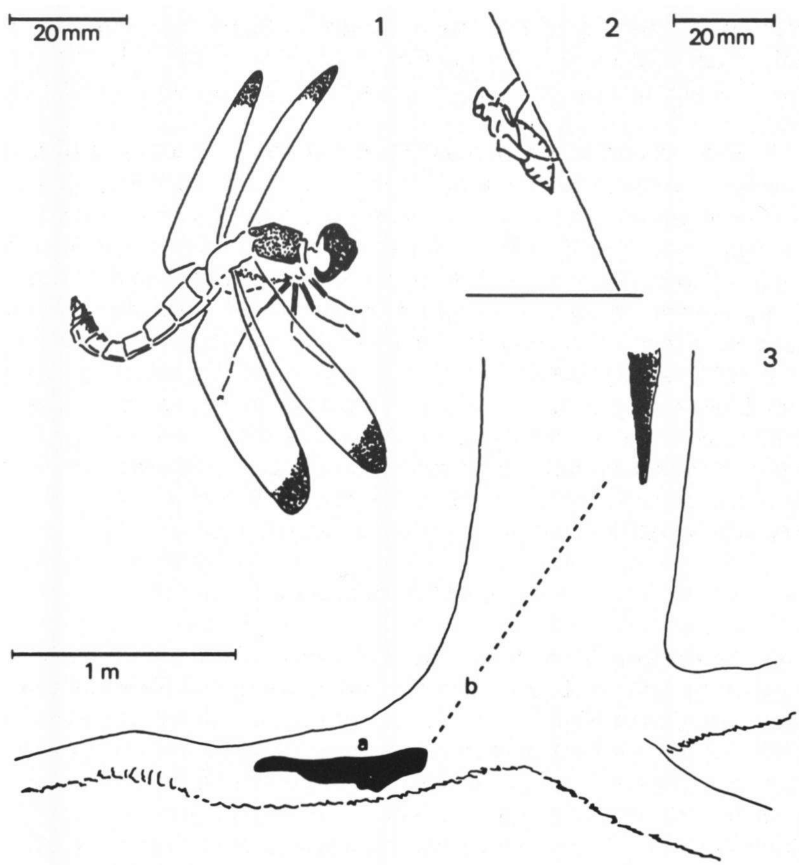
A related consideration is that the tree-hole habitat is always difficult and sometimes impossible to sample effectively for larvae of Odonata — especially Anisoptera — because the occupants are usually extracted by suction through a narrow tube. Thus we agree with LOUNIBOS (1980) that his finding of Odonata larvae (all of which may have been the megapodagrionid *Coryphagrion grandis* Morton) in 5.8% of 295 tree holes probably underestimated their actual occurrence in the cavities he sampled.

In 1979, hoping to find larvae of *C. grandis*, we examined tree holes in Lounibos' survey area in coastal Kenya. We found not *C. grandis* but *Hadrothemis scabrifrons* (Ris) — apparently the first anisopteran to be reported from a natural tree cavity in Africa. The circumstances in which we encountered these larvae support the expectation that more species of Anisoptera will be found in this kind of habitat.

OBSERVATIONS

On September 29, 1979 we examined some of the tree holes formerly sampled by Dr L.P. Lounibos in the Makadara Forest, Kenya. During his survey LOUNIBOS (1980) had found a total of 23 larvae (presumably of *Coryphagrion grandis*) in 13 of 163 samples from this site. During our brief visit we collected, from a water-containing cavity in a tree root, 2 larvae of *Hadrothemis scabrifrons*, a libellulid known only from forests of the Cameroons and Zaire, and from coastal Kenya and Tanzania (PINHEY, 1962). The larva of this species had not been known before, and a description of it (together with larvae of *Hadrothemis camarensis* and *H. coacta* (Karsch)) will be prepared in due course.

The 2 larvae of *H. scabrifrons* crawled actively out of decaying leaves and sludge which had been scooped by hand out of the hole. They were in the penultimate and final instar (body length 23 and 27 mm, respectively). The dorsum of the abdomen was not conspicuously covered by hair-like setae. Both larvae were taken to Cambridge, U.K., kept there under a 12-hr photoperiod at about 25°C, and fed on small Diptera, mainly larvae of Chironomidae and *Aedes aegypti* (L.). The smaller larva entered the final instar on October 28 or 29 and tried to emerge on December 23, 1979. The larger larva emerged successfully on November 1, 1979, and identification (by P.S.C.) was based on the female adult it disclosed. Though offered other inclinations, this larva chose to emerge at an angle of about 60° to the horizontal (Fig. 2). The adult survived for 8 days after emergence, remaining



Figs. 1-3. *Hadrothemis scabrifrons* (Ris): (1) newly emerged female adult, showing posture of abdomen; — (2) exuvia in situ after emergence; — (3) larval habitat (a) in root of tree. For explanation see text.

for most of that time perched, head uppermost, with the last 4 abdominal segments abruptly curved dorsad (Fig. 1).

On December 30, 1979 one of us (A.W.R. McC.) revisited Makadara Forest and thoroughly examined the tree holes and its contents, finding 2 more libellulid larvae (body length about 2 and 11 mm) which, by association, we tentatively assign to *H. scabrifrons.*

All measurements in the following account are approximate.

The Makadara Forest (4° 14'S, 39°23'E; 425 m above m.s.l.) is in the Shimba Hills National Reserve, 30 km southwest of Mombasa, Kenya. It is a mixed broad-leaved forest of the Coastal type classified as "*Sterculia-Chlorophora/ Memecylon* lowland rainforest" by MOOMAW

(1960) and as "*Chlorophora* other species forest" by GLOVER (1973). The forest has been much damaged by wood cutters (removing *Chlorophora excelsa*) who have left tracks and clearings now supporting a dense growth (up to 3 m high) of broad-leaved grasses, Marantaceae etc. The tree containing the larvae of *H. scabrifrons* stood a few metres from such a clearing. The undisturbed forest had generally a sparse herb and shrub layer and the ground is littered with fallen wood. The (broken) canopy is at 25 m for the taller trees, but emergents may rise to 40 m.

The cavity containing the larvae of *H. scabrifrons* was in the root of a large tree of *Sterculia appendiculata* K. Schum. (Sterculiaceae) (Fig. 3). The heart of this tree was rotten and the trunk had a long internal crack (Fig. 3, *b*), at least 1.8 m long, through which water could drain from trunk to root cavity, thus accounting for the large amount of detritus and water that we found in the cavity. The root (not soil) formed the floor of the cavity. Thus, in the terminology of KITCHING (1971), it was presumably a 'pan', not a 'rot hole' — yet it enjoyed the added productivity of a rot hole by virtue of its direct access to the decomposing wood (and other organic material) in the trunk of the tree. It must accordingly be regarded as an exceptional example of a tree hole.

The opening to the hole was about 0.8 m long, and had an area of 970 cm^2 — though only one third of this, or less, when viewed from directly above, because of the overhanging nature of the roof of the cavity. The opening was at 20-30° to the vertical except at the narrower end where it was perhaps 50°; seen from directly above, it presented a width of 2.5 cm (at *a* in Fig. 3) to 9 cm. The lip of the hole was about 10 cm above the leaf-covered forest floor which sloped evenly away from the tree at a gradient of 1 in 5. In our opinion, water could never have flowed from the ground surface into the hole, and no ground pool could have formed within several metres of the hole.

Inside, the cavity had a greatest depth of 18 cm (close to the lip) and contained 30 litres of sludge. The water surface (which had a greatest width of 30 cm at the lip) had an area of 3870 cm^2 and lay 1.2 cm below the lip. There was not more that 1-2 cm of free water above the sludge. The root was hollow for a further 0.8 m beyond the water-containing part. The sludge consisted of fragments of wood, seeds, twigs, leaves and arthropod cuticle, and included a vertebra, and what appeared to be soil — which had perhaps washed down from nests of swallows and wasps in the trunk.

On December 30, 1979 a rough estimate of the macrofauna (noted by A.W.R. McC.) in 4.3 litres of sludge was: Libellulidae — 2 larvae; Coleoptera: Helodidae — 30 larvae; and among the Diptera: Syrphidae — 4 larvae; Tipulidae — 25 larvae, 3 pupae; Psychodidae — 50 larvae, 5 pupae (*Telmatoscopus?*); and Culicidae — 200-250 larvae and pupae, 2 or 3 egg rafts (*Culex nebulosus* Theobald). Much smaller insects, such as larvae of Ceratopogonidae and Mycetophilidae, could have been overlooked; however, if present, they were not numerous.

Observations made in Makadara Forest in April 1981 (D.L.R. McCrae, 1981, pers. comm.) suggest the probable nature of the encounter site — or rendezvous — in *H. scabrifrons*, and thus perhaps in other sylvan Odonata that occupy phytotelmata. Between about 1345 and 1415 hrs (Solar Noon being at 1223 hrs) on April 5, a mature male of *H. scabrifrons* was perched on a broken branch about 2 m above the ground and 0.3 m above a tangle of dead, leafless branches of a fallen tree. The male was in a clearing made by the fallen tree beside a woodcutters' path in the forest. From his perch he commanded a good view of the clearing, much of which was in sunlight. The clearing was within 100 m of the root cavity in which larvae of *H. scabrifrons* had been found in 1979. When a female flew into the clearing, the male chased her. After doing this for about 30 seconds, he flew evenly above and just behind the female with the tip of his abdomen curled ventrally to an increasing extent. He then grasped the female in flight, almost certainly in the tandem position which the pair retained while they flew briefly around the clearing. Then they settled, apparently in copula (i.e. the wheel position), on a leafy perch beside and slightly above the fallen tree. They remained so attached for close to 90 seconds, a period interrupted by 2 or 3 short flights probably caused by disturbance by the observer. After alighting again on a leafy perch (not the male's original perch) they separated and then both flew around in the clearing for a short time before the male was caught (by D.L.R. McCrae) and the female flew away, probably because efforts had been made to catch her. On the upper surface of the fallen tree in the clearing was a shallow depression containing water, dead leaves, very few insects and no detectable dragonly larvae. Because conditions in the Shimba Hills had been very dry until March 23/24 1981, it can be assumed that the depression had contained water for less than 2 weeks. Reinforced by the foregoing observations, we favour the supposition that sunlit clearings in forest may constitute the normal rendezvous for this species, and that the attractiveness of such sites (to both sexes) may be increased if they feature small bodies of standing water.

DISCUSSION

Our finding of larvae of *H. scabrifrons* leads us to speculate that more Anisoptera may be found in tree holes if appropriate sampling methods are used. It also suggests that the habit of ovipositing in tree holes may exist in *Hadrothemis* (witness the occurrence of larvae and dead adult females of *H. camarensis* in bamboo pots in Uganda), some species of which are known to breed in forest. One of us (P.S.C.) found 2 larvae of *H. coacta* (identified when they later emerged) in a small shaded pool in the South Busoga Forest, Uganda (33°29'E, 0°25'N) in December 1954; and NEVILLE (1960) has seen

H. coacta and *H. infesta* (Karsch) ovipositing in pools in the Bobiri Forest Reserve, Ghana. Perhaps, as previously suggested (CORBET, 1962, p. 13), some species may have it within their behavioural repertoire to lay in small pools on the forest floor as well as amongst cavities in tree roots and in tree holes above ground level. In this connexion we may note the recent finding, from a tree hole 30 cm above ground level, of a caddisfly larva usually found in forest pools (BARNARD, 1978). Also relevant here is the collection of half-grown larvae of *Gynacantha* from a pan (a groove in the trunk of a fallen tree in forest) in Costa Rica (D.R. Paulson, 1981, pers. comm.).

It is not obvious to us how *H. scabrifrons* placed eggs in the cavity in Makadara Forest. Species of *Hadrothemis* seen to oviposit over ground pools (cf. NEVILLE, 1960) have either flown or hovered close to the water surface and washed the eggs from the abdomen (*H. infesta*) or — like *Belonia croceipennis* (Sélys) (WILLIAMS, 1977), *Orthemis ferruginea* (Fabricius) (D.R. Paulson, 1981, pers. comm.) and *Orthetrum* sp. (CORBET, 1962, p. 16) — flicked eggs in a scoop of water on to a surface above water level (*H. coacta*). A female trying to adopt the first method would find herself severely restricted in her movements within the cavity, perhaps impracticably so; and the absence of standing water outside the hole would make the second method impossible to use. In our view, it is more likely in this case that the ovipositing female settled on the tree root, either dropping eggs from above through the narrow (2.5 cm wide) opening (in the manner of *Davidius moiwanus taruii* Asahina & Inoue (INOUE & SHIMIZU, 1976)) or placing them on the inside wall of the cavity, or on the sludge, at or just above the water surface (in the manner of *Micrathyria ocellata* Martin (PAULSON, 1969)). The oviposition behaviour of Anisoptera utilising phytotelmata would repay further investigation and could be readily studied by employing artificial test containers.

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