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OVIPOSITION BY *PHAON IRIDIPENNIS* (BURMEISTER) IN KENYA (ZYGOPTERA: CALOPTERYGIDAE)

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Territorial behaviour and courtship are briefly described. During oviposition, much of which occurs without male guarding, females make slits in the stems of *Cyperus dereilema*. The slits are up to 40 mm long and contain eggs packed in a single file at a density of 1 egg per 0.44 mm. Heavy parasitism of the eggs in one slit was discovered.

INTRODUCTION

There is much interest in the reproductive biology of the Calopterygidae, particularly in species from America (JOHNSON, 1962; WAAGE, 1973, 1978, 1984), Europe (BUCHHOLTZ, 1951, 1955; ZAHNER, 1960; HEYMER, 1973) and Asia (KUMAR & PRASAD, 1977; HIGASHI & UEDA, 1982; MIYAKAWA, 1982; NOMAKUCHI et al., 1984). Not only have calopterygids been used in numerous studies of territorial behaviour, courtship and male guarding, but they were also the first animals in which sperm competition by sperm removal with the penis was demonstrated (WAAGE, 1979). However, little is known about African members of the family, although some such as *Umma* spp., are as beautifully winged as any calopterygid. Most members of the family oviposit on vegetation at the water surface or below it by making a series of separate incisions into leaves or stems, into each of which one egg is normally placed (e.g. ROBERT, 1958). In contrast, female *Phaon iridipennis* are shown here to oviposit into plants above the water surface by making long slits in the stems, into which they place a tightly packed row of eggs.

STUDY AREA

Observations were made at a small, fast-flowing stream (ca 1-2 m wide and 0.5 deep), densely shaded among trees at Hunter's Lodge, Simba, Kenya, a site previously described (MILLER, 1982). Because it was controlled by a dam and fed by springs, the stream showed little seasonal fluctuation. Observations were made during a visit between April 7 and April 25, 1984.

REPRODUCTIVE BEHAVIOUR

Phaon iridipennis is a common African calopterygid occurring in forests throughout much of the continent (PINHEY, 1961). The sexes are similar, unlike most other members of the family, except that the male has a small pterostigma and the female none, and the female's abdomen is 82-89% of the length of that of the male. The wings are not coloured, but in both sexes they glitter characteristically when moved and this makes the insects easy to see when they fly in shaded areas but they are otherwise difficult to detect.

During visits to the same area in May and June 1981, and in July, 1982, no reproductive behaviour was observed although the species was abundant among the trees. However, in April, 1984 many individuals were sexually active in the vicinity of a forest stream. Males appeared to act territorially on the stream edge, perching on overhanging vegetation, and flying towards and chasing intruding conspecifics. When an intruder perched close to a resident male, the latter hovered immediately above it for several seconds. The intruder responded usually by flapping its wings slowly and, if a male, it also elevated the tip of its abdomen and then flew off, chased by the resident. If the intruder was a female it also would flap its wings but without elevating the abdomen. It then flew to another perch with the male pursuing and the procedure was usually repeated several times within 1-2 m of the resident male's original perch. If the female did not fly away, the male landed on her wings and quickly assumed the tandem position. The pair might then move a short distance before copulating, which normally lasted for 1-2 minutes. After separating they sat together, and the female then either began to oviposit nearby or flew away. In the former case the male usually perched within 0.5 to 1.0 m and challenged intruders as before, thereby providing some protection to the female from other males: however guarding could not be identified as a clearly distinctive behaviour pattern. Moreover, much oviposition occurred after 17:00 h (88 min before sunset) by females alone after males had left the stream. Thus although males seem to act territorially and exhibit a simple form of courtship, the occurrence of guarding remains uncertain.

OVIPOSITION

Eggs were laid into the cylindrical stems of *Cyperus dereilema* Steudel

(identification provisional), which was the most abundant plant on the margins of the stream. Females chose living stems which were more or less horizontal and 5-10 cm above the water. Bouts of egg-laying were observed for up to 40 minutes and they continued until about 18:00 h by when the light under the trees was dim, sunset being at 18:28 h. During oviposition, a female bent her abdomen through 180° bringing the ovipositor up close to her legs, and she slowly worked her way along a stem. *Lestes* (ROBERT, 1958) and *Selysioneura* (LIEFTINCK, 1953) also oviposit with the abdomen similarly bent.

Stems on which oviposition had been observed were collected and preserved in 2% formaldehyde. Their subsequent examination showed that females made continuous incisions along the stem which in 8 examples were 40, 40, 32, 30, 29, 28, 23 and 5 mm long (Fig.1). Eggs, which are 1.36-1.44 mm long and 0.25 mm wide, were packed into the slit, lying at 50-60° to the long axis of the stem in a single file. They were placed at regular intervals of 0.44 mm (± 0.05 s.d.; n=487 eggs in 7 batches); in one 40 mm slit, for example, there were 91 eggs. Some stems had 2 or 3 slits in parallel, and there were also occasional signs of abortive starts — i.e. short slits with either 1 or no egg in them. Eggs laid at some unknown time previous to collection of a stem had turned brownish and the slit margin had also darkned but not sealed up. *Cyperus* stems are filled with aerenchyma and thus the eggs are well provided with air and moisture.

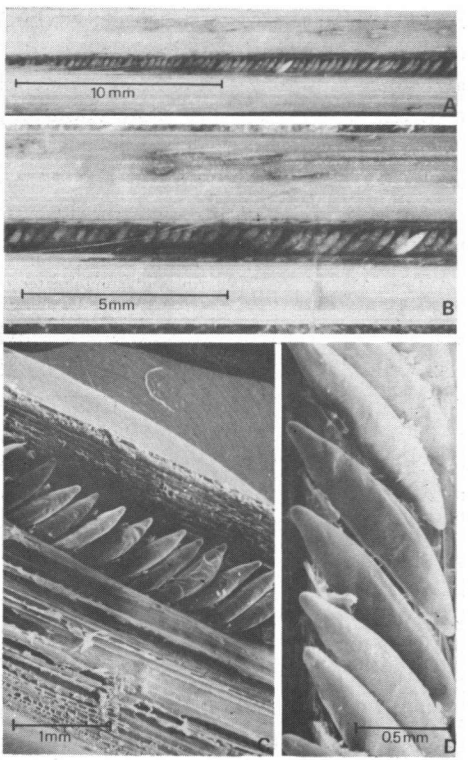

Fig. 1. Eggs of *Phaon iridipennis* in situ within a stem of *Cyperus dereilema:* (A) a complete row of 61 eggs; — (B) part of a row; — (C) scanning electronmicrograph of part of an egg row with the anterior poles uppermost; — (D) the same enlarged.

The egg chorion is smooth and there was no sign of spumaline (Fig. 2). Eggs were always orientated with the anterior pole, from which the larva hatches,

towards the outside and up to 1 mm below the surface of the stem. The posterior pole, sometimes crumpled, was thrust in towards the centre of the stem.

One clutch of 61 eggs from a stem in which oviposition had not been observed contained 14 mature hymenopterous larvae lying beside broken *Phaon* egg shells, and several other eggs contained similar but smaller larvae. Chalcids (e.g. *Prestwichia*) are known to parasitise dragonfly eggs in the water, but the parasites of those laid out of the water are not known (ASKEW, 1971). The hymenopterous larvae were 1.3 to 1.4 mm long, i.e. about the same length as the eggs.

DISCUSSION

Most endophytic Zygoptera and Aeshnidae make a series of separate small slits in plant material into each of which 1-3 eggs are placed (ROBERT, 1958; CORBET, 1962). The positioning of many eggs in a single long slit, as noted in *Phaon iridipennis*, is an unusual practice and would possibly seem to be disadvantageous for three reasons: (1) it might lead to more extensive damage to the stem, particularly when several slits are placed close together, and this in turn might jeopardise the eggs; (2) it might allow parasites to find more eggs; (3) larvae hatching synchronously from the closely packed eggs might interfere with each other or be more prone to predation. However, this mode of oviposition may be advantageous if it allows eggs to be laid more rapidly, or if it facilitates oviposition in hard plant material. The longest period of uninterrupted oviposition observed was 40 minutes and the greatest number of eggs in a slit was 91. This gives an approximate rate of

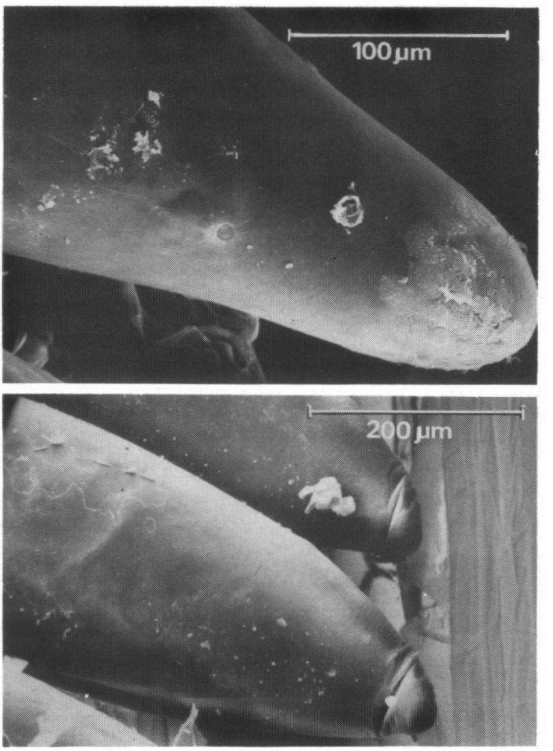

Fig. 2. Scanning electronmicrographs of the anterior pole (upper) and the posterior pole (lower) of eggs of *Phaon iridipennis*. The micropyle appears about 150 µm from the anterior pole, to one side.

oviposition of 2.3 eggs min^{-1} which compares poorly with the mean rates in *Calopteryx maculata* of 6.6 into stems and leaf axils of *Ranunculus aquatilis*, 7.0 into leaves of *Onoclea sensibilis*, 8.7 into leaves of *Sagittaria* spp. and 9.7 into leaves of *Sparganium* spp. (WAAGE, 1978). The stems of *Cyperus* may be much tougher and more difficult to penetrate than those of the plants normally used by *Calopteryx* spp., and a continuous incision may be the best means of dealing with this type of plant.

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