

MALE COMPETITION IN *PTEROPTYX* FIREFLIES:
WING-COVER CLAMPS, FEMALE ANATOMY,
AND MATING PLUGS

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A variety of male insect structures are used to hold females during mating including mandibles (Sivinski 1981), tergal gin traps (pinching organs) (Morris 1979), genital claspers (Wing 1982), antennae and modified legs (Parker 1970). Such structures may prevent other males from taking over a receptive female (Parker 1970), and they may enable the male to manipulate the female to his advantage—e.g. for forceful insemination (Thornhill 1982; see also, Lloyd 1979). The hooked elytral tips of *Pteroptyx* fireflies, long a puzzle to biologists who observed them and also the primary criterion for separating the genus *Pteroptyx* from *Luciola*, are used to clamp the female during mating in *Pteroptyx valida*, and probably other species. Here we present the details of this clamping as it occurs in *P. valida*.

METHODS

At sites near Bangkok, Thailand, we collected fireflies by hand and by sweeping tree foliage with an aerial net. Fresh specimens were dissected and others were preserved in alcoholic Bouin's solution for sectioning. Pairs in copula (duration unknown) were collected by gently clipping their leaf perch from the tree and placing it in a cyanide jar. Dead pairs that remained joined were transferred to alcoholic Bouin's solution. Four fixed pairs were embedded in paraffin and sectioned (10 microns), two longitudinally and two in cross section. Slides were stained with Delafield's hematoxylin and eosin. Four individual males and four females were prepared the same way.

RESULTS AND DISCUSSION

Copulations occur in certain trees where *P. valida* fireflies congregate. Males perch on foliage of a tree and flash signals, and a female, having joined a particular male on his perch, is courted by the male (Lloyd et al., in press; see also, Case 1980; and Lloyd 1973). Once the female allows intromission, control over the congress passes to the male because of the use of his clamp.

In *valida* males, and probably males of other *Pteroptyx* species, a "genital pocket" opens at the tip of the abdomen (Fig 1; Lloyd et al., in press). The pocket is formed by the terminal abdominal sternite and tergite which

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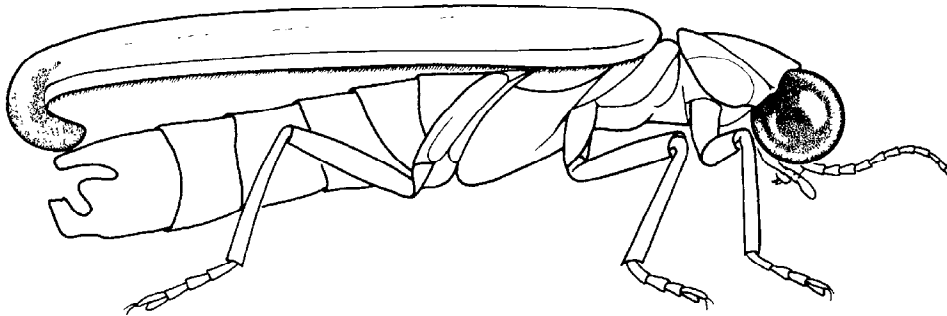


Fig. 1. *Pteroptyx valida* male. Note the hooked elytral tip and "genital pocket" in the terminal abdominal segment.

are not joined distally. The male genitalia are situated within the pocket, and are covered by a two-piece sheath when not in use. The location of the aedeagus requires that the female terminalia enter the male's pocket for intromission. When the female terminalia are in the male's genital pocket and the two are turned tail-to-tail (Fig. 2; Lloyd and Wing 1981), the female is gripped in the jaws of the male's copulatory clamp. The lower jaw of the clamp is the terminal abdominal sternite of the male (Fig. 3). The hind margin of this sternite curves upward, forming a lobed ridge (Baltentyne and McLean 1970), and this heavily sclerotized ridge presses upward on the venter of the female's abdomen during copulation. The opposing (upper) jaw of the clamp is the male's strongly deflexed elytral tips (Fig. 1 and Fig. 3). (The deflexed elytral tips, found only on males, are the characteristic from which the genus takes its name: Ptero=wing, ptyx=fold.) During mating the male elytra are positioned under those of the female (Fig. 2), and the male hooks his elytral tips around the anterior margin of the female's sixth abdominal tergite. In the grip of male's elytral hooks dorsally and his sternite ventrally, the female abdomen is doubly bent (Fig. 3). Thus, the female vagina and abdominal tip are swallowed and clamped by male structures.

In *valida* females a bursa copulatrix (Fig. 4), similar to those found in certain other beetles (Becker 1956a,b; Surtees 1961) receives the male ejaculatory products. This chamber is reinforced by sclerotized plates and

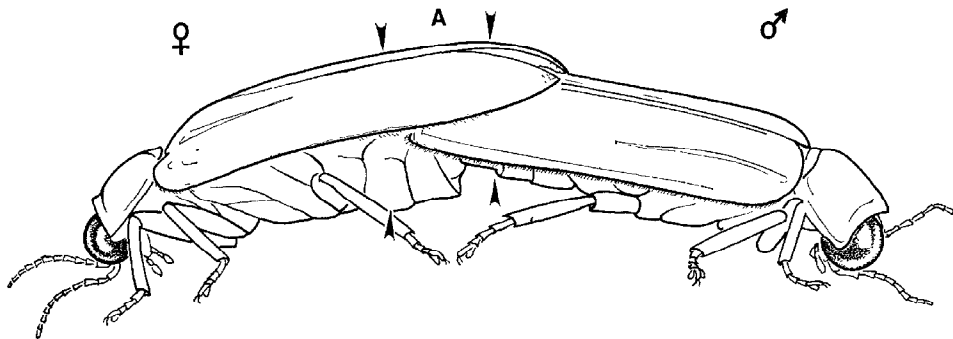


Fig. 2. A copulating *P. valida* pair: orientation for Fig. 3. Area "A" (delimited by arrows) shows the region shown in longitudinal section in Fig. 3.

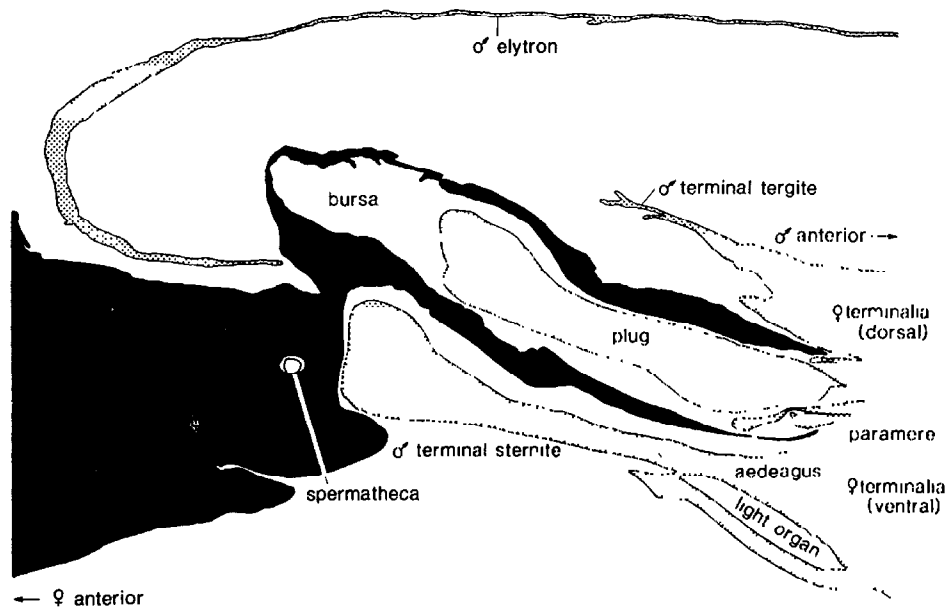


Fig. 3. Longitudinal section of a mating *P. valida* male and female. See Fig. 2 for orientation. Note that the female's elytra, which normally rest above the male's elytra as in Fig. 2, are not shown.

fishbone-like rods that probably prevent damage to the female by the male clamp, for it is in this region of the abdomen where the lower jaw of the male clamp is applied. The elytral hooks of the male press at the region of the abdomen where the anterior end of the bursa is situated (Fig. 3).

The spermathecal duct and a large female accessory gland join the bursa at its anterior end, and the common oviduct joins posteriorly (Fig. 4). Dissections of fresh specimens showed that the bursae of mated females contain a rubbery "plug" that is probably the remains of a spermatophore used to carry the sperm from the aedeagus to the spermatheca (Fig. 4). The plug consists of a rubbery layer enclosing a fluid core. The male reproductive system includes three pairs of accessory glands, products of which form the plug. No mated female, including those kept alive for up to five days before dissecting, was found to be without a plug. This suggests that a plug remains in place at least semi-permanently, and perhaps for the life of the female. A plug is carried in the anterior, expanded end of the bursa (Fig. 4) where it does not interfere with egg passage. The plug may prevent subsequent insemination of the female by other males due to blocking access to the spermatheca (see Gregory 1965; Parker 1970).

The inner surface of the bursa has sclerotized teeth that may hold the plug away from the wall of the bursa, creating a space through which sperm can migrate from the spermatheca to the eggs at the opposite (posterior) end of the bursa (see Hinton 1964, for a discussion of such teeth).

When female insects mate more than once, male competition results in tactics of many forms. Males reduce competition from sperm of subsequent mates by using mating plugs, mate guarding, and prolonged copulation (Parker 1970, Sivinski 1983a). Males overcome such measures by previous males by removing mating plugs, etc. (Parker 1970). Males reduce

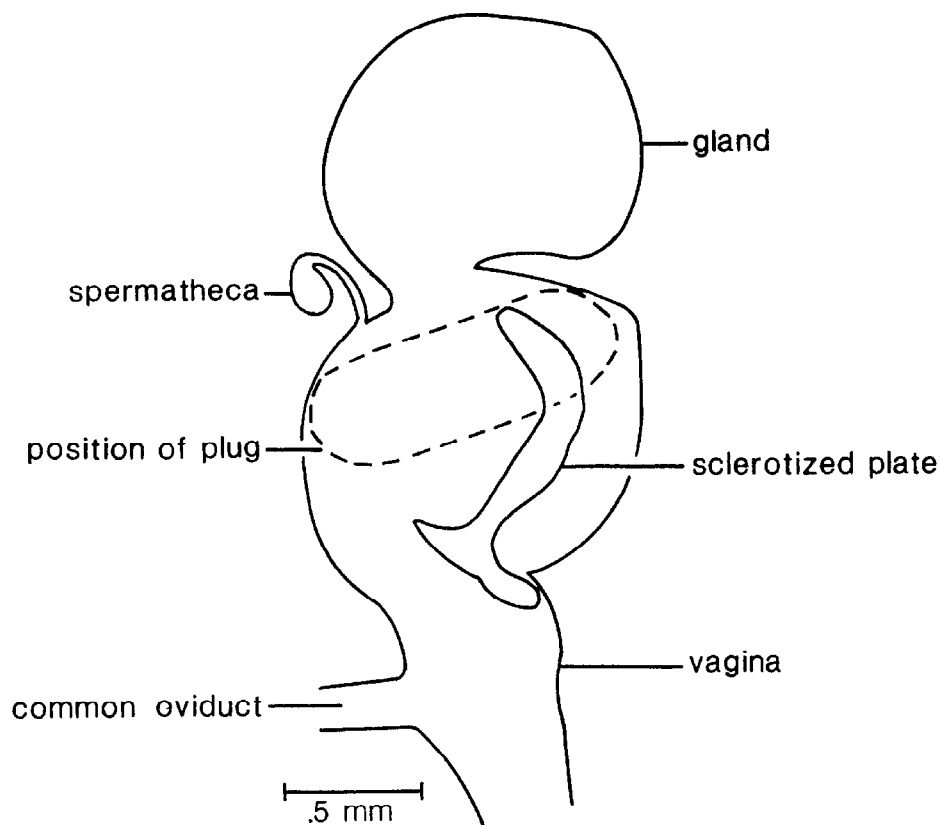


Fig. 4. Internal reproductive structures of a *P. valida* female.

competition from previous males by removing (Waage 1979) or preventing the use of their sperm (Parker 1970, Wing 1982). Females have a reproductive interest in the matter and may act to overcome male tactics that keep females from realizing benefits of multiple mating (see Walker 1980, Sivinski 1983b, and Sakaluk and Cade 1983 for discussion of such benefits). Males may counter these female actions, and so on (see Lloyd 1979).

P. valida copulations occur amidst high densities of intensely competing males. The clamp used by *valida* males may function in the manipulation of the female during placement of the plug, resulting in a reduced chance of subsequent insemination of the female. The clamp may also prevent take-over of the female by other males during copulation. Whatever its function, the *valida* clamp is the first report of a male insect using wing covers to control female genitalia during copulation.

SUMMARY

Pteroptyx valida males use their hooked wing covers to clamp females during mating. Female internal reproductive anatomy includes reinforced structures in the region where the clamp presses. The male clamp may have a role in positioning the spermatophore within the female, and/or the clamp may prevent other males from taking over the female.

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