

SHORT COMMUNICATIONS

**EVIDENCE OF SPERM DISPLACEMENT
IN *ISCHNURA AURORA* (BRAUER)
(ZYGOPTERA: COENAGRIONIDAE)**

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Five spindle-shaped sperm 'pellets' (bundles) were found in the vagina of copulation-interrupted androchrome ♀. The second and third pellets had a long thin tail while the fourth had partly and the fifth completely disintegrated. In an other ♀, the vagina was packed with sperm material even though the sperm storage organs (spermatheca and bursa copulatrix) were completely filled. It is proposed that this sp. exhibits a transitional reproductive behaviour with respect to sperm competition.

INTRODUCTION

Ischnura aurora (Brauer) is an interesting coenagrionid with an unusual reproductive behaviour. In New Zealand, *I. aurora* males have been observed to mate only with freshly emerged females and oviposition is unguarded (ROWE, 1978). In India however, mating takes place among fully mature individuals followed by oviposition (SRIVASTAVA & SURI BABU, 1984). Oviposition may be unguarded or in tandem (ARMSTRONG & CORBET, 1980; SRIVASTAVA & SURI BABU, 1984). Moreover, in India, teneral females have never been observed in copula (A. Mitra, T.R. Mitra and B. Suri Babu, pers. comm.). Because of this disparity, while studying the post-ovarian genital complex of *I. aurora* (ANDREW & TEMBHARE, 1996), I took special interest to observe and record any unusual condition of the sperm material in females caught in copula.

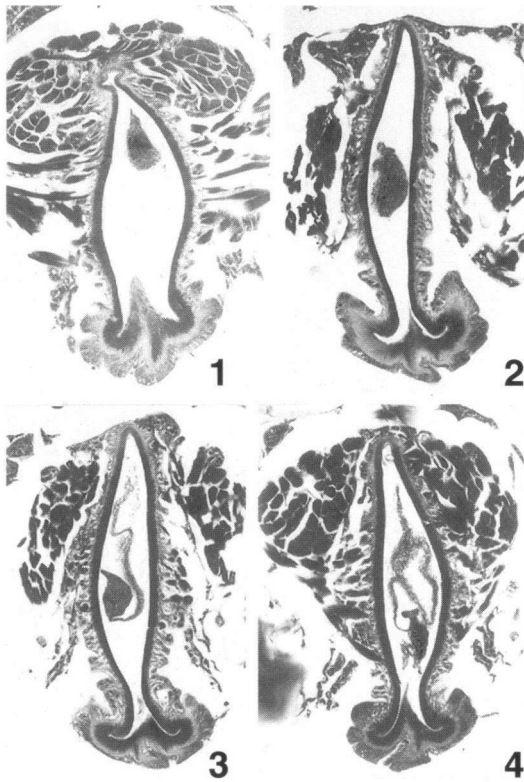
MATERIAL AND METHODS

The female damselflies (androchrome forms) in copula (N = 7) were collected around Barai Pond (Brahmapuri, M.S., India) in the months of August-October 1995-99. The abdomen was immediately cut open and fixed in

Bouin's fluid for 12-18 hours. The post-ovarian genital complex was dissected in 70% ethanol, dehydrated, cleared in xylene and embedded in paraffin wax at 60-62°C. Serial sections of 4-6 µm thickness were cut and stained with Heidenhain's Iron-Haematoxylin-Orange G.

OBSERVATIONS

In *I. aurora* the post-ovarian genital complex (POGC) is located on the eighth abdominal sternum below the terminal abdominal ganglion. It is composed of a spherical, bulbous bursa copulatrix, a sub-spherical spermatheca and a laterally compressed, tubular vagina. The spermatheca is connected to the bursa copulatrix by a thin, twisted, long duct and the bursa copulatrix is connected to the vagina by a short bursa communis. All the components are similar in their histology and contain the outer muscular, middle epithelial and inner cuticular layers (ANDREW & TEMBHARE, 1996).



Figs 1-4. *Ischnura aurora*, transverse section of vagina with sperm pellets ($\times 80$): (1) first compact pellet; - (2) second and (3) third pellet with long sperm tail; - (4) partly disintegrating fourth pellet.

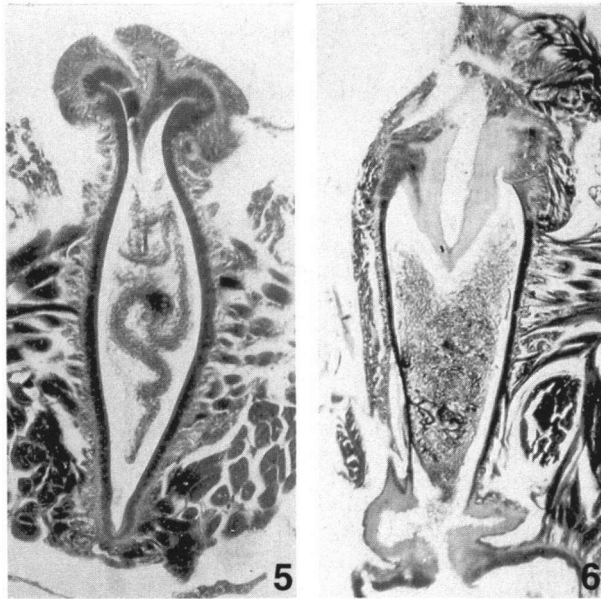
The sperm material is regularly observed in the sperm-storage organs (bursa copulatrix and spermatheca) of the POGC. The spermatozoa are randomly scattered in the thick mucilaginous seminal fluid, but the concentration of spermatozoa varies from specimen to specimen without any regularity. Interestingly, in two females, sperm material was also observed in the vagina. In the first case, five spindle-shaped sperm "pellets" (bundles) were found in the mid-region of the vagina (Figs 1-5). These compact pellets ($40-55 \pm 18-30 \mu\text{m}$) contained negligible amounts of seminal fluid. The second and third pellets had a thin long tail of sperm material while the fourth had partly disintegrated. A completely disintegrated fifth pellet was present near the fourth (Fig. 5). The pellets were present

diagonally in the vagina, the anterior one being dorsal and the posterior one ventral in position. In the second female, the vagina was packed with sperm material even though the sperm storage organs were completely filled (Fig. 6).

DISCUSSION

ROBINSON & ALLGEYER (1996) while tracing the evolution of monandry in ischnuran damselflies placed *I. aurora* in Group-I of one time copulators, with solitary oviposition mostly on the report of ROWE (1978, 1987) that in New Zealand *I. aurora* females were observed to copulate immediately following their emergence. But in India, SRIVASTAVA & SURI BABU (1984) recorded the copulation of mature individuals followed by solitary oviposition whereas ARMSTRONG & CORBET (1980) reported that *I. aurora* displayed tandem oviposition. Amit Mitra (pers. comm.) observed that in Dehra Dun (N. India), males of *I. aurora* carry the female in tandem for more than an hour before forming the copulatory wheel. Similar pre-copulatory guarding behaviour is also reported in *Sympetrum depressiusculum* and other odonates which exhibit sperm competition (MILLER et al., 1984). Disparity in reproductive behaviour is also reported in *I. elegans*. In England it is monandrous (PARR & PALMER, 1971), but in southern France most females are polyandrous, providing an opportunity for sperm competition (MILLER, 1987a, 1987b; COOPER et al., 1996). Similar opportunity for sperm competition can also exist in *I. aurora*.

The penis of *I. aurora* has little microspination on its short, wider flagella and as such is not capable of removing sperm (ROBINSON & NOVAK, 1997). However, *I. pumilio* a polyandrous species, has similar microspination on its thin and long flagella. In Odonata, a thin and long flagella is mostly effective in extracting sperm material from



Figs 5-6. *Ischnura aurora*, vagina [$\times 80$]: (5) disintegrating fifth pellet; — (6) section of the post-ovarian genital complex showing sperm mass in the vagina.

the spermatheca (CORDERO & MILLER, 1992; SAWADA, 1995). *I. aurora* can probably displace only the sperm material of the bursa copulatrix since its short and wide (paired) flagella cannot enter the thin, twisted, long spermathecal duct.

The presence of sperm pellets in the vagina of *I. aurora* indicate that the flagella of the penis pulls out and molds spindle-shaped sperm mass (pellets) from the bursa copulatrix and pushes it out in the vagina with the help of its backwardly directed spines. These pellets are probably collected/stored or molded in the 'scoop' of the penis. According to NOVAK & ROBINSON (1996) the curved, oriental fan-like scoop in some unknown way is involved in sperm displacement. The scoop is also found in polyandrous *I. gemina* and *I. denticollis*.

The preserved solitary females are sometimes found to contain sperm in the vagina which could have been deposited by the last male, or could have been ejected by the females during capture and preservation (MILLER, 1982, 1987b). In the present study, the presence of sperm-material (excess) in the vagina is left by the last male to copulate and could not have been ejected by the female since the bursa copulatrix and spermatheca are completely packed with sperm mass.

I. aurora probably exhibits a transitional reproductive behaviour in the ischnuran group since the heterochrome females found in New Zealand are monandrous (ROWE, 1978), whereas the androchrome forms found in India (FRASER, 1933) are polyandrous and exhibit sperm competition.

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