Odonatologica 38(3): 267-271 *September 1, 2009*

SENSILLA ON THE MALE PARAPROCTS OF *PROTONEURA ROMANAE* MEURGEY (ZYGOPTERA: PROTONEURIDAE)

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Received March 19, 2009 / Revised and Accepted May 29, 2009

The paraprocts of *P. romanae* Meurgey bear 2 types of aporous mechanoreceptive sensilla: sensilla chaetica and sensilla filiformia. During tandem formation the tactile sensilla chaetica, inform the ♂ of the maintenance of the ♀. The sensilla filiformia are vibroreceptors sensitive to air movements caused by the female taking off.

INTRODUCTION

Several papers have been published on the morphology and structure of the caudal appendages of Odonata, especially concerning the corresponding topography between male caudal appendages and female mesothorax (WILLIAMSON & CALVERT, 1906; WALKER, 1903, PINHEY 1963; LIEFTINCK, 1981) and its role in avoiding or inhibiting heterospecific pairing (DUMONT & BORISOV, 1993; JURZITZA, 1974, 1975; TENNESSEN, 1975; ROBERTSON & PATERSON, 1982; MOULTON et al., 1987; JUSTUS et al., 1990; BATTIN, 1993; MAY, 1993). However, there have been few studies on the sensory apparatus of both male caudal appendages and female mesothorax (especially the mesostigmal laminae). ROBERTSON & PATERSON (1982) in their work on some South African *Enallagma*, stated that the mesostigmal laminae of the female bears mechanoreceptors, thought to be stimulated by the male caudal appendages during tandem linkage. TENNESSEN (1975) found beneath the mesal margin of the male superior appendages of *Enallagma* spp. specialized cells thought to be both secretory and sensory, that maybe able to detect chemotactile stimuli during tan-

dem linkage, and enable females grasped by a male to take avoiding action and prevent heterospecific tandems from forming. Besides facilitating species recognition, the apposition of male and females structures may create a channel of sensory communication.

The present work on the fine structure of the sensilla of the male caudal appendages of *Protoneura romanae* Meurgey was carried out to aid our understanding of the sensory basis of odonate behaviour.

MATERIAL AND METHODS

The adult males were taken from a small stream at Sofaïa, Basse-Terre, Guadeloupe (FWI) on 1st February 2006. For study with the scanning electron microscopy (SEM), the superior caudal appendages of two males were dehydrated in absolute ethanol, mounted on specimen holders, and coated with a thin layer of gold and palladium in a JFC 1 100 sputter coater. Preparations were examined with a Jeol JSM 6 400 SEM at different magnifications. The terminology of ZACHARUK (1985) is used in naming the types of sensilla.

RESULTS

Two types of sensilla were found on the paraprocts of *P. romanae*; aporous sensilla chaetica and aporous sensilla filiformia with a characteristic arrangement (Fig. 1). The aporous sensilla chaetica are principally located on the internal face of each paraproct, with few on the dorsal face. There are 40 with a length reaching 60 µm and a basal diameter reaching 2.5 µm. They take the form of a frayed stiff hair, each inserted in a cupola reaching 7.5 µm diameter and 7.5 µm in length (Fig. 2).

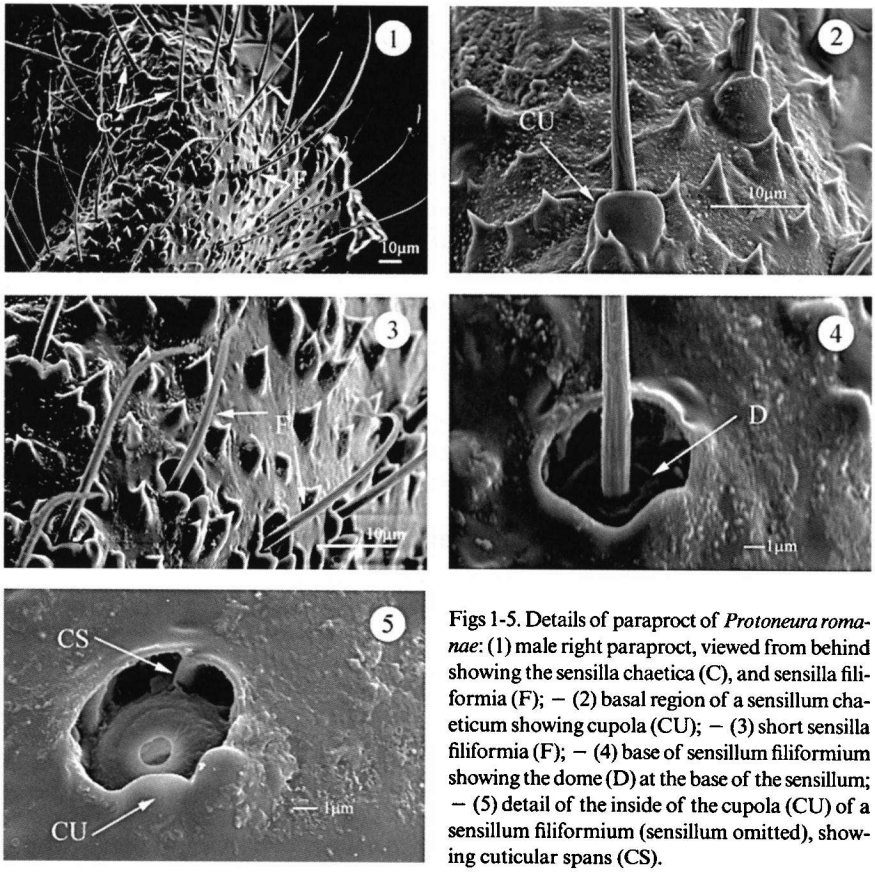
The aporous sensilla filiformia are located principally on the external face of each paraproct. They take the form of a thin hair, with a basal diameter of 1.3 µm, flexible and longitudinally striated. There are 20, varying in length between 26 µm and 70 µm (Fig. 3). They are each inserted on a dome measuring 5.5 µm in diameter, with an opening which narrowly enclose the base of the sensilla (Fig. 4). The dome itself is maintained by cuticular spans at the bottom of a broader cavity of 7.8 µm diameter (Fig. 5).

DISCUSSION

Aporous sensilla chaetica are tactile receptors, stimulated by the female mesostigmal laminae during tandem linkage. Already observed on the female prothorax of some Coenagrionidae (ROBERTSON & PATERSON, 1982), their presence on the superior caudal appendages of the male *Protoneura romanae* suggest that both male and female are able to recognize and then avoid heterospecific pairing. Sensilla chaetica may also play an important role during tandem flight in maintaining male grip on the female prothorax.

Sensilla filiformia are found on the abdominal appendages of terrestrial insects belonging to different orders (GNATZY, 1976; GNATZY & SCHMIDT, 1971), and on the antennae and caudal appendages of odonata larvae (MEURGEY & FAUCHEUX, 2006a, 2006b; FAUCHEUX, 2007). On the superior caudal appendages of all insects, the articulation of the sensilla with the tegument is classified according to three types (FAUCHEUX, 2002). The basal structure of the sensilla in *P. romanae* belongs to types 1 and 3. As in type 1 (*Acheta* sp., *Gryllus* sp., *Thermobia domestica*, *Monotylota ramburi*) the sensilla, inserted in a broad cup, has its displacements limited by the edges of the cup itself. However, as in type 3 (cockroaches, Dermaptera), the displacement of the sensilla is possible only because of its insertion, inside the dome, via a deformable articular membrane allowing various slopes (GNATZY, 1976).

When located on the cerci of non-flying insects (cerci of cockroaches, embiids, earwigs), sensilla filiformia react to air displacements caused by a predator,



Figs 1-5. Details of paraproct of *Protoneura romanae*: (1) male right paraproct, viewed from behind showing the sensilla chaetica (C), and sensilla filiformia (F); – (2) basal region of a sensillum chaeticum showing cupola (CU); – (3) short sensilla filiformia (F); – (4) base of sensillum filiformium showing the dome (D) at the base of the sensillum; – (5) detail of the inside of the cupola (CU) of a sensillum filiformium (sensillum omitted), showing cuticular spans (CS).

and involve the escape behaviour. This is especially well studied in cockroaches (PUMPHREY & RAWDON-SMITH, 1937; ROEDER, 1948).

In flying insects, abdominal sensilla filiformia have only been described on the male genitalia of the primitive microlepidopteran *Apoplania valdiviana* Davis & Nielsen (Neopseustidae) (FAUCHEUX, 1999, 2005) and on the superior caudal appendages of *P. romanae*.

The presence of sensilla filiformia on the paraprocts of *P. romanae* suggests that, as in other insects, they are stimulated by air displacements and could replace vision from behind, allowing the avoidance of direct predation by reacting to air movements, due to predator approach. Field observation of reproductive behaviour led us to consider that the sensilla filiformia may also have a role during tandem oviposition. TRAPERO QUINTANA et al. (2005) in their study on the reproductive behaviour of *P. capillaris*, stated that several factors could interrupt oviposition, such as wind or water movements due to aquatic insects. Aquatic insects such as Heteroptera are considered to be direct predators, and their approach induces escape behaviour in odonates. Both *P. capillaris* and *P. romanae* insert their eggs in unstable supports such as dead leaves, wood sticks and others floating debris. The wind generally increases the instability of the support itself, and may initiate escape behaviour.

We observed several tandem pairs of *Protoneura romanae* during flight and oviposition, and noticed that the female leads the tandem pair in flight and takes off first from the oviposition support. This suggests that the sensilla filiformia on the external side of the male superior caudal appendages may also play a role during tandem oviposition and react to air displacement due to the female taking off, allowing synchronisation of the separation of the pair.

ACKNOWLEDGEMENTS

We wish to acknowledge PIERRE WATELET, Director of the Museum of Natural History of Nantes, France for facilitating the use of the SEM and ALAIN BARREAU, Centre of SEM, University of Nantes, France, for technical assistance.

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