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Sensilla coeloconica on the maxillipede of the centipede *Craterostigmus tasmanianus* Pocock, 1902 (Chilopoda, Craterostigmomorpha)

Alfred Ernst[1], Jörg Rosenberg[2], Robert Mesibov[3] & Gero Hilken[4]

[1]Friedrich-Schiller-Universität, Jena, [2]Ruhr-Universität, Bochum
[3]Queen Victoria Museum, Launceston, Australia [4]Universitätsklinikum, Essen

Abstract

The cuticular hair sensilla on the surface of the poison claw of the maxillipedes in *Craterostigmus tasmanianus* were examined using scanning electron microscopy. Three different types of sensilla coeloconica occur: (1) thick conical sensilla, (2) thin slender sensilla, and (3) long tapered sensilla. Each sensillum coeloconicum consists of a short sensory peg in a cuticular pit. The terminal pore on the tip of each sensillum coeloconicum points to a chemoreceptive function. These structures are possibly involved in the analysis of prey. Other sensory functions of the sensilla coeloconica in Chilopoda are discussed.

Zusammenfassung

Sensilla coeloconica am Maxilliped von *Craterostigmus tasmanianus* Pocock, 1902 (Chilopoda, Craterostigmomorpha) – Auf der Suche nach Sensillen auf den Giftklauen des Maxillipeden von *Craterostigmus tasmanianus* wurden 3 verschiedene Typen von Sensilla coeloconica mit rasterelektronenmikroskopischen Methoden nachgewiesen. Der in eine Grube eingesenkte Sinnesstift besitzt eine Terminalpore, die als Beleg für eine chemorezeptive Funktion angesehen wird. Es ist wahrscheinlich, dass diese Sensillen die Eindringtiefe der Giftklaue in die Beute kontrollieren und ihnen somit eine wichtige Funktion beim Nahrungserwerb zukommt. Größenunterschiede und regionale Verteilung der Sensillen auf den Maxillipeden erlauben eine klare Differenzierung der 3 Sensillentypen. Vergleiche zu Sensilla coeloconica anderer Chilopoden- und Antennaten-Taxa werden gezogen.

1. Introduction

As in other chilopods the maxillipedes of *Craterostigmus tasmanianus* Pocock, 1902 play an important role in detection and capture of prey. These modified legs of the first trunk segment terminate in a curved, claw-like poison fang. Close to the apex of each maxillipede a poison gland opens on the dorsal side. The presence of sensory structures on the poison claw for assisting with penetration into the prey may be assumed. Evidence for sensilla on the maxillipedes of *Scolopendra morsitans* has been presented by Jangi & Dass (1977). These authors suggest a chemoreceptive role for the poison fang, as documented by scanning electron microscope (SEM) examination and stimulation experiments.

The maxillipedes of several centipedes bear on their surface a scatter of sensilla, each with a terminal pore. These sensilla are called sensilla coeloconica and are found in representatives of Scutigeromorpha, Lithobiomorpha, Scolopendromorpha, and Geophilomorpha. Previous studies used mainly SEM, and only two species have been investigated in more detail using transmission electron microscopy (TEM): *Necrophloeophagus* (*Geophilus*) *longicornis* (Geophilomorpha) and *Lithobius forficatus* (Lithobiomorpha) (Ernst 1995, 2000, Ernst & Rosenberg 2001, Rosenberg & Ernst 2001). The present study is the first to demonstrate that sensilla coeloconica are present on the maxillipedes of *Craterostigmus tasmanianus*. The results are discussed in connection with the ground pattern of the Chilopoda with respect to the sensory equipment of the maxillipede.

2. Material and methods

Heads of *Craterostigmus tasmanianus* preserved in 70% ethanol were mounted on Leit-Taps (Plano) and sputtered with a 25 nm gold film (BAL-TEC SCD 005) before examination with SEM (LEO 1450 VP).

The centipedes were collected by R. Mesibov on 21. August 2000 in northwest Tasmania: Wandle River, 41-22-15 south, 145-34-49 east, grid reference CQ812190, 570 m, in an *Eucalyptus delegatensis* forest with a rainforest understorey, under small logs.

3. Results

The maxillipedes of *Craterostigmus tasmanianus* consist of a plate-like coxosternite and two four segmented telopodites (Fig. 1). The coxosternite shows a distinct fusion suture and the two anterior processes bear 5 to 7 cuticular teeth each (Fig. 1). Each telopodite consists of a large prefemur, a ring-shaped (annular) femur and tibia, and an enlarged tarsus, the poison claw (Figs. 1, 2). The inner surface of the prefemur has 5 cuticular teeth. The poison gland, located within the telopodite, opens a little below the tip of the claw.

The basal part of the tarsal segment bears several hair-like sensilla trichodea (up to 315 µm in length) and some sensilla microtrichodea (up to 12.5 µm in length) (Fig. 5). The distal part of the tarsus is covered by numerous sensilla coeloconica of different size (Figs. 3 – 6). Each sensillum is composed of a short peg-shaped sensory cone situated in an oval pit (Fig. 6). On the ventral side of the claw we counted 109 sensilla coeloconica, on the dorsal side 130 sensilla coeloconica and along the rim of a groove on the inner side of the maxillipede 40 sensilla coeloconica. The density of the sensilla increase from the base (2 – 3/50 µm^2) to the tip of the claw (4 – 5/50 µm^2; Figs. 3 – 5).

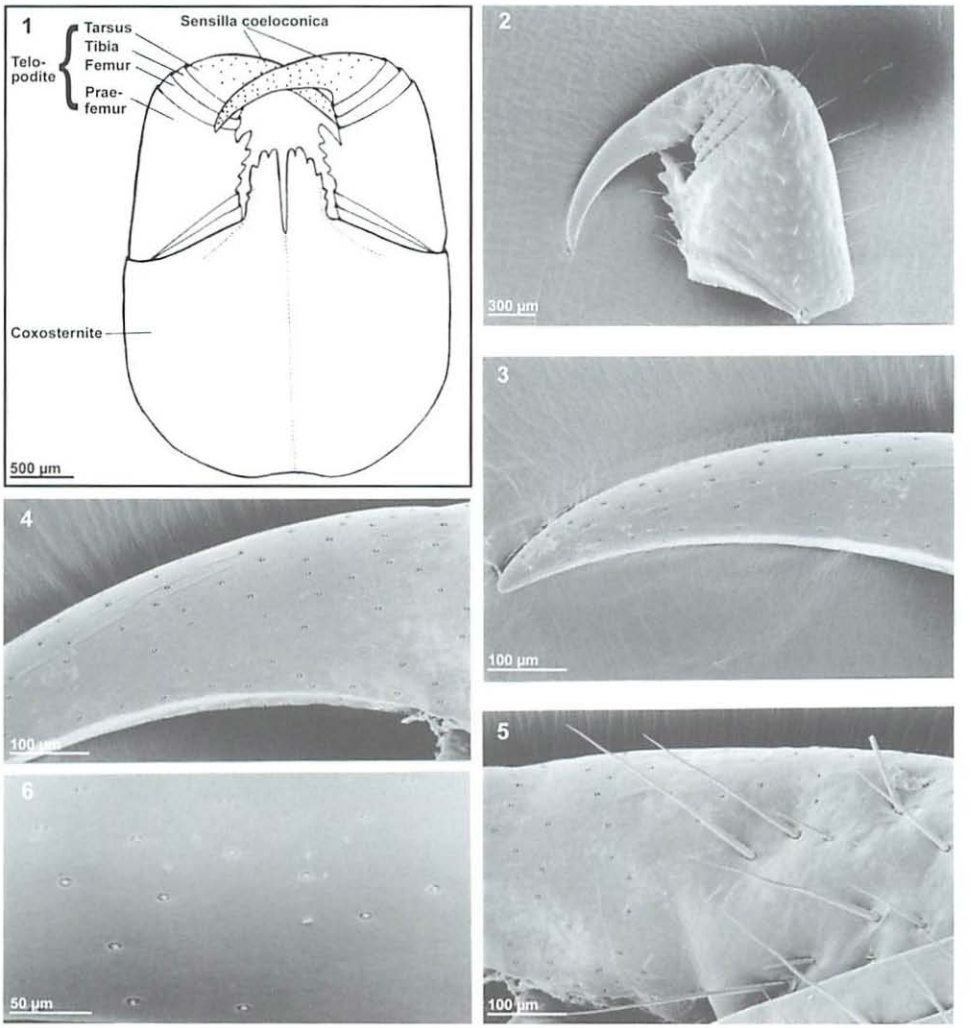
Three different types of sensilla coeloconica are distinguished. They are located on different sites of the tarsal segment of the maxillipede:

Type I: Thick and mostly conical sensilla. Numerous, located on the dorsal and ventral side of the maxillipede (Figs. 8 – 11).

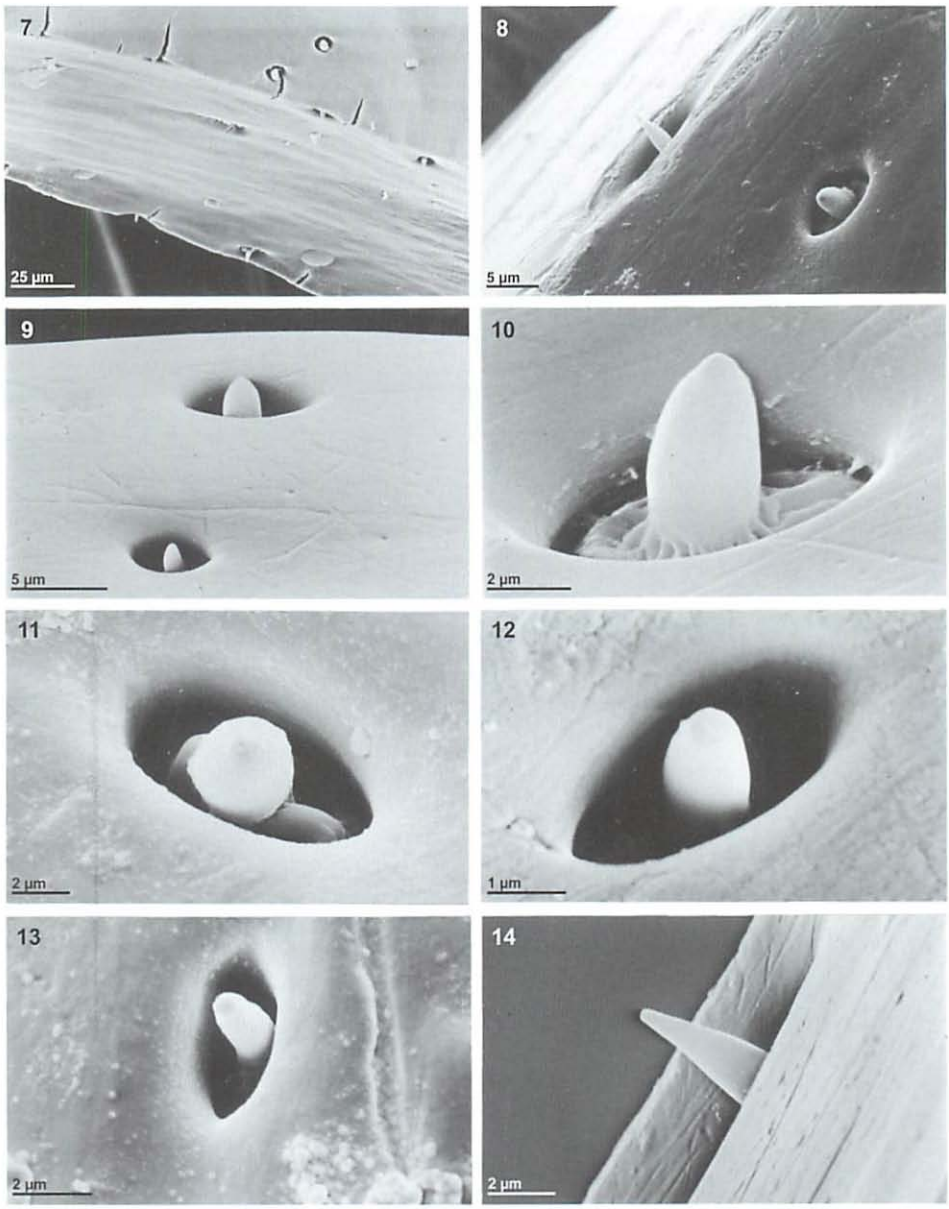
Type II: Thin and slender sensilla with rounded tips. Sparse, located only at the end of the claw (Figs. 9, 12, 13).

Type III: Long and tapered sensilla. In two rows along the rim of a groove on the inner side of the maxillipede (Figs. 7, 8, 14).

The thick **type I sensilla coeloconica** consist of conical and acute sensory cones with smooth surfaces. They are located centrally in a circular to oval pit. The pit diameters vary from 5.4 to 9.7 µm. Each sensillum has a terminal pore (0.12 µm diameter) at the tip of the cone (Fig. 11). The basal part of the cone is attached via a folded cuticular membrane to the wall of the pit (Fig. 10). Type I sensilla coeloconica are up to 4.8 µm long and from 2 to 3.2 µm in diameter.



Figs. 1 – 6 Sensilla coeloconica of *Craterostigmus tasmanianus*. – 1) Maxillipede (dorsal view, semi diagrammatic); 2) Left telopodite, ventral view; 3) Tip of the claw with numerous sensilla coeloconica (ventral view); 4) Middle region of the claw with numerous sensilla coeloconica (ventral view); 5) Ventral base of the claw with numerous sensilla trichodea and some sensilla microtrichodea; 6) Distal region of the claw (ventral) with numerous sensilla coeloconica (detail)



Figs. 7 – 14 Types of sensilla coeloconica in *Craterostigmus tasmanianus*: 7) Two rows of long sensilla coeloconica (type III) on the inner side of the maxillipede; 8) Detail with one thick s. coeloconicum (type I, right) and one long s. coeloconicum (type III, left); 9) Ventral tip of the claw with one thin (type II, lower part) and one thick sensillum coeloconicum (type I, upper part); 10) Type I sensillum coeloconicum with its basal folded cuticle; 11) Type I sensillum coeloconicum with a small terminal pore; 12) Type II sensillum coeloconicum with a large terminal pore; 13) Type II sensillum; 14) A long sensillum coeloconicum of type III on the inner side of the claw

The thin and slender **type II sensilla coeloconica** (Figs. 9, 12, 13) also have smooth surfaces. Each sensillum is located centrally in a circular cavity (diameter 4.1 to 6.9 µm) with a terminal pore up to 0.4 µm diameter. The terminal pore often appears closed by an electron-dense secretion product of the receptor-lymph fluid. The cone is up to 2.6 µm long and 0.8 to 1.8 µm in diameter.

The long and tapered **type III** sensilla coeloconica is characterized by a velvety surface (Figs. 7, 8, 14).Type 3 sensilla are not as smooth as type 1 and 2 sensilla. They are up to 4.5 µm long and from 1.4 – 1.9 µm in diameter. The terminal pore is present but difficult to detect. Each cone is situated in a large and elongated pit of 6.2 to 9.3 µm in diameter.

4. Discussion

Information on structure and function of cuticular hair sensilla in Chilopoda is meager. The first light microscopical observations were published by FUHRMANN (1922). Fine structural investigations were hitherto limited to *Lithobius forficatus* and *Necrophloeophagus longicornis* and focused mainly on sensilla on the antennae. Four distinct types of antennal hair sensilla with different functions have previously been described in centipedes:

(1) **Sensilla brachyconica** in *N. longicornis* with biciliate sensory cells. They are thought to function as thermo- and hygroreceptive sensilla (ERNST 1981, 1996, 1999).

(2) **Sensilla basiconica** in *N. longicornis* with uniciliate receptor cells (ERNST 1979) and in *L. forficatus* with uni- and biciliate receptor cells (KEIL 1975) with pore openings in the cuticular wall. They seem to function as olfactory sensilla.

(3) **Sensilla trichodea** with terminal pores in *N. longicornis* (ERNST 1976, 1996, 1999) and *L. forficatus* (KEIL 1975, 1976) with uniciliate chemoreceptive and biciliate mechanoreceptive cells which are thought to be contact-chemoreceptors.

(4) **Sensilla microtrichodea** with terminal pores in *N. longicornis* with uniciliate chemoreceptive and biciliate mechanoreceptive cells (ERNST 1983, 1996, 1997) and in *L. forficatus* without terminal pores and only with uniciliate mechanoreceptive cells (KEIL 1975).

Sensilla trichodea have also been found on the maxillae of *N. longicornis* (ERNST 1994). Review articles concerning location, structure and possible function of cuticular sensilla in »myriapod antennata« (Chilopoda, Diplopoda and Symphyla) are given by HAUPT (1979), NGUYEN DUY-JACQUEMIN (1990), and ERNST (2000). As electrophysiological investigations of sensilla have not yet been undertaken, the functions of these structures can only be inferred from morphological and fine structural details.

The present study demonstrates that the two tarsi of the maxillipedes of *Craterostigmus tasmanianus* are covered by numerous sensilla coeloconica. In the remaining chilopods three types of sensilla coeloconica of different size and shape are found. Nevertheless it is obvious that the length of each sensillum are larger in *C. tasmanianus* than in the above-mentioned chilopods (*L. forficatus*, *N. longicornis*; compare ERNST & ROSENBERG 2001). Each sensillum is composed of a short peg-shaped sensory cone situated in a

cuticular depression. The sensilla reach only a short distance above the rim of the pit. As revealed by SEM each sensillum bears a terminal pore.

The existence of a terminal pore on the tip of the sensilla coeloconica of *C. tasmanianus* suggests that the sensilla functions as a chemoreceptor. It is likely that the sensilla are involved in the detection of the prey and the control of claw penetration into the prey. Terminal pores are found in nearly all sensilla coeloconica of the hitherto investigated chilopod species. They are only absent in the thick conical type I sensilla of the maxillipedes of *N. longicornis* and *Cryptops hortensis* (Ernst & Rosenberg 2001).

In addition, the existence of uniciliate mechanoreceptive sensory cells with tubular bodies in the type II sensilla coeloconica of *L. forficatus* has been revealed by ultrastructural investigations (Rosenberg & Ernst 2001). These sensilla may function as contact chemoreceptors. In *N. longicornis* it has been shown that the thick type I sensilla coeloconica lack terminal pores and consist of 2 types of dendritic outer segments of different diameter. This points to a possible double function of these type I sensilla coeloconica: as hygro- and thermoreceptors, comparable to those in insects (Ernst 2000, Ernst & Rosenberg 2001). But ultrastructural and/or electrophysiological investigations are needed to reveal the function for the sensilla coeloconica of *C. tasmanianus*.

In all investigated chilopod species 3 types of sensilla are found: many thick sensilla (type I) distributed densely on the dorsal and ventral surface of the claw, only few thin sensilla (type II) located at the end of the maxillipede and long and tapered sensilla (type III) located in two rows on the inner side of the maxillipede (compare Ernst 1995, Ernst & Rosenberg 2001, Rosenberg & Ernst 2001). The occurrence of three types of sensilla in every higher taxon of the Chilopoda suggests that the particular arrangement of sensilla on the maxillipedes is an autapomorphic feature of the centipedes. It remains unclear whether sensilla coeloconica are homologous within the Antennata and thus part of a ground plan, since distinct structural differences (absence of terminal pores, ultrastructural details) are found among centipedes (Ernst 1995, 2000, Ernst & Rosenberg 2001, Rosenberg & Ernst 2001), millipedes (Nguyen Duy-Jacquemin 1983), and insects (Yokohari 1981, 1983, Altner et al. 1983).

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Authors' addresses:

Dr. Alfred Ernst
Institut für Spezielle Zoologie und Evolutionsbiologie
Friedrich-Schiller-Universität
D-07743 Jena

Dr. Jörg Rosenberg
Fakultät für Biologie, Lehrstuhl für Tierphysiologie, Ruhr-Universität Bochum
D-44780 Bochum
E-Mail: joerg.rosenberg@ruhr-uni-bochum.de

Dr. Robert Mesibov
Queen Victoria Museum & Art Gallery, Launceston
PO Box 101
Penguin, Tasmania, Australia 7316
E-Mail: mesibov@southcom.com.au

Dr. Gero Hilken
Zentrales Tierlaboratorium, Universitätsklinikum Essen
D-45122 Essen
E-Mail: gero.hilken@uni-essen.de