

The Great Lakes Entomologist

Volume 19
Number 4 - Winter 1986 *Number 4 - Winter*
1986

Article 4

December 1986

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Recommended Citation

Bland, R. G. 1986. "Antennal and Mouthpart Sensilla of the Blister Beetle. *Meloe Campanicollis* (Coleoptera: Meloidae)," *The Great Lakes Entomologist*, vol 19 (4)
DOI: <https://doi.org/10.22543/0090-0222.1582>
Available at: <https://scholar.valpo.edu/tgle/vol19/iss4/4>

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ANTENNAL AND MOUTHPART SENSILLA OF THE BLISTER BEETLE, *MELOE CAMPANICOLLIS* (COLEOPTERA: MELOIDAE)R. G. Bland¹

ABSTRACT

Sensilla on the sexually dimorphic antennae of the blister beetle, *Meloe campanicollis*, were primarily sensilla chaetica with scattered socketed and non-socketed sensilla basiconica. Forked chaetiform sensilla on the female's first segment are displaced by the antennal socket rim when the male grasps and lifts her antennae with segments 5 to 7 of his antennae. Segments 5 to 7 lack dense sensilla chaetica and have only patches of shorter sensilla. The segments also contain a high density of epidermal gland ducts compared to other segments. Maxillary palpi apices were similar in males and females, but the female's labial palpi contained fewer narrow and many more short, broad sensilla basiconica than the male's.

North American blister beetles (Meloidae) in the genus *Meloe* are dull black beetles, often with metallic blue, green, or purple hues. These soft-bodied beetles lack hind wings or have abbreviated, basally imbricated elytra. The subgenus *Meloe* is characterized, in part, by a modification of the male's antennae that functions to receive the female's antennae during courtship.

Pinto and Selander (1970) described the sexual behavior of *Meloe* species in their review of the bionomics and classification of New World *Meloe*. The male's antenation of the female is the dominant display activity. The male mounts the female dorsally and periodically attempts to grasp the basal or middle region of the female's antennae with segments 5 to 7 of his corresponding antennae. The three segments form a clasp that secures the antenna from underneath by bending at the articulation of segments 6 and 7. He then raises his head slightly which pulls the female's antennae upward. Antennal stroking toward the distal end is the most common motion and appears to be the result of unsuccessful attempts to grasp the female's antennae, such as when they are not easily accessible or are moving, rather than a consummatory act. Palpation of the female is a second display motion that occurs during antenation, whereby the male uses his maxillary palpi to rub the top and front of her head.

The specialized use of the clasping region of the male's antennae indicated that specific sense receptors might be present in that region, and complementary mechanoreceptors that respond to stroking may occur on the female's antennae. Therefore the morphology and distribution of all sensilla on the antennae and apex of the maxillary and labial palpi of *Meloe campanicollis* Pinto and Selander were characterized with a scanning electron microscope.

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METHODS AND MATERIALS

Specimens were collected in central Michigan in October 1984. Antennae and mouthparts were sonicated in a surfactant and air dried. They were sputter-coated with 30 nm of gold and observed with an AMR- 1200 scanning electron microscope.

RESULTS

Antennae

The antennae of males and females are 11-segmented and dimorphic (Fig. 1). Sensilla have been placed into five groups, A to E, and all sensillar types are found on the antennae of males and females except for two kinds of sensilla basiconica with sockets that were not observed on the female's antennae.

A. Sensilla chaetica (Fig. 2). These ridged receptors represent over 90% of the antennal sensilla. Long sensilla, 80–240 μm in length, are on segments 1 to 5 and 7 of the male's antenna and 1 to 7 on the female's. The longest sensilla occur on segments 1 and 2. Medium-length sensilla, 35–65 μm long, occur on segments 6 and 8 to 11 of the male's antennae and 4 to 11 on the female's.

B. Forked chaetiform sensilla (Figs. 3,4). Approximately 32 bifurcated chaetiform sensilla occur on the dorsal, lateral, and lateroventral portions of the basal region of segment one. They range from 20 to 110 μm in length. Some receptors are trifurcated on the female. When the antennae are raised, the forked sensilla shown in Figure 4 contact the rim of the antennal socket and are pressed forward.

C. Sensilla basiconica with sockets. Non-ridged, short sensilla, often with a bulbous socket (Fig. 5) are scattered on all segments and range from 10 to 14 μm in length. They also occur in two to three irregular rows near the tip of segment 10 on the male's antennae. Scattered, stout sensilla 9–15 μm long and with a smooth surface are found on segment 1.

A few stout, ridged, uniporous sensilla (Fig. 6) averaging 30 μm in length are scattered on the dorsal surface of segment 5 on the male. About 10 ridged, slender receptors (Fig. 9), 25 μm long, occur in the inner and outer patches of sensilla on segment 6 of the male.

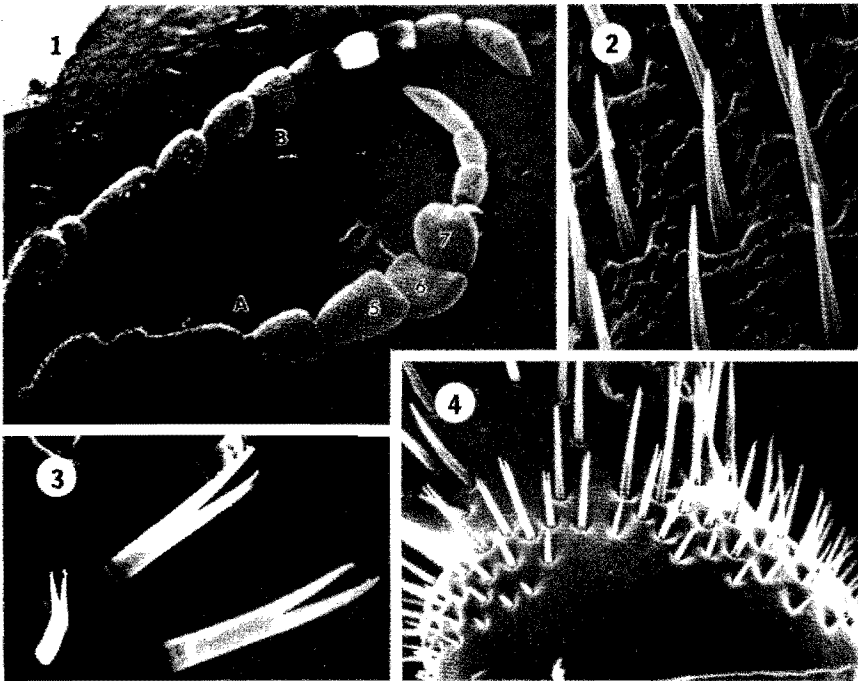
D. Sensilla basiconica without sockets. Non-ridged, short receptors occur on segments 10 and 11, with most on segment 11. The base enlarges into a bulbous projection that is continuous with the cuticle. They are uniporous and average 12 μm in length.

E. Domed sensilla basiconica (Fig. 7). Approximately 40 short, domed sensilla are scattered primarily over the basal two-thirds of segment 9 on the male's antennae. They are in sockets and are 6–10 μm in diameter and 5 μm high. These sensilla are also scattered in small numbers on segments 1 to 3 and 11 of the female's antennae.

Segments 5 to 7 of the Male's Antenna

In addition to having a different shape and arrangement from the other segments, these three segments also differ in two more ways.

1. They have fewer and shorter sensilla on the surfaces that contact the female's antenna (Fig. 8). On segment 6, a patch of 25–32 sensilla occur on the inner and outer halves of the dorsal surface. Most are medium length (35–50 μm), ridged sensilla chaetica as described in group A. About 10 short, ridged basiconic sensilla (Fig. 9) (group C) form the remainder on this segment; some also occur on the lower anterior face of segment 5. The lower posterior face of segment 7 has a small inner patch of sensilla similar to the inner patch of segment 6.



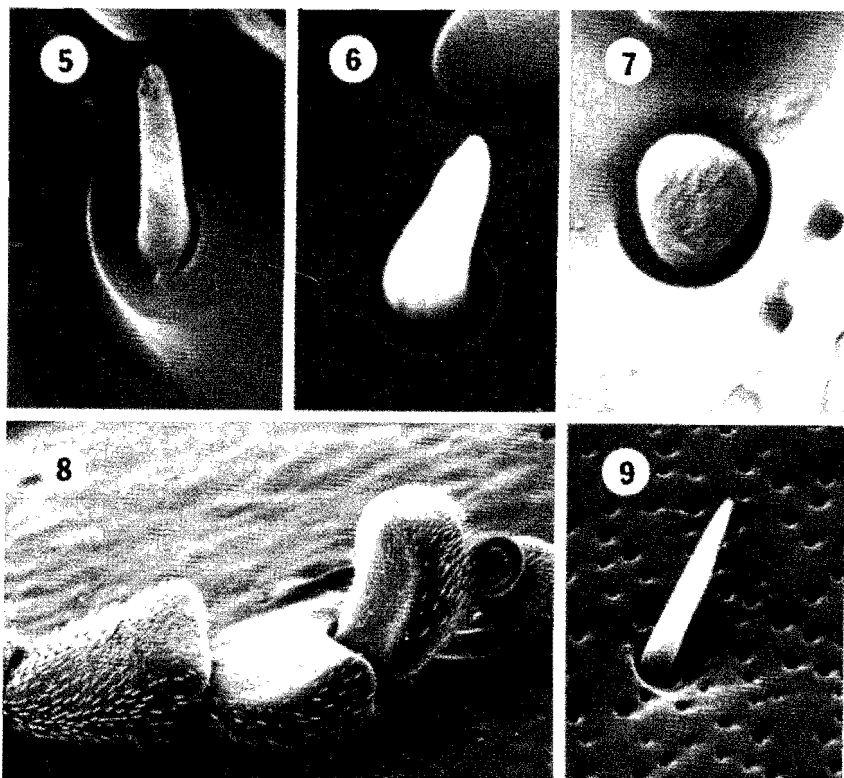
Figs. 1–4. (1) Antennae of a male (A) and female (B) *M. campanicollis*. Segments 5–7 are used to grasp the female's antenna or they may stroke her antenna if grasping is unsuccessful (10X). (2) Sensilla chaetica, medium length, on the dorsal surface of segment 5. These and the long sensilla chaetica are the most common receptors. This segment has a high density of epidermal gland ducts (675X). (3) Forked chaetiform sensilla on segment 1 (675X). (4) Arc of forked and single-tipped chaetiform sensilla at the base of segment 1. The longer receptors are displaced forward by the rim of the antennal socket when the antenna is raised (175X).

2. The density of epidermal gland ducts (Figs. 2,9) on the contacting surface of the three segments increases up to twice that of the non-contacting surface and nearly five times that of the remaining segments (Table 1). The ducts range from 0.6 to 1.5 μm in diameter.

Mouthparts

The terminal segment of the maxillary palpus is a flattened cylinder with a shallow furrow at its apex (Fig. 10). The furrow on the male's palpus averages 40 μm in width and 400 μm in length, and it contains about 110 basiconic sensilla (Fig. 11). Approximately 70 sensilla are broad and 7–8 μm long; 40 are narrower and 5–8 μm long. Terminal pores were observed on both narrow and broad sensilla. The furrow on the female's palpus is larger (60 \times 700 μm) and has approximately 107 broad and 88 narrow sensilla to total 195 receptors.

The apex of the male's labial palpus has a furrow that averages 30 μm wide and 350 μm long. Approximately 70 basiconic sensilla are present and consist of about 20 broad sensilla 5–10 μm long, and 45 narrower sensilla 4–5 μm long. Terminal pores were



Figs. 5–9. (5) Sensillum basiconicum with a bulbous socket on segment 10 (3970X). (6) Sensillum basiconicum with ridges and a terminal pore on segment 5 of the male (1590X). (7) Domed sensillum basiconicum (3970X). (8) Segments 5, 6, and 7 of the male's antenna illustrating the paucity of sensilla on the surfaces that grasp the female's antenna (30X). (9) High density of spidermal gland ducts on segment 6 of the male's antenna; also shown is a ridged and slender sensillum basiconicum (1110X).

observed only on the narrower sensilla. There were a few very short, broad sensilla 2–4 μm long. The female's labial furrow was 40 μm wide and 350 μm long. About 16 sensilla were broad, 19 were narrower, and 48 were very short and broad.

DISCUSSION

Scanning electron microscope studies of antennal sensilla and, to a lesser extent, mouthpart sensilla of adult beetles have been conducted by Mustaparta (1973), Payne et al. (1973), Dyer and Seabrook (1975), Hatfield et al. (1976), Staetz et al. (1976), Smith et al. (1976), Harbach and Larson (1977), Juberthie and Massoud (1977), Peck (1977), Dickens and Payne (1978), Bland (1981), Whitehead (1981), and Hallberg (1982a,b). Investigations that have emphasized cell ultrastructure by utilizing transmission electron microscopy were reviewed by Zacharuk (1985).

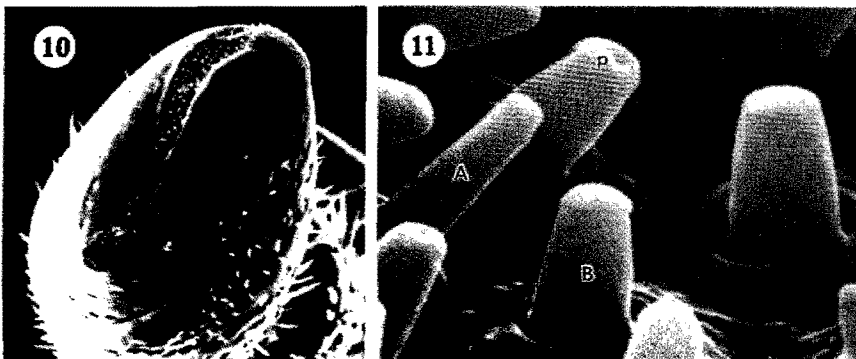
Table 1. Mean number of epidermal gland ducts per mm² on antennal segments of male and female beetles.

| Segment | Ducts/mm ² | |
|------------|-----------------------|--------|
| | Male | Female |
| 1 | 1.4 | 0.7 |
| 2 | 1.7 | 1.8 |
| 3 | 1.7 | 2.0 |
| 4 | 2.1 | 2.0 |
| 5 | 10.5 ^a | 0.7 |
| 6 | 19.5 ^b | 0.5 |
| 7 | 14.0 ^c | 0.8 |
| 8 | 3.5 | 1.4 |
| 9 | 3.5 | 1.7 |
| 10 | 4.0 | 2.5 |
| 11 | 6.0 | 2.5 |
| | Average | |
| 1-4 + 8-11 | 3.0 | 1.8 |
| 5-7 | 14.7 | 0.7 |
| 1-12 | 6.2 | 1.5 |

^a14.2/mm² on anterior (contacting) side; 7.5/mm² on dorsal and ventral sides.

^b11.2/mm² on ventral side.

^c19.4/mm² on posterior (contacting) side; 9.1/mm² on dorsal, ventral and anterior sides.



Figs. 10-11. (112X). (1) Narrow (A) and broad (B) basiconic sensilla on the apex of a maxillary palpus; (p) = terminal pore (3485X).

The sensilla on the antennae of *M. campanicollis* are very similar in external morphology to many of those of other beetles although the sensilla combinations vary for each species. There were no unusual mechanoreceptors on the female's antennae that might indicate a differential response to antennation by the male. The predominant sensilla chaetica are typical of mechanoreceptors, although there are also chemoreceptors with pointed tips as well as some with an additional mechanoreceptive function (McIver 1975). The tactile function of these sensilla is supported by the observation that the

antennation of the female by the male has a calming effect on the female and elicits the first sign of female receptiveness (Pinto and Selander 1970). When the female's antennae are raised by the male, the arc of forked mechanoreceptors on the basal portion of segment one is displaced by the socket rim. Their displacement may increase her receptivity to genital probing by the male as observed by Pinto and Selander (1970). The sensilla basiconica with sockets are most likely chemoreceptors. Sensilla basiconica with expanded bases and without sockets may be hygro- or thermoreceptors, based on similar non-porous sensilla identified by Altner et al. (1983). As with *M. campanicollis*, they found small numbers of these sensilla concentrated near the tip and distributed in low numbers on the rest of the antenna of a variety of insects. The domed basiconic sensilla lack a terminal pore and resemble mechanoreceptive campaniform sensilla, except that they rise from a relatively deep socket. Altner et al. (1983) described a similarly shaped hygro- or thermoreceptor on a carabid beetle although it also had a shallower socket.

The lack of long sensilla chaetica and fewer medium-length sensilla chaetica on the clasp segments of the male's antenna may provide a more solid and stable surface as well as more surface for grasping the female's antenna. The patches of shorter sensilla then are available to supply a more direct mechanoreceptive function since they are not overlaid by the larger sensilla.

The reason for the high density of epidermal gland ducts on the three segments is not readily apparent. They are responsible for secreting the cement layer of the epicuticle (Wigglesworth 1972). If these ducts release the same amount of fluid as on other segments, their high density may result in an overflowing effect to produce a thick and smooth buildup of the cement layer. Observations directly into the ducts showed no evidence of a sensillum. However, some cuticular pits are known to have deeply recessed sensilla ampullacea or campaniforma (Zacharuk 1985). An ultrastructural study is necessary to elucidate the nature of these ducts and determine the function of the various sensilla on the antennae and mouthparts.

The apex of the maxillary and labial palpi had no unusual sensilla present. The male's maxillary palpus had 50% more sensilla per unit area than the female's, and 9% more broad sensilla and 9% fewer narrow sensilla. The greater density on the male may increase his stimulus receptivity during his palpation of the female.

Although the sensilla on the apex of the male's labial palpus were only 14% more dense than those on the female's, there was a notable difference in the percentages of sensillar types. On the male's apex, 64% were the narrower type compared to 23% on the female, and only 7% were short and broad compared to 58% on the female. Pinto and Selander (1970) briefly described the feeding and grooming habits of *Meloe* spp. and did not identify any differences between males and females. Thus the large number of short, broad sensilla on the female may indicate their use in the selection, excavation, and filling of ovipositional sites as described by Pinto and Selander (1970).

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