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ANTENNAL SENSILLA AND SETAE OF *ANOPLIUS TENEBROSUS* (CRESSON) (HYMENOPTERA: POMPILIDAE)

STEVEN R. ALM AND FRANK E. KURCZEWSKI

(SRA) New York State Agricultural Experiment Station, P.O. Box 727, Hudson Valley Laboratory, Highland, New York 12528; (FEK) Department of Environmental and Forest Biology, SUNY College of Environmental Science and Forestry, Syracuse, New York 13210.

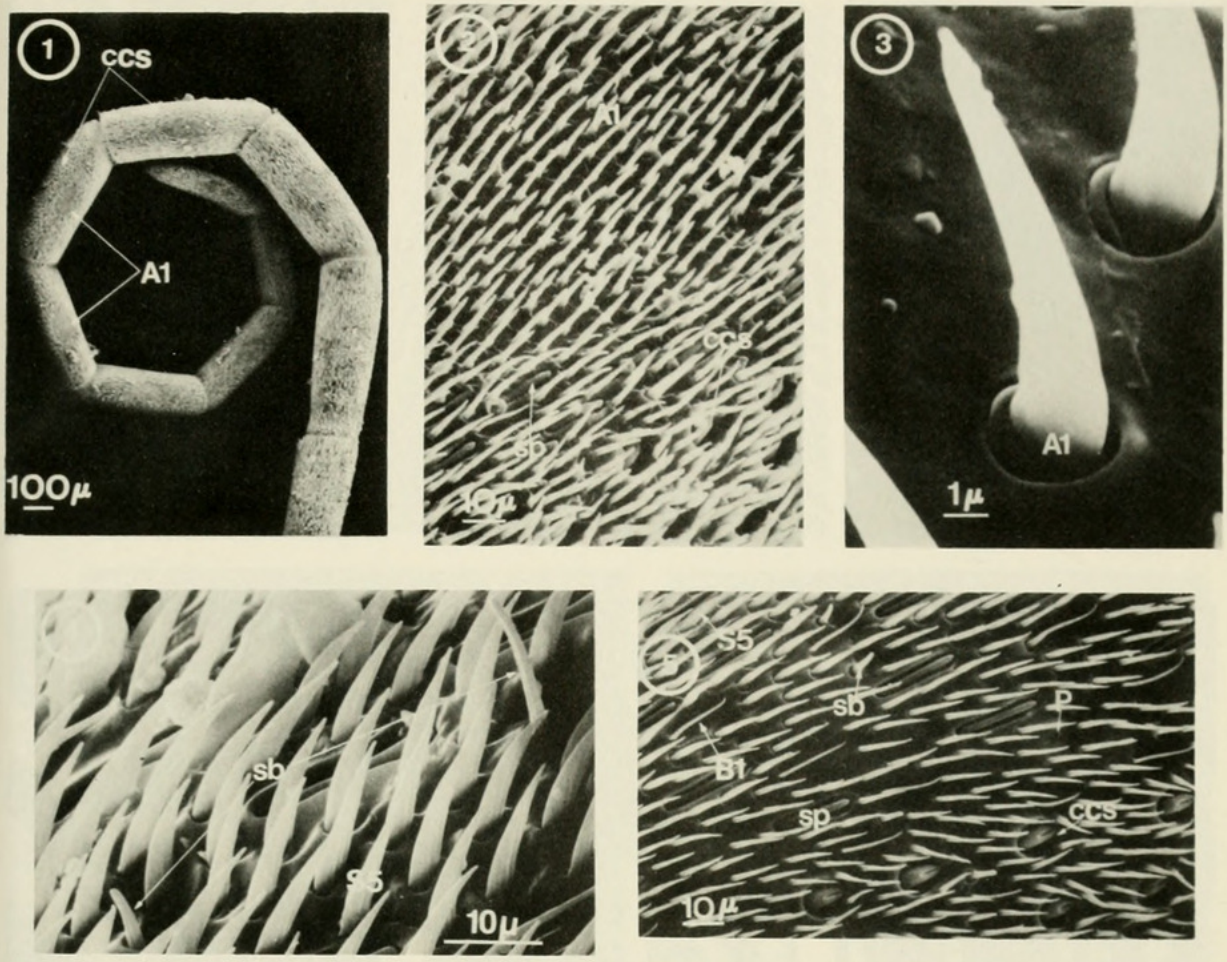
Abstract.—The antennal sensilla and setae of both sexes of *Anoplius tenebrosus* (Cresson) (Pompilidae) were examined with a scanning electron microscope. Sensilla placodea, corrugated conical sensilla, pit organs, sensilla campaniformia, sensilla trichodea A1, B1, C1, sensilla basiconica, and several types of setae were found, and are described and illustrated. The sensilla are rather similar in both sexes, except that females have numerous corrugated conical sensilla which males lack. Sensilla trichodea C1 are found only in the males. While most of the setae are similar in the two sexes, the shape and sculpturing of some distinguish males from females.

Scanning electron microscopy studies of Hymenoptera to date have primarily involved parasitoids, ants, social wasps, and bees. No such studies have been reported for the Pompilidae, or spider wasps. In the following examination of *Anoplius tenebrosus* antennae, the external morphology of various sensilla are illustrated and described. Morphological similarities of *A. tenebrosus* sensilla to those of other Hymenoptera are noted, and the possibilities of functional analogies are discussed.

MATERIALS AND METHODS

Air dried antennae of male and female *A. tenebrosus* were mounted on specimen studs with silver conducting paint. Specimens were coated *in vacuo* with a gold/palladium mixture. The microscope used was an ETEC autoscan, model R1, at accelerating voltages of 10–20 KV.

The nomenclature follows that of Ågren (1977), who combined the classifications of Lacher (1964) and Esslen and Kaissling (1976), except for the corrugated conical sensillum and sensilla trichodea designated A1, B1, C1 for Pompilidae. Flagellar segments are designated fl.1, 2, etc. from proximal to distal.



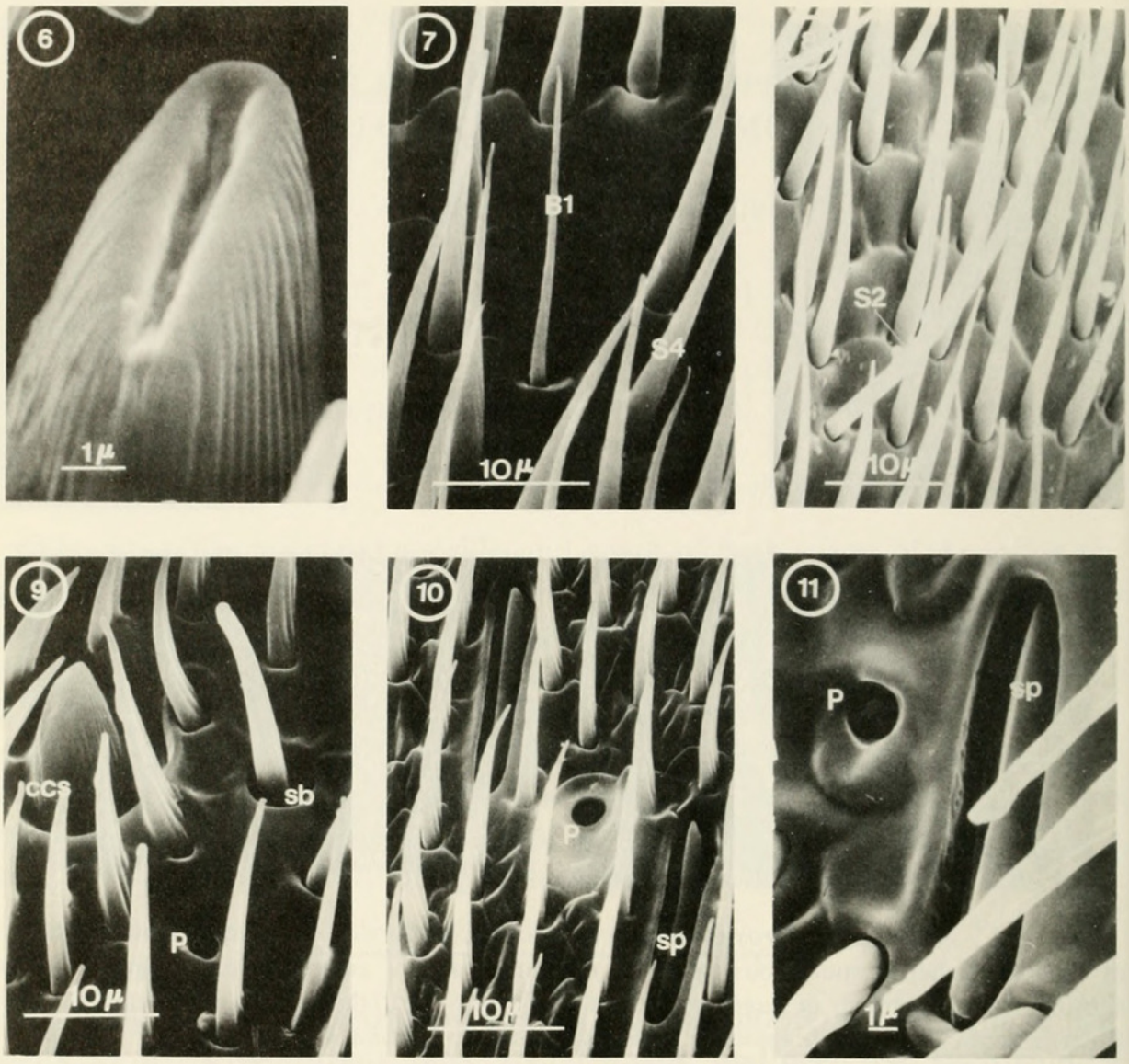
Figs. 1–5. *Anoplius tenebrosus*, female antenna. 1, Underside of antenna showing patches of sensilla trichodea; numerous openings on outer edge of antenna are corrugated conical sensilla. 2, Enlargement of flagellar segment 5. 3, Sensilla trichodea, flagellar segment 10. 4, Enlargement of flagellar segment 4. 5, Enlargement of flagellar segment 7. A1 = sensilla trichodea; B1 = slender sensilla trichodea; ccs = corrugated conical sensilla; P = pit organ; sb = sensilla basiconica; sp = sensilla placodea; S5 = sabre-shaped seta.

Results

Specimens of Pompilidae have filiform antennae. Females of *A. tenebrosus* have 12 segments, males 13 including the scape and pedicel. The sensilla and setae are as follows:

Sensilla placodea (Figs. 2, 5, 10, 11, 16, 17, 20).—These elongate sensilla are found on fl.2–11 in males and are distributed around the entire flagellum. In females they are found on fl.1–10 and are dispersed in an area encompassing slightly more than half of each flagellum. Females possess a region of corrugated conical sensilla in which s. placodea are not found. Sensilla placodea consist of pits averaging 3.5 × 18.4 μ (females), 3.7 × 18.3 μ (males) which contain elongate sensilla.

Corrugated conical sensilla (Figs. 1, 2, 5, 6, 9).—These sensilla are found only in females on fl.1–10. They are one of the more numerous types of

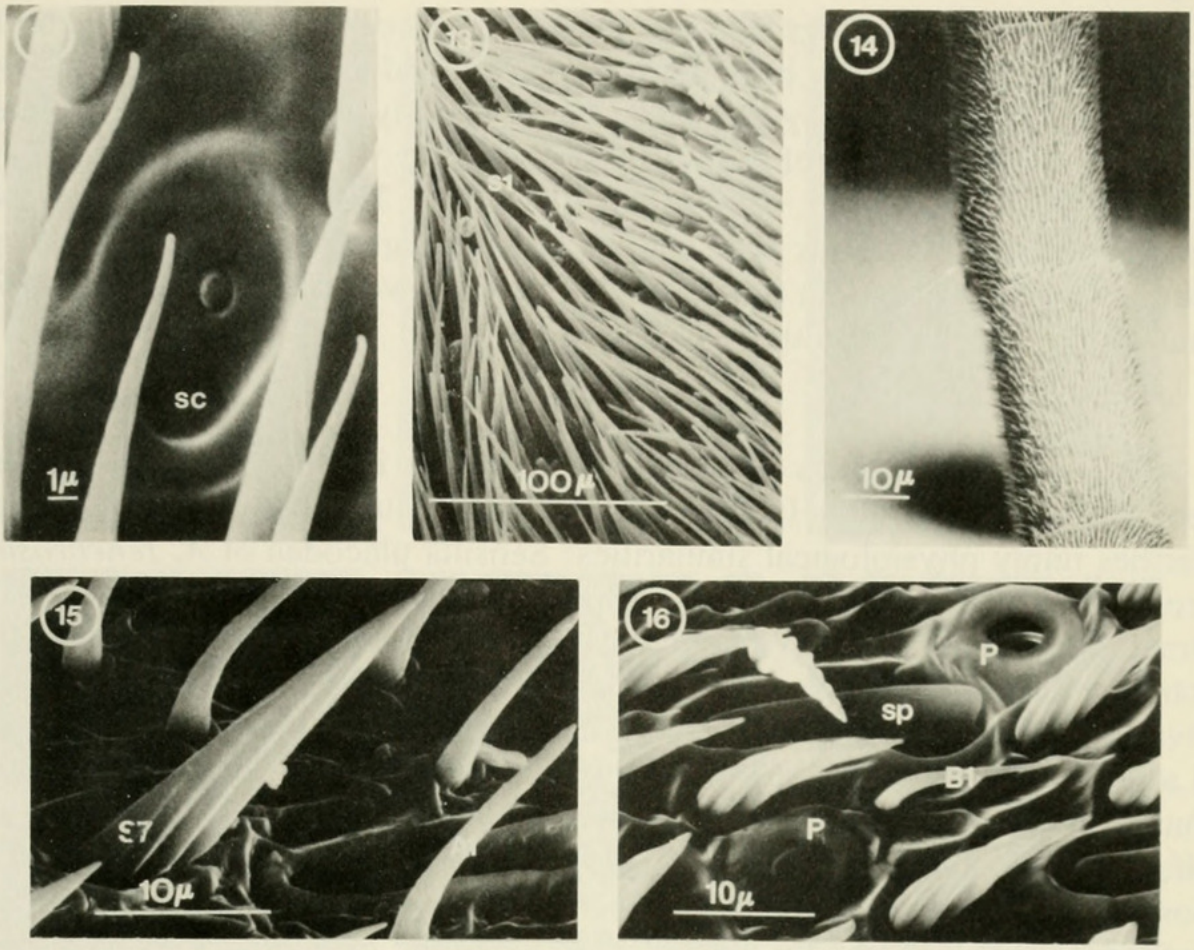


Figs. 6–11. *Anoplius tenebrosus*, female antenna. 6, Corrugated conical sensilla, flagellar segment 2. 7, Enlargement of flagellar segment 1. 8, Long setae on scape. 9, Enlargement of flagellar segment 2. 10, Enlargement of flagellar segment 6. 11, Enlargement of flagellar segment 2. B1 = sensilla trichodea; ccs = corrugated conical sensilla; P = pit organ (Fig. 9, probably s. ampullacea; Fig. 10, probably s. coeloconica); sb = sensilla basiconica; sp = sensilla placodea; S2 = long seta; S4 = seta.

sensilla *A. tenebrosus* females possess (see Fig. 1). The oval pit surrounding the sensillum is approximately 7.6 × 9.6 μ and contains a conical shaped peg which is corrugated and has the apex recessed.

Pit organs (Figs. 5, 9–11, 16, 18, 21).—Pit organ openings of *A. tenebrosus* range from 1.1 to 5.7 μ. Some pit organs contain pegs that are not exposed above the rim around the opening.

Sensilla campaniformia (Figs. 12, 20).—Sensilla campaniformia are found on fl.1, 3–6, and 9 in males and 1–10 in females. They consist of a slightly



Figs. 12–16. *Anoplius tenebrosus*, antenna. 12–13, Female. 14–16, Male. 12, Enlargement of flagellar segment 1. 13, Enlargement of scape, 14, Flagellar segments 5–8 showing differential setae on underside of antenna (arrow); region composed of stout setae, sensilla trichodea, and sensilla placodea. 15, Enlargement of flagellar segment 7. 16, Enlargement of flagellar segment 2. A1 = sensilla trichodea; B1 = sensilla trichodea; P = pit organs; sc = sensilla campaniformia; sp = sensilla placodea; S1 = smooth setae; S7 = stout setae.

depressed oval region ca. 6.3 × 9.6 μ (females) and 5.5 × 6.9 μ (males) with a centrally located node.

Sensilla trichodea A1 (Figs. 1–3, 15, 17).—These receptors are found on the undersides of fl.1–10 in females and 1–11 in males. They occur in patches in females; in males they are more numerous but are not found in patches. This sensillum is smooth, sabre-shaped and appears to have a terminal papilla.

Sensilla trichodea B1 (Figs. 5, 7, 16).—Sensilla trichodea B1 are found on all flagellar segments and pedicels of both males and females. They are slender structures that lay close and nearly parallel to the cuticle.

Sensilla trichodea C1 (Figs. 17, 19).—These sensilla are found mainly on the undersides of fl. 1–11 in males. They are deeply ridged and are nearly perpendicular to the flagellar segment.

Sensilla basiconica (Figs. 4, 5, 9, 18).—These receptors are found in both sexes on all flagella. They have blunt tips, are found in pits and are relatively common (see Fig. 5). They are ridged but not nearly as much as s. trichodea C1. There are two sizes of this sensillum (see Fig. 4).

Setae S1–S7 (Figs. 4, 5, 7, 8, 13, 15, 17, 18, 21, 22).—These appear to be modifications of one basic type and the sculpturing and thickness vary considerably from smooth on the scape (S1) to stout with deep sculpturing (S7, males only) on the flagellum.

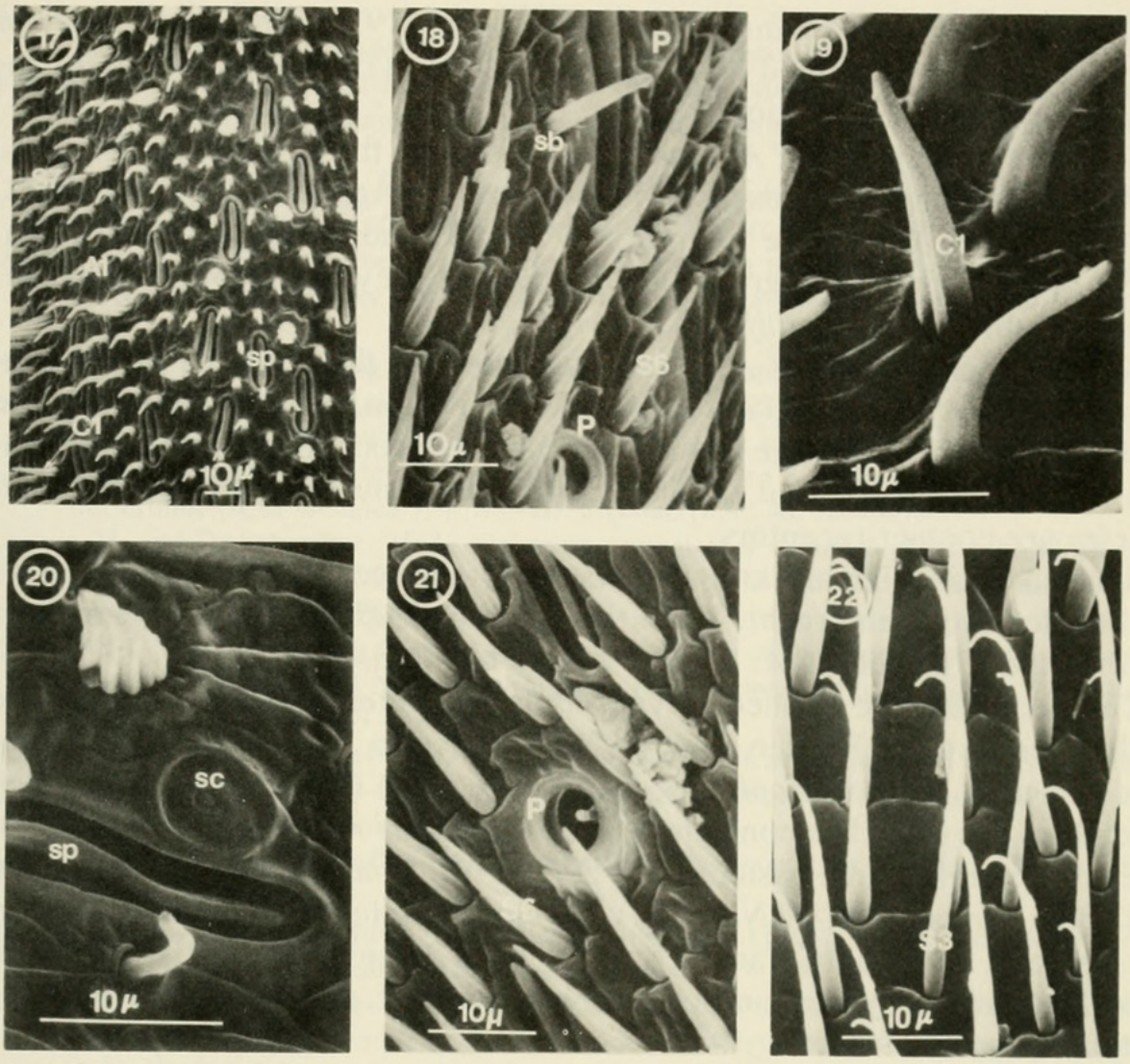
Discussion

Although the functions of the various sensilla in Pompilidae and other morphologically related Hymenoptera are mostly unknown, structural similarities imply physiological similarities. Sensilla placodea of *A. tenebrosus* are similar to those found in the Vespidae (Spradbery, 1973; Callahan, 1975), Braconidae (Norton and Vinson, 1974a, 1974b; Borden et al., 1978b), and Ichneumonidae (Borden et al., 1973, 1978a; Norton and Vinson, 1974b). Oval s. placodea of *Apis mellifera* L. have been shown to be odor receptors (Lacher and Schneider, 1963 [cited by Ågren, 1977]). Slifer (1970) suggested that the s. placodea of *Nasonia vitripennis* (Walker) (Pteromalidae) have an olfactory function. Richerson et al. (1972) and Richerson and Borden (1972) postulated that the s. placodea of *Coeloides brunneri* Viereck (Braconidae) function in host finding by detection of metabolic heat produced by a host beetle larva beneath bark.

Corrugated conical sensilla are found only in females of *A. tenebrosus*. The apex of this sensillum was found to be recessed in air dried specimens. Spradbery (1973) called similar structures on Vespidae, s. campaniformia; however, it seems unlikely that so many s. campaniformia would be found on the antenna. Callahan (1975) named a similar sensillum of *Polistes metricus* Say (Vespidae) a corrugated pyramidal sensillum, and his nomenclature has been modified for the conical shaped peg of *A. tenebrosus*. Kaissling (personal communication) stated that this receptor is reminiscent of a taste bristle, s. chaeticum. Ulla Klein, working in Kaissling's laboratory, found similar structures to be taste bristles in crickets.

Pit organs are thought to function as CO_2, temperature, and/or humidity receptors in *A. mellifera* (Lacher, 1964 [cited by Ågren, 1977]). In *A. tenebrosus* they may function similarly. These organs can be separated into s. ampullacea or s. coeloconica by the structure of the sensory peg within the pit (Dietz and Humphreys, 1971). Scanning electron microscopy of *A. tenebrosus* antennae does not reveal enough of the peg to differentiate between these organs.

Sensilla campaniformia are probably mechanoreceptors in *A. mellifera* (Esslen and Kaissling, 1976 [cited by Ågren, 1977]). Dietz and Humphreys



Figs. 17–22. *Anoplius tenebrosus*, male antenna. 17, Enlargement of flagellar segment 2. 18, Enlargement of flagellar segment 8. 19, Enlargement of flagellar segment 3. 20, Enlargement of flagellar segment 9. 21, Enlargement of flagellar segment 9. 22, Enlargement of pedicel. A1 = sensilla trichodea; C1 = sensilla trichodea; P = pit organ (probably sensilla coeloconica in Fig. 21); sb = sensilla basiconica; sc = sensilla campaniformia; sp = sensilla placodea; S3 = seta; S6 = seta; S7 = stout seta.

(1971) suggested that mechanical depression of the node of s. campaniformia in *A. mellifera* may result in a neural response but added that the numerous hairs on the antennae would probably prevent that mode of stimulation from taking place. S. campaniformia have been found in several species of bees, but not in all wasps.

Sensilla trichodea A1 of *A. tenebrosus* bear resemblance to the small trichoid of *Cheiloneurus noxius* Compere (Encyrtidae) (Weseloh, 1972), curved non-fluted sensilla of *Cardiochiles nigriceps* Viereck (Braconidae) (Norton and Vinson, 1974a), s. chaetica$_1$ in *A. mellifera* (which also has a terminal papilla) (Whitehead and Larsen, 1976), and the s. trichodea A of

Colletidae (Ågren, 1977) and Andrenidae (Ågren, 1978). The morphology of a similar sensillum studied by Slifer and Sekhon (1961) in *A. mellifera* indicated an olfactory function.

Sensilla trichodea B1 of *A. tenebrosus* resemble the s. trichodea B2 of *A. mellifera* (Esslen and Kaissling, 1976 [cited by Ågren, 1977]) and the s. trichodea B of Colletidae (Ågren, 1977) and Andrenidae (Ågren, 1978). Lacher (1964 [cited by Ågren, 1977]) indicated they are responsive to mechanical stimuli in *A. mellifera*.

Sensilla trichodea C1 of *A. tenebrosus* look like the fluted basiconic sensilla of *Cardiochiles nigriceps* (Norton and Vinson, 1974a). However, the tip is more pointed and the sculpturing more pronounced. Norton and Vinson (1974b) suggested that the fluted basiconic sensilla of three parasitoid species are contact receptors.

Sensilla basiconica are known to be olfactory receptors in many insects (Schneider and Steinbrecht, 1968), although attempts to determine a function for these sensilla in *A. mellifera* have been unsuccessful.

The nomenclature applied to various hymenopteran sensilla is unstable at the present time. Borden et al. (1973) described a "new" sensillum (truncate cuticular peg) on *Itoplectis conquisitor* (Say) (Ichneumonidae) which resembles the small basiconicum b of *Cheiloneurus noxius* (Weseloh, 1972). The small, subterminal basiconicum of *C. noxius* may be homologous to the basiconic capitate peg of *Nasonia vitripennis* (Miller, 1972). Other similarities among sensilla of various groups have been discussed. Only from knowledge of the neuro- and electrophysiology of each sensillum will this instability be resolved.

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