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Sensilla and Comparative Morphology of the Apical Segments of the Female Maxillary and Labial Palpi in the Genus *Damaster* (Coleoptera: Carabidae)

Jung Lark KIM and Tsukané YAMASAKI

Department of Natural History, Graduate School of Science, Tokyo Metropolitan University, Minami-ohsawa 1–1, Hachioji-shi, Tokyo, 192–0397 Japan

Abstract. Sensilla on the female maxillary and labial palpi of five species of the genus *Damaster* were investigated with scanning electron microscopy. A total of 6 types of sensilla were observed in the apical semi-membranous area of both palpi: peg-like sensilla basiconica, cone-like sensilla basiconica types I and II, multiporous sensilla types 1 and 2, and sensilla campaniformia. No difference in the distribution pattern of sensilla between the maxillary and labial palpi were found. Based on the external morphology, each type of basiconic sensilla could be subdivided into 3, 7 or 2 subtypes, respectively. While the multiporous and campaniform sensilla were common in all the species examined, interspecific distributional variation in the subtypes of those sensilla basiconica were noticed. In addition to these results, comparative morphology of the apical segments of both palpi is discussed.

Key words: Sensilla, palpus, Carabidae, *Damaster*.

Introduction

The structure and related feeding mechanism of the mouthparts of carabid beetles have been well known (*e.g.*, Ishikawa, 1978; Evans & Forsythe, 1985). However, information of the sensilla responsible for perceiving stimuli has been provided recently. Kim & Yamasaki (1996a) have reported the sensilla on the mouthparts with the antenna and other body parts of *Carabus* (*Isiocarabus*) *fiduciarius saishutoicus*. The same authors (1996b) have discussed distribution patterns and probable functions of sensilla and comparative morphology of the apical segments of the female maxillary and labial palpi in the genus *Leptocarabus*. In this successive paper for providing further information to carabid sensory system, sensilla on the apical segments of the female maxillary and labial palpi in the genus *Damaster* are described. The structure of the apical segments of both the palpi are also compared.

Materials and Methods

Five female carabid species in 3 subgenera of the genus *Damaster* were invetigated: *Damaster* (*Acoptolabrus*) *leechi*, *D.* (*A.*) *gehinii*, *D.* (*Coptolabrus*) *jankowskii*, *D* (*C.*) *smaragdinus* and *D.* (*Damaster*) *blaptoides*. The conducted methods for scanning electron microscopy and measurements for sensilla and both palpi are as described in the preceeding report (Kim & Yamasaki, 1996b).

The abbreviations used for Tables and Figures are as follows: lee, *D.* (*A.*) *leechi*; geh, *D.* (*A.*) *gehinii*; jan, *D.* (*C.*) *jankowskii*; sma, *D.* (*C.*) *smaragdinus*; bla, *D.* (*C.*) *blaptoides*.

Results

The apical segments of 4-segmented maxillary and 3-segmented labial palpi of the genus *Damaster* are somewhat subtriangularly extended distally. The sensilla at the distal semi-membranous portion of both apical segments were investigated. The sensilla occur abundantly at the portion, but they are categorized as a total of 6 types: peg-like sensilla basiconica, cone-like sensilla basiconica types I and II, multiporous sensilla types 1 and 2, and sensilla campaniformia. No difference in the distribution pattern of sensilla between the maxillary and labial palpi is found. The sensilla types and their mean dimensions are summarized in Table 1.

Sensilla basiconica

These apically uniporous and smooth-surfaced sen-

Table 1. Mean dimensions (μm, length×basal width)* of sensilla in the apical semi-membranous areas of the female maxillary and labial palpi of the genus *Damaster*.

Sensilla type		Species				
		lee	geh	jan	sma	bla
Basiconic						
peg-like	1	3.7×3.0	3.3×2.4	4.2×2.6	3.7×2.9	3.5×2.8
	2	2.8×2.6	2.8×2.2	3.2×2.4	2.8×2.4	3.0×2.7
	3	2.4×2.4	—**	—	—	2.6×2.1
cone-like I	1	3.2×2.4	3.2×2.2	3.7×2.7	3.5×2.6	3.7×2.7
	2	2.4×2.2	2.6×2.2	2.6×2.4	2.6×2.6	3.2×2.6
	3	—	2.2×2.0	2.2×2.1	2.1×2.1	—
	4	2.5×1.9	—	—	—	—
	5	—	—	2.7×1.9	—	—
	6	—	—	—	2.1×1.9	—
	7	—	—	—	—	3.2×2.2
cone-like II	1	2.6×1.9	3.0×1.7	—	—	3.7×2.4
	2	—	—	—	—	3.2×2.2
Multiporous	1	4.3	3.2	5.6	5.1	4.7
	2	5.4	5.2	4.4	5.4	4.8
Campaniformia		0.7	0.7	0.8	0.9	0.7

* Dimensions of the multiporous sensilla types 1 and 2 are of the long axes and campaniform sensilla are of the diameter for cap.

** A dash means that appropriate sensillum was not found.

silla are observed abundantly in all the species examined. Based on the external morphology, peg- and cone-like types I and II sensilla basiconica could be subdivided into 3, 7 and 2 subtypes, respectively (Figs. 1–9). Interspecific differences of distribution patterns of those subtypes are recognized among the species examined.

Peg-like sensilla are gently narrowed to a blunt tip (Figs. 1–4 and 8). All the subtypes are similar in shape to one another, but are classified by the size. The smallest subtype 3 is not found in *D.* (*A.*) *gehinii* and the species of the subgenus *Coptolabrus*.

Cone-like sensilla basiconica type I are somewhat strongly narrowed to an apex (Figs. 1–9). Although subtype 1 of *D.* (*A.*) *gehinii* has more sharpened tip than in the other species examined (Fig. 1), subtypes 1 to 3 are generally obtuse and subdivided by the size. The smallest subtype 3 is not observed in *D.* (*A.*) *leechi* and *D.* (*D.*) *blaptoides*. The shaft of subtype 4 is strongly narrowed to a uniporous tip and occurs only in *D.* (*A.*) *leechi* (Fig. 5). Acute subtype 5 (Fig. 6) is found in *D.* (*C.*) *jankowskii*. Subtype 6 (Fig. 7) of *D.* (*C.*) *smaragdinus* is similar to subtype 3 but has evidently narrower width. More or less lanceolated subtype 7 (Fig. 8) is observed only in *D.* (*D.*) *blaptoides*.

Cone-like sensilla basiconica type II have a slightly drawn, uniporous blunt tip (Figs. 1–2, 4 and 9). They are not observed in the subgenus *Coptolabrus*. Subtype 2 is similar in shape to subtype 1 but has evidently smaller size (Fig. 4) and is found only in *D.* (*D.*) *blaptoides*.

Multiporous sensilla

These probable placoid sensilla occur in a small number in all the species examined.

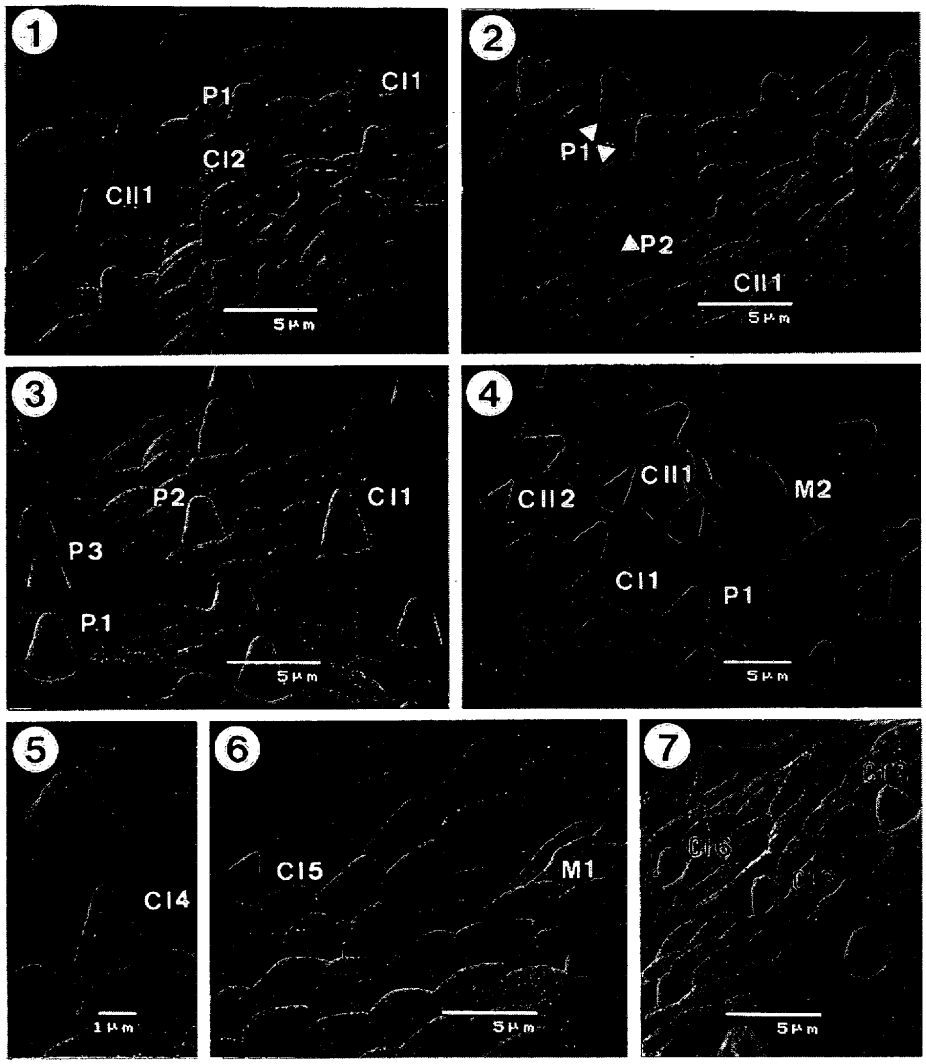
Multiporous type 1 (Figs. 6 and 10) is usually elliptical and level with the surrounding surface or somewhat raised. Some irregular variations in size and shape are found.

Multiporous type 2 (Figs. 4 and 8) is circular and also level with the surrounding surface or somewhat raised with the surrounding cuticle. The surface is generally plain but rarely depressed in the central part.

Sensilla campaniformia

These small sensilla occur abundantly in all the species examined. The papilla-like sensilla are surrounded by a ring of slightly raised cuticle (Fig. 11).

The shapes of the apical segments of the maxillary and labial palpi are compared. The illustrations and dimensional ratios of length/apical width are given in Fig. 12 and Table 2. If the ratio values are lower, it may mean that the dilatation degree of the apex is larger for the length of the segment or its length is shorter for the apical dilated degree. Generally, the

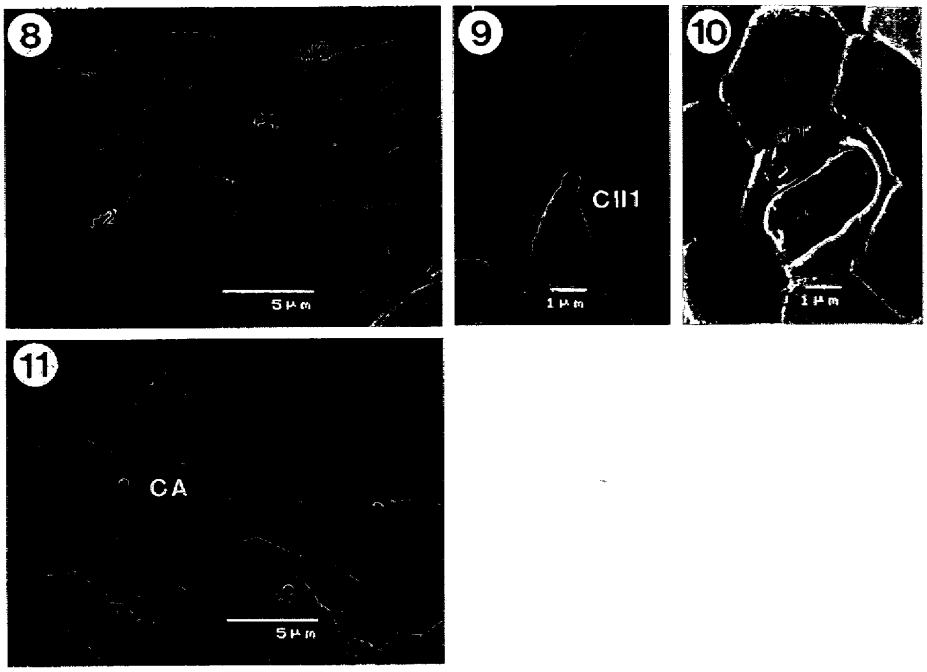


Figs. 1–7. Sensilla in the apical semi-membranous area of the female maxillary and labial palpi of the genus *Damaster*. —— 1, *D.* (*A.*) *gehinii*; 2 and 5, *D.* (*A.*) *leechi*; 3 and 7, *D.* (*C.*) *smaragdinus*; 4, *D.* (*D.*) *blaptoides*; 6, *D.* (*C.*) *jankowskii* (Figs. 2, 3 and 5 are of the maxillary palpus and the others of the labial palpus; P1, P2 and P3 = peg-like sensilla basiconica subtypes 1, 2 and 3, respectively; CI1 to CI6 = subtypes 1 to 6 of cone-like sensilla basiconica type I, respectively; CII1 and CII2 = subtypes 1 and 2 of cone-like sensilla basiconica types II, respectively; M1 and M2 = multiporous sensilla types 1 and 2, respectively).

labial palpus has slightly lower ratio values than the maxillary palpus. Interspecific difference of the values is recognized. In *D.* (*D.*) *blaptoides*, the values of both palpi are the highest, *i.e.*, having the largest apical dilatation as illustrated in Fig. 12 and the smallest in *D.* (*A.*) *leechi* among the species examined.

Discussion

The palpal chemosensilla responsible for tasting and smelling, some also having mechanosensitivity, are primarily or wholly concentrated at or near the tip of the terminal segment (Zacharuk, 1985). Especially, in both adult and larval beetles, the apices of the palpi nearly always bear a semi-membranous area set with short sensilla (Crowson, 1981). This is no exception in the genus *Damaster*, that is, a total of 6 types of sensilla are observed abundantly at the apical semi-membranous portion. The probable function of the palpal sensilla at the portion has been suggested in the genus *Leptocarabus* (Kim & Yamasaki, 1996b): uniporous basiconic sensilla as contact, gustatory or taste, multiporous sensilla as olfactory, and companiform sensilla as mechanosensilla. The sensitivities of these kinds of sensilla are supported by the authors (*e.g.*, Schneider & Steinbrecht, 1968: McIver, 1985; Zacharuk, 1980; 1985). Along the shafts of palpal segments, two types of basiconic sensilla have been reported in *Carabus* (*Isiocarabus*) *fiduciarius saishutoicus* (Kim & Yamasaki, 1996a). Though they have not



Figs. 8–11. Sensilla in the apical semi-membranous area of the female maxillary and labial palpi of the genus *Damaster*. ——8, *D.* (*D.*) *blaptoides*; 9–11, *D.* (*A.*) *gehinii* (Figs. 8 and 10 are of the maxillary palpus and the others of the labial palpus; CI7 = subtype 7 of cone-like sensilla basiconica type I; CA = sensilla campaniformia).

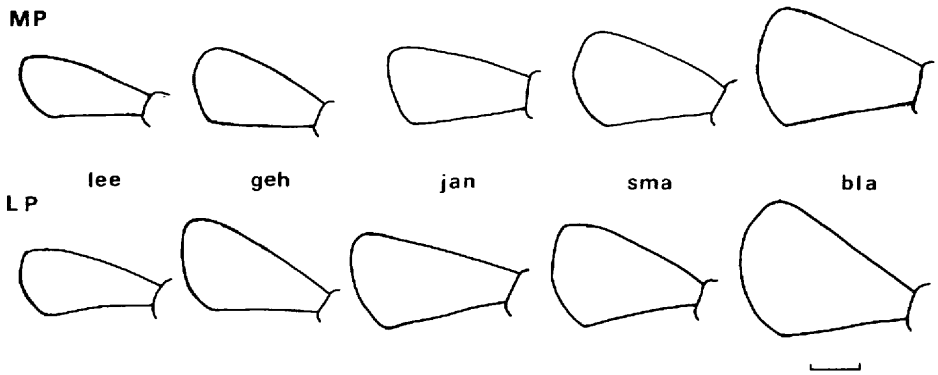


Fig. 12. Apical segments of the maxillary (MP) and labial (LP) palpi of the genus *Damaster* (Scale bar = 500 μm).

Table 2. Mean dimentional ratios (length/apical width) of the apical segments of the female maxillary and labial palpi of the genus *Damaster*.

Palpus	Species				
	lee	geh	jan	sma	bla
Maxillary	2.0	1.8	1.7	1.6	1.4
Labial	2.0	1.9	1.6	1.5	1.3

been illustrated, these are also found in this study and the above mentioned genus *Leptocarabus*. These sensilla on the structures are considered to act as mechanosensilla (Zachruk, 1985).

In comparison with the distribution patterns of palpal sensilla of the genus *Leptocarabus* in the preceding paper (1996b), dome-like basiconic sensilla are not found in this study. On the other hand, in the genus *Damaster* of this study, the cone-like sensilla basiconica, showing some different distribution patterns among the species examined, are more diversely distributed. And their type II and subtypes 4 to 7 of type I are newly observed in this study. The others, peg-like basiconic, multiporous and campaniform sensilla, are observed commonly in both the genera.

Interspecific difference in shapes of the terminal segments of the maxillary and labial palpi causing by various apical dilatation degree is noticed. Accordingly, though many characters have been used for phylo-

genetical study of the genus *Damaster* (Ishikawa, 1986), not only those difference in shape of the apical segments but also the variations in sensillar distribution patterns are expected to provide additional information for ultimate phylogenetical research in this taxon and other carabid beetles.

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