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continued on the back inside cover

Cover: Tamil Lacewing *Cethosia nietneri* with colour pencils and watercolours for the background; detailing with fine liners by Elakshi Mahika Molur.

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ARTICLE

Ultra-structure of antenna, eye, mouthparts and sensilla of *Cheilomenes sexmaculata* Fabricius, 1781 (Coccinellidae: Coleoptera)

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Abstract: *Cheilomenes sexmaculata* Fabricius, 1781 is a well-known ladybird beetle that feeds primarily on aphids, mealy bugs, phytophagous mites, scale insects, and other small insects and is an important bio-control agent of aphids. Evolution in the structure of mouthparts is known to be associated with the composition of food material and feeding behaviour. The sensilla present on mouthparts plays a pivotal role in feeding mechanisms. Feeding mechanism of ladybird beetles will be better understood if the fine structure of mouthparts, modifications in the structures, and presence of different sensilla on the mouthparts of *C. sexmaculata* are understood. Using scanning electron microscopy, the functional morphology of mouthparts of *C. sexmaculata* was studied and compared with the fine structures with those of other Lady Beetles. The labrum, mandibles, maxillae, labium, and hypopharynx make up the mouthpart of *C. sexmaculata.* This study includes a thorough description of each mouthpart and the different kinds of sensilla. In the current study, three types of sensilla chaetica, four types of sensilla basiconica, two types of sensilla styloconica, one type of sensilla placodea, one type of sensilla coeloconica, one type of sensilla campaniformia, and one type of cuticular pore using characters like the length, morphology, and distribution of the sensilla were studied. The structure of the mouthparts and the purposes of the sensilla on them is discussed with reference to other coleopterans. The results obtained in the current study will provide better insights into the functional morphology of lady beetles.

Keywords: Functional morphology, labrum, labium, ladybird beetles, mandible, maxilla, scanning electron microscopy, sensilla.

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Author contributions: PGG, MSP involved in the designing experiments, conduct of experiments, data analysis and manuscript writing. All authors have read and approved the final manuscript.

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INTRODUCTION

One environmentally friendly way to combat the threat of pests is through the use of biological control agents (Ayer et al. 1976). The biological control of aphids, mealy bugs, phytophagous mites, and scale insects is attributed to some species of lady beetles (Samways et al. 1997; Sarwar & Saqib 2010; Li et al. 2012). In most coleopterans, mouthparts have evolved for chewing solid food material (Belhoucine et al. 2013). The members of the Coccinellidae family are equipped with chewing mouthparts (Ayer et al. 1976). Several mouthparts, including the mandible, maxilla, labium, and palpi, are significant in feeding behavior (Seo & Youn 2000; Wang et al. 2000; Luo et al. 2006; Wei et al. 2015; Hao et al. 2019). In ladybird beetles, the feeding process is quite complicated, and the maxillary palpi and labial palpi play a crucial role in contact reception and the chewing process (Hao et al. 2019). Most of these structures are generally classified as the labio-maxillary complex and may show differences in type and feature depending on their feeding mechanism. Sensilla, or sensory structures are present in the insect body and are home to neurons responsible for smell, taste, sound, touch, proprioception, and perception of temperature, humidity, and space (Ruschioni et al. 2019). The variation in feeding behavior is mainly influenced by sensilla presented on mouthparts (Brożek & Bourgoin 2013). In addition to aiding in identifying food resources, these sensilla are crucial for determining the precise microhabitat and assessing the quality of food (Ruschioni et al. 2019). Similarly, mouthparts and antennal sensilla help in finding mating partners and in finding suitable oviposition sites on the host plants (Li et al. 2022). In this context, a detailed study of mouthparts is important for understanding the feeding mechanism of bio-control agents and for developing effective management strategies against pests (Rani & Madhavendra 1995, 2005; Hao et al. 2019). Numerous studies have been carried out to comprehend the functional morphology of the mouthparts of beetles earlier (Eilers et al. 2012; Wilhelmi & Krenn 2012; Belhoucine et al. 2013; Moon 2015; Chen et al. 2016).

Very few have described the ultra-structure of the mouthparts of the predatory lady beetles (Thornham et al. 2007; Hao et al. 2019). *C. sexmaculata* Fabricius, 1781 is a member of Coccinellidae and is well known for predating on aphids and small insects (Yilda et al. 2017). Understanding the ultrastructure of mouthparts will provide better insight into the feeding mechanism and will be helpful in designing and implementing an effective biological control program. To the best of the knowledge, no previous attempts have been made to elucidate the fine structure of mouthparts of *C. sexmaculata* using scanning electron microscopy. In this study, the functional morphology of mouthparts, especially the fine morphology of labrum, labium, mandibles, maxillae, eye, antenna, and various sensilla of *C. sexmaculata,* was studied using the scanning electron microscope. Additionally, the importance of the structure of mouthparts and sensilla in the feeding habit of *C. sexmaculata* were also discussed.

MATERIAL AND METHODS

Collection sites

Cheilomenes sexmaculata adults were collected from Alapalli (19.430 °N, 80.047 °E) and Gadchiroli (20.158 °N, 79.998 °E) areas of central India, eastern Vidarbha region of Maharashtra. The Gadchiroli district's forest includes reserved and protected forest areas measuring 218,529.27 ha excluding 882.22 ha Zudpi jungle (https://mahaforest.gov.in). Forest cover mainly consists of dry deciduous miscellaneous forests.

Sample collection

The specimens were collected by net and handpicking and then kept in the laboratory at 4°C after being preserved in 70% ethanol. Voucher specimens are deposited in the Government Science College specimen voucher repository (Accession Number GSC/Zoo/2021/Coleoptera-6).

Sample preparation for scanning electron microscopy

The mouthparts of *Cheilomenes sexmaculata* were dissected using a stereo microscope (Stemi 509, Carl Zeiss, Germany) using fine needles and then cleaned using 70% ethanol. After that, the samples were dehydrated for 30 min each in ethanol grades of 80%, 90%, & 95%; for 45 min in 100% ethanol; and subsequently dried in a desiccator. The dried mouthparts and whole head were glued to aluminium stubs using conducting carbon tape and coated with gold/palladium (40/60) using a high-resolution sputter coater (Quorum, United Kingdom) for a thickness of about 10 nm. The samples were subsequently examined with a Tescan Wega 3 scanning electron microscope (Tescan, Czech Republic) operated at 20 kV using an SE detector. Mouthparts of five males and five females were observed initially under a stereo microscope (Stemi 509 stereomicroscope equipped with camera and imaging software, Zeiss, Germany) and no clear sex-dependent morphological differences were found in the mouthparts. The description of sensilla was followed as per the nomenclature given by Altner & Prillinger (1980), and Brożek & Bourgoin (2013). Using Tescan Wega threes software, the length, diameter, and distribution of each type of sensilla from 10 adult male and 10 adult female specimens of *Cheilomenes sexmaculata* were measured. Each type of sensilla's length, base, and diameter are measured from 146 microphotographs of various mouthparts, and the results are tabulated as mean ± SD (Tescan Electron Microscope Software, Wega 3, Tescan Czech Republic) (Table 1).

RESULTS

Mouthparts in *C. sexmaculata* consist of the mandibles, maxillae, labium, labrum, and hypopharynx. Only the labrum and the maxillary palp can be seen on the front of the head when observed dorsally. From the ventral view, part of the mandibles appears below the labrum. The labium is positioned between the left and right maxillae in the central part (Image 1). There is a non-sclerotized hypopharynx on the labium's inner wall. The eyes and antennae are visible from the dorsal side.

Morphology of the labrum.

The anterior border of the anteclypeus has an oval-shaped labrum attached to it. Sensilla chaetica 3 (Sch3) are found arranged in a row close to the frontal margin on the dorsal surface of the labrum, while sensilla chaetica 2 (Sch2) are arranged on the left and right margins (Images 2). Sensilla basiconica 1 and 2 (Sb1, Sb2) and several cuticular pores (cp) are present at the margin (Image 2). Sensilla coeloconica (sco) is observed on the ventral surface of the labrum, close to a row of sensilla chaetica 3 (Image 2). Campaniform sensilla (Sca) are also observed on the ventral surface. The ventral surface of the labrum was concave (Image 2) and covered with different cuticular, spiny (Image 2), and palmate processes (Image 2).

Morphology of mandibles

Left and right mandibles are found attached to the head with dorsal and ventral articulations (Image 3). The inner margin of the mandible is divided into two main regions: the molar region and the incisor region (Image 3). The incisor region possesses pointed teeth apically. The mandible's dorsal view revealed a rough cuticle (Image 3), a lot of cuticular pores (Cp) strewn across the surface, and sensilla chaetica 1 (Sch1) near the condyle (Image 3). The ventral surface of the mandible also appears rough, and palmate cuticular processes are seen close to the ventral condyle; no other sensilla are noticed (Image 3). Petaloid cuticular processes covered the upper portion of the dorsal condyle (Image 3). Single tubercle forms the molar region (Image 3). On mandibles, a prostheca with short, comb-like setae extends along the incisor margin up to the base of the incisor projection (Image 3). The prostheca has a smooth surface with low cuticular pores (Cp). The articulating surface is hemispheric with a smooth surface ventrally and oval with cuticular processes dorsally (Image 3). Around the ventral condyles, the cuticle is smooth and has many cuticular pores (Cp) (Image 3). On the margin of the ventral region, there is an additional cluster of spiny cuticular processes.

Morphology of maxillae

The paired maxillae are found placed in longitudinal clefts on either side of the labium (Image 1) and show the usual parts: cardo, stipites, galea, lacinia, and maxillary palps (Image 1 & 4). The cuticle of the semicircular cardines (Image 4) has Cp on it. The stipites are flat plates with sensilla chaetica 1 and 2 (sch1, sch2) on the surface (Image 4). The maxilla includes the inner lacinia and outer galea, the two distal lobes (Image 4). The galea is a spoon-like structure, and it is covered with sensilla basiconica 3, 4 (Sb3, Sb4) and cuticular pores (Cp) (Images 4A,B,J,K). A triangular depression is present on the top of the galea (Images 4J,K). Brush-like lacinia is located below the galea, and sensilla basiconica 3 (Sb3) is present at the edge and on the whole apical area of lacinia and sensilla basiconica 4 (Sb4) on the ventral side (Image 4). In *C. sexmaculata*, the maxillary palpi are well developed and comprise four articles that widen gradually; the final article has a somewhat triangular shape (Image 4). Maxillary palpi surfaces are scaly, with cuticular pores (Cp), sensilla chaetica 2 (Sch2), and sensilla basiconica 1 and 2 (sb1 and sb2) dispersed across each segment (Image 4). In the middle region, two main types of sensilla styloconica (Sty1 and Sty2) and sensilla placodea 1 (Sp1) at the margin of the sensory field of the maxillary palp are present (Image 4I).

Morphology of labium

In general, the labium of an insect mouthpart is composed of the prementum, postmentum, glossae, paraglossae, and labial palpi. In *C. sexmaculata,* the paraglossa and glossa formed a combined structure named ligula (Image 5). The prementum is wider and

Table 1. Morphology measurements and distribution of sensilla on mouthpart of *Cheilomenes sexmaculata*.

Type	Shape	Socket	Surface	Pore	Length (µm) with average and standard deviation	Basal diameter (µm) with average and standard deviation	Distribution
Sch1	Hair, peg	Concave	Grooved	No	34.02 (6.83)	3.7 (0.75)	lig, mx, mp, antenna, lm
Sch2	Hair	Concave	Grooved	No	62.2 (15.99)	4.47 (0.93)	lm, lig, prm, mp, mx, lp
Sch3	Hair, peg	Concave	Grooved	No	348.54 (137.15)	13.2 (7.45)	lm, lig, mp
Sb1	Peg	Concave	Smooth	No	6.44 (2.25)	2.1 (0.73)	lm, lp, prm, md, mp, mx, gal, lig,
Sb2	Peg	Concave	Smooth	No	15.64 (4.32)	3.27 (1.17)	lm, md, mp, gal, lac, lig, mp, lp
Sb3	Hair, peg	Concave	Smooth	No	34.94 (9.06)	5.41 (0.45)	lm, md, mx, lac, lig
Sb4	Hair, peg	Concave	Smooth	No	67.65 (7.00)	4.55 (0.76)	gal, lac
Sty1	Conical	Convex	Grooved	Tp	3.12 (0.52)	1.61 (0.27)	lp, mp
Sty2	Cylindrical	Convex	Grooved	Tp	2.64 (0.35)	1.99 (0.38)	mp
Sco	Round						lm
Sca	Round						lm
Cp	Round						lm, lig, mx

Sch 1–3—sensilla chaetica I–III | Sb 1–4—sensilla basiconica I–IV | Sty 1–2—sensilla styloconica I–II | Sco—sensilla coeloconica | Sca—sensilla campaniformia | Cp—cuticular pore | Tp—terminal pore | mp—maxillary palp | gal—galea | lac—lacinia | lb—labium | lm—labrum | lp—labial palp | md—mandible | mx—maxillae.

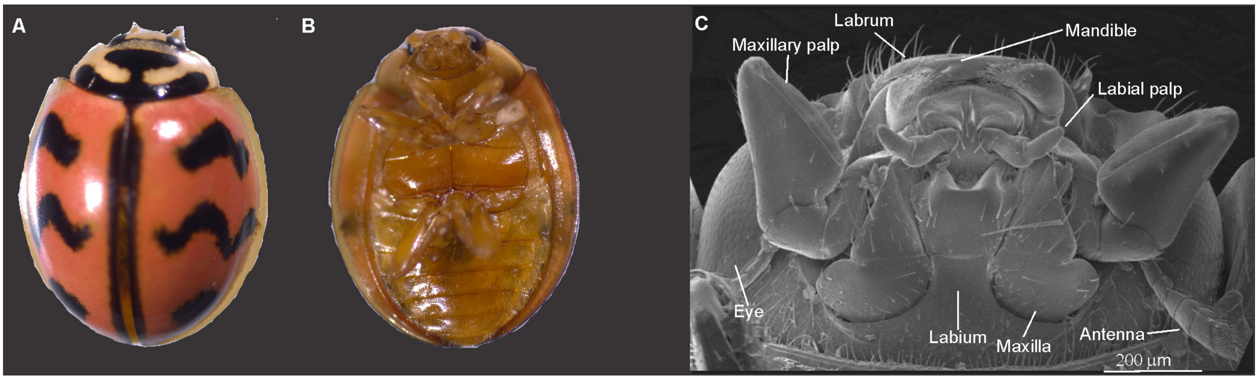

Image 1. Stereo microscope images of adult *Cheilomenes sexmaculata* and scanning electron micrographs of its mouthparts: A—dorsal view | B—ventral view | C—SEM ventral view of head showing the position and morphology of labrum, mandibles, maxillae, maxillary palpi, labium, and labial palpi. © Mandar Painganka & Prakash Ghagargunde.

elevated at the upmost end while a little narrow and without elevation at the bottom (Image 5). The cuticle of the postmentum is smooth with numerous cuticular pores (Cp) and sensilla chaetica 2 (Sch2) (Images 1 & 5). Two symmetrical labial palpi are present on the ligula, which are inserted into the prementum (Image 5). Sensilla basiconica 2 (Sb2), spiny and palmate processes cover the terminal portion of the ligula (Images 5), while sensilla chaetica 1 and 2 (Sch1, 2) and cuticular pores (Cp) are present in the proximal part (Image 5). The labial palp is elongated and shows three segments. The basal segment is short, bearing almost no sensillum (Image 5). With a reticulated surface, the elongated middle segment progressively widens from base to top and bears sensilla chaetica 1 (Sch1), sensilla basiconica 1 and 3 (Sb1, Sb3) (Image 5). With a single circular sensory field at the distal end, the final segment has a bullet-like shape (Image 5). In this sensory field, there are- 18 sensilla styloconica 1 (Sty1), but no other sensilla or cuticular pore is observed. (Image 5).

Types of sensilla

The mouthparts of *C. sexmaculata* exhibit 13 different subtypes of sensilla in total: these are three types of sensilla chaetica, four types of sensilla basiconica, two types of sensilla styloconica, one type of sensilla placodea, one type of sensilla coeloconica, one type of sensilla campaniformia, and one type of cuticular pore

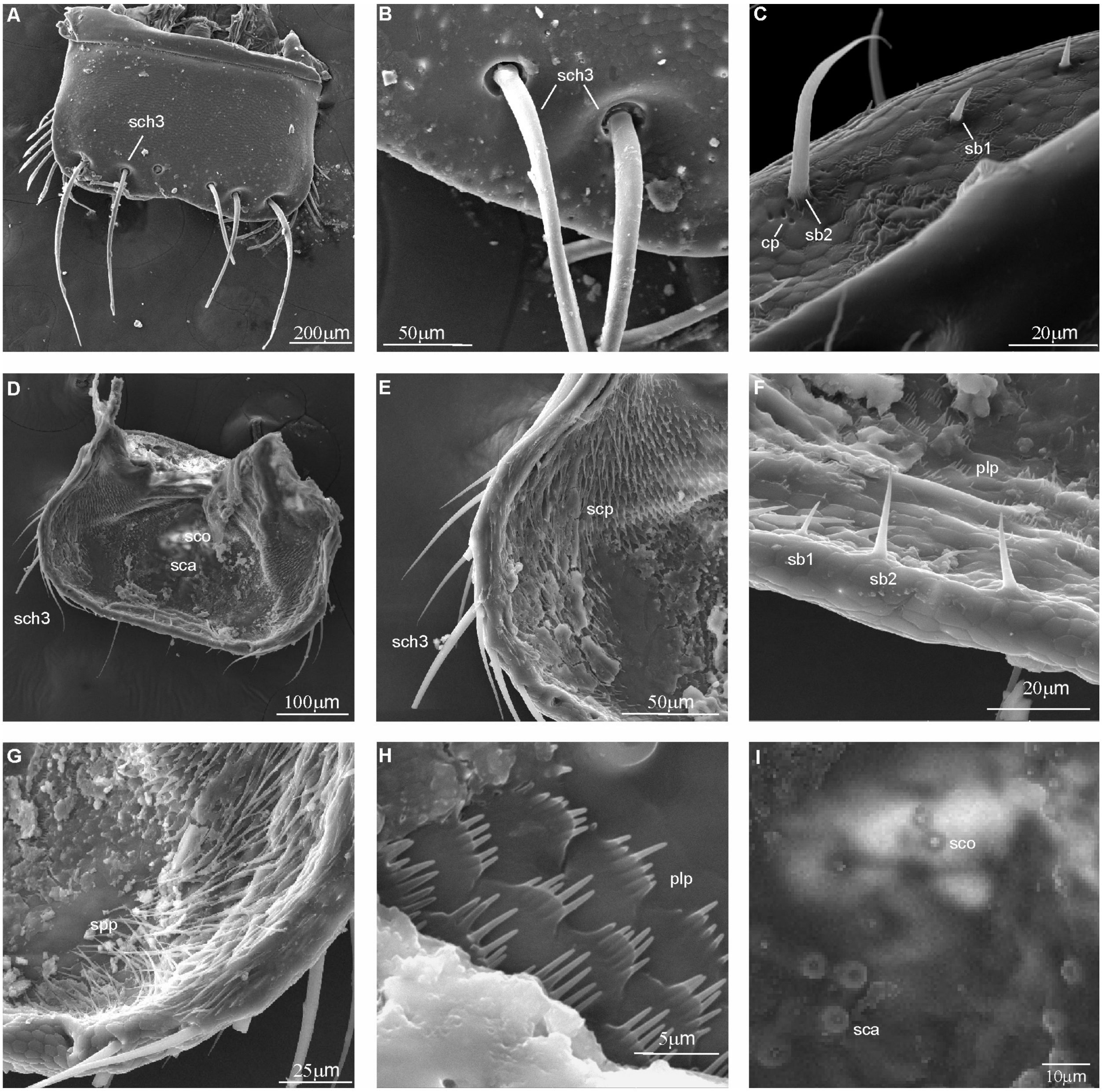

Image 2. Scanning electron micrographs of the labrum of *Cheilomenes sexmaculata*: A—dorsal view of labrum | B—sensilla chaetica3 (sch3) | C—cuticular pores (cp), sensilla basiconica1 and 2 (sb1,2) at margin | D—ventral view of labrum | E—scaly process on epipharynx | F—sensilla basiconica1,2 (sb1,2) at margin and palmate process on epipharynx | G—spiny process on epipharynx | H—palmate processes | I—sensilla campaniformia (sca), sensilla coeloconica (sco) on epipharynx. © Mandar Paingankar & Prakash Ghagargunde.

(Table 1).

Based on length and diameter, three types of sensilla chaetica, sensilla chaetica 1 (Sch1) , sensilla chaetica 2 (Sch2), and sensilla chaetica 3 (Sch3) are observed on the mouthpart surfaces of *C. sexmaculata*. Sensilla chaetica 1 (Sch1) are short, robust sensilla that resemble hair or pegs and are placed into a round, concave socket. They are present on the mandibles, stipites of maxilla, ligula, prementum, and labial palp of labium (Images 3,4,5, I,K). Sensilla chaetica 2 (Sch2) has an external morphology resembling a peg. They are distributed on the lateral margin of the labrum, mandibles, stipites of the maxilla, ligula, and prementum of the labium (Images 3,4,5,D,I). Sensilla chaetica 3 (Sch3) resembles sensilla chaetica 1 and 2 (Sch1, Sch2) in terms of their morphology and resembles hair or pegs. Sensilla chaetica 3 (Sch3) tapers toward the apical end from a broad base. They are dispersed throughout the ligula of the labium and the outer front margin of the labrum (Images 2 & 5).

Four types of sensilla basiconica, sensilla basiconica

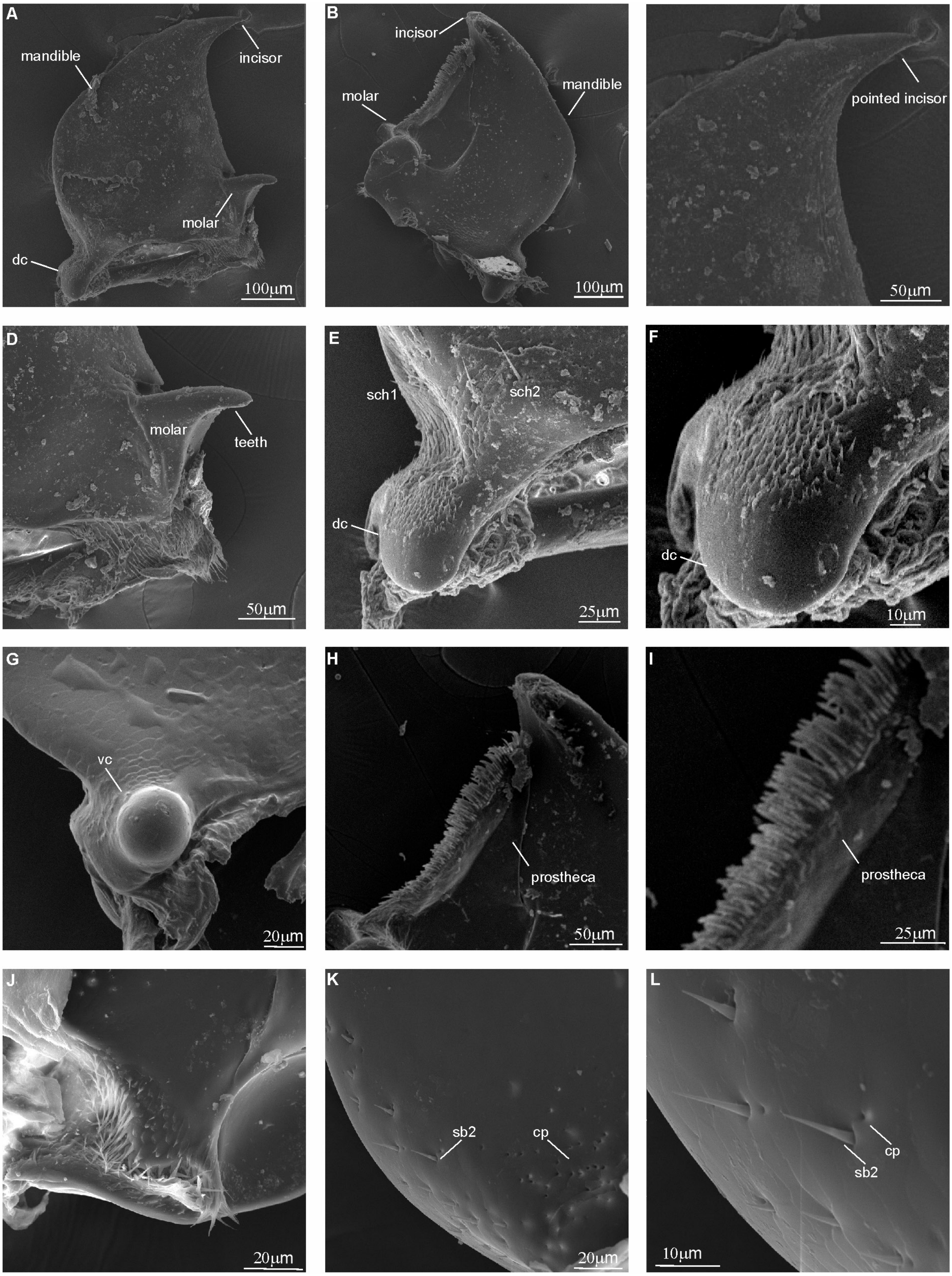

Image 3. Scanning electron micrographs of the mandible of *Cheilomenes sexmaculata*: A—dorsal view | B—ventral view with dorsal and ventral teeth (Dt, Vt) | C—pointed incisor | D—molar teeth | E—dorsal condyle | F—close view of dorsal condyle | G—ventral condyle | H—prostheca | I—setae of prostheca | J—spiny processes close to molar teeth | K—sensilla basiconica 2 (Sb2) and cuticular pores (cp) on mandible | L—sensilla basiconica 2 and cuticular pores. © Mandar Paingankar & Prakash Ghagargunde.

1 (Sb1), sensilla basiconica 2 (Sb2), sensilla basiconica 3 (Sb3), and sensilla basiconica 4 (Sb4) are observed on different mouthparts of *C. sexmaculata*. Sensilla basiconica 1 (Sb1) is inserted into a round, concave socket and is short, straight, thick at the base, and sharp at the tip. Sensilla basiconica 1 (Sb1) has a smooth surface. They are found distributed on the side margin of the labrum, maxillary palp, and labial palp (Images 2,4). Sensilla basiconica 2 (Sb2) is relatively straight and longer than sensilla basiconica 1 (Sb1), has a smooth surface, and is thick at the base while sharp at the tip (Images 2,3). These are distributed on the ventral margin of the labrum and mandibles. Placed in concave sockets, sensilla basiconica 3 (Sb3) is stronger than sensilla basiconica 1 and 2 (Sb1, Sb2). Sensilla basiconica 3 (Sb3) has a smooth exterior devoid of pores. Sensilla basiconica 4 (sb4) was found to be stronger and longer than the other, hair- and peg-like sensilla with a smooth surface bearing no pores, and they are only present on the galea and lacinia of the maxilla (Images 4).

Sensilla styloconica 1 (Sty1) is a conical structure with a petal-shaped convex socket. They are present on the central part of the maxillary palpi and labial palpi (Images 4,5). The cylindrical sensilla styloconica 2 (Sty2) is placed into a convex socket. These sensilla's tips are flat, and their upper surfaces are smooth. They are visible on the central region of the maxillary palpi (Image 4).

At the margin of the sensory field of maxillary palp, spiny, triangular, non-sensory, dentiform cuticular projections are distributed among these circular, slightly convex, rugose sensilla placodea 1 (sp1) found embedded (Images 4H–I).

Sensilla coeloconica (Sco) are round structures with bumps in the center that cannot be distinguished clearly. They are present on the ventral surface of the labrum (Image 2).

Sensilla campaniformia (Sca) are round with a circular depression at the center and observed only on the ventral surface of the labrum (Image 2). The labrum, mandibles, maxilla, and labium all have small, round, pores called cuticular pores (Cp) (Images 2,3,4,5).

Morphology of antenna and eye

The antennae of *C. sexmaculata* are made up of a scape, pedicel, and flagellum. There are nine flagellomeres in the flagellum; the first flagellomere has sensilla chaetica 1 and 2 (Sch1, Sch2), while the scape has sensilla chaetica 3 (Sch3). Sensilla basiconica 1 and 2 (Sb1, Sb2) are present on the tip of the ninth flagellomere and lower part of scape (Image 6). *C. sexmaculata* has compound eyes made up of ommatidia. The surface of the ommatidia is smooth; only a few randomly distributed interommatidial hairs are present (Image 6).

DISCUSSION

Information about the feeding ecology of several insect species has been well documented in the literature; very few studies have been targeted to describe the mouthparts at the ultra-microscopic level (Belhoucine et al. 2013; Moon 2015; Chen et al. 2016; Nel et al. 2018; Hao et al. 2019). Ample literature is available on the mouthpart structures and feeding mechanisms of ground beetles, coccinellid beetles, and other coleopterans (Forsythe 1982, 1983; Ricci & Stella 1988; Pradhan 1938; Samways et al. 1997; Moon 2008; Karolyi et al. 2016), very few studies are available on predatory lady beetles. Lady beetles are known as potent bio-control agents, therefore, understanding the ultrastructure of mouthpart morphology will provide better insights into the feeding mechanism of *C. sexmaculata*. The better understanding of the ultrastructure of mouthparts will be helpful in designing and implementing an effective biological control program (Karolyi et al. 2016). One significant aphidophagous predator in Asia is the ladybird *Cheilomenes sexmaculata* (F.) (Agarwala & Yasuda 2000). Aphids such as *Aphis craccivora* (Koch) (Agarwala et al. 2001), *Aphis gossypii* (Glover), *Rhopalosiphum maidis* (Fitch), *Myzus persicae* (Sulzer), *Uroleucon compositae* (Theobald), *Lipaphis erysimi* (Kaltenbach), and *Aphis nerii* (Boyer de Fonscolombe) have all been observed to be among its prey (Omkar & Bind 2004). In high-temperature agroecosystems and greenhouses, its voracity and heat endurance may make it an effective biological control agent (Wang et al. 2013). In the current study, using scanning electron microscopy,the morphology of mouthparts of *C. sexmaculata* was described. This may be the first attempt to comprehensively describe the fine structures and various sensilla present on its mouthparts.

The scanning electron microscopic studies showed typical chewing types of mouthparts of *C. sexmaculata*. The ultrastructure of mouthparts of *C. sexmaculata* showed a resemblance with other ladybird beetles such as C. *transversguttata and H. variegate* (Hao et al. 2019). Unlike other zoophagous species, *C. sexmaculata* shares a mandibular morphology with polyphagous species, which are versatile, non-specialized, and lack particular adaptations for crushing or capturing prey (Forsythe 1983). Unlike *C. sexmaculata*, zoophagous species,

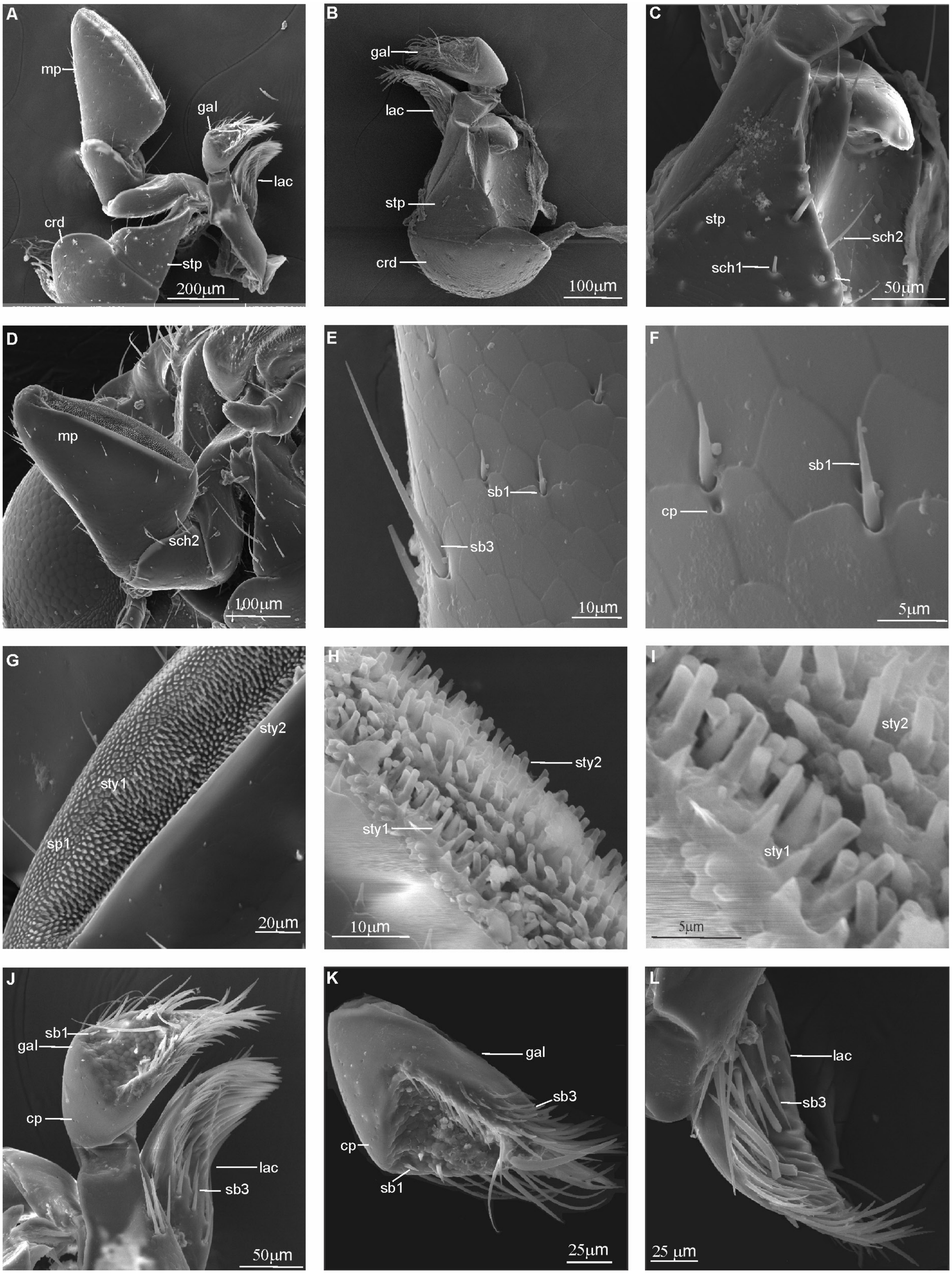

Image 4. Scanning electron micrographs of the maxilla of *Cheilomenes sexmaculata*: A—ventral view | B—galea, lacinia, stipes and cardo | C—stipes | D—maxillary palp | E—sensilla basiconica1 and 3 (sb1,3) on maxillary palp | F—sensilla basiconica 1 (sb1) and cuticular pore (cp) close view | G—sensory field of maxillary palp | H—sensory field on maxillalry palp | I—sensilla styloconica 1 and 2 (sty1,2) | J—galea, lacinia with sensilla basiconica 1 and 3 (sb1,3) | K—galea showing sensilla basiconica 1, 3 (sb1,3) and cuticular pores (Cp) | L—lacinia showing sensilla basiconica 3, 4 (sb3,4).

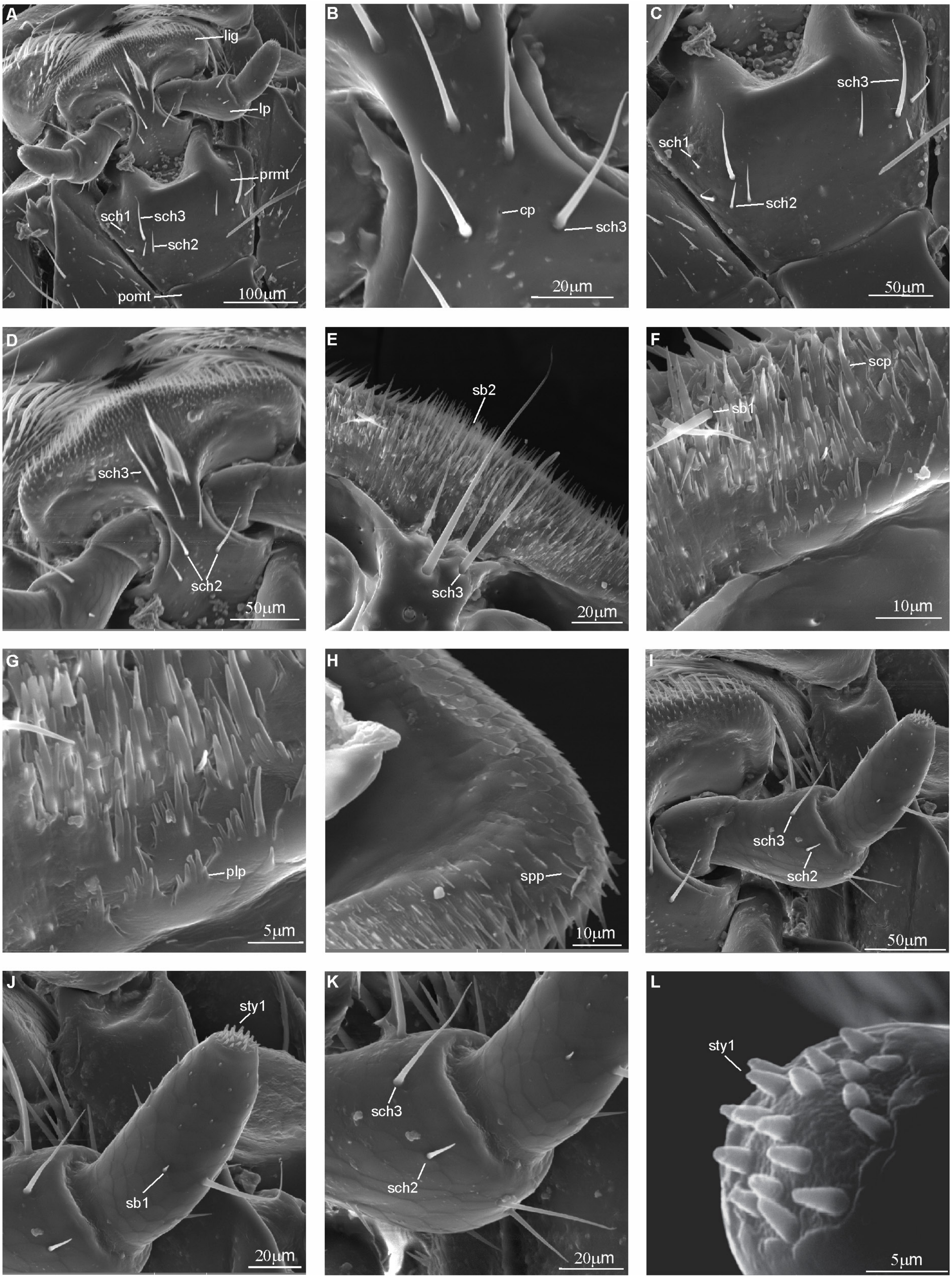

Image 5. Scanning electron micrographs of the labium of *Cheilomenes sexmaculata*: A—ventral view showing ligula, labial palp, prementum, postmentum | B—sensilla chaetica 3 (sch3) and cuticular pore (cp) on ligula | C—sensilla chaetica 1, 2, 3 (sch1,2,3) on prementum | D—sensilla chaetica 2, 3 (sch2,3) on ligula close view | E—sensilla chaetica 3 (sch3) and sensilla basiconica 2 (sb2) on ligula | F—scaly and palmate processes | G—palmate processes | H—scaly processes | I—sensilla chaetica 2, 3 (sch2,3) on labial palp | J—sensilla styloconica 1 (sty1) on last segment of labial palp | K—sensilla chaetica 2, 3 (sch2,3) on middle segment of labial palp | L—sensilla styloconica 1 (sty1) and sensilla placodea 1 (sp1) at sensory field on top of last segment of labial palp. © Mandar Paingankar & Prakash Ghagargunde.

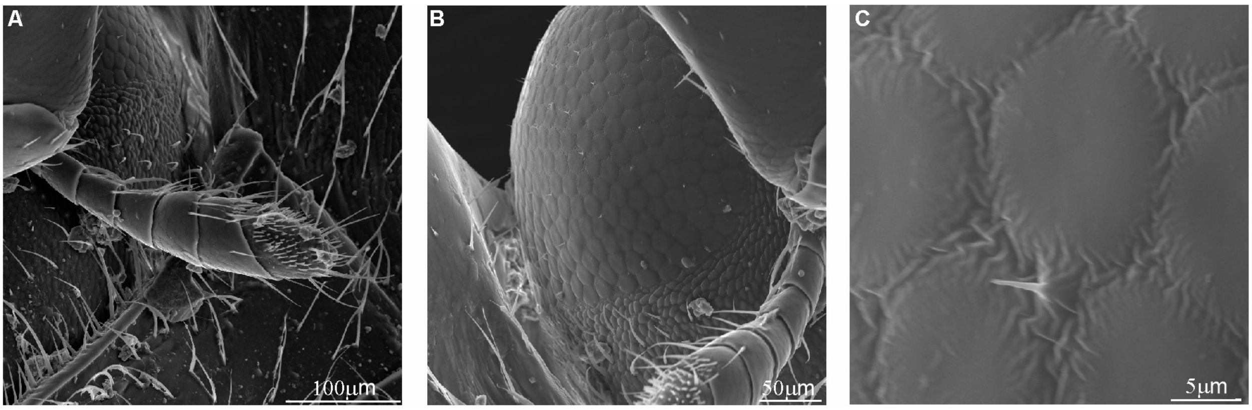

Image 6. Ultrastructure of the antenna and eye of *Cheilomenes sexmaculata*: A—antenna showing flagellum, scape, and sensilla | B—compound eye | C—hexagonal ommatidia with interommatidial hairs. © Mandar Paingankar & Prakash Ghagargunde.

such as tiger beetles, have mandibles that are trigonal in dorso-ventral aspect (Ball et al. 2011). Phytophagous species ingest plant juices by scraping leaf surfaces with multidentate mandibles, whereas insectivorous species use unidentate or bifid incisors of mandibles for piercing the prey. During the scarcity of natural prey, few insectivorous species feed on pollen as an alternative source (Samways et al. 1997). It was observed that *C. sexmaculata's* mandibular morphology resembles that of insectivorous beetles like *Coccinella transversoguttata* (Hao et al. 2019). Gut content analysis of *C. sexmaculata* showed the presence of traces of plant material in a few specimens. These observations suggest that when there is limited availability of prey, *C. sexmaculata* might be feeding on plant material. *C. sexmaculata* has a setal row on its prostheca. In scavenger carabids like *Carabus, Calosoma, Cychrus,* and *Scarites*, a brush of dense setae was present on the ventral surface of each mandible (Evans & Forsythe 1985), but in *C. sexmaculata* it is present between the incisor and molar region. In the submolar region of some mandibulate Carabidae, a tuft of mesally projecting setae and, more posteriorly, a soft flap-like structure was observed (Evans & Forsythe 1985)

A long incisor tooth with two or three terebral teeth has been documented in the majority of Cicindelidae taxa (Ball et. al. 2011). Smooth dorsal surface of the mandible with sch1, Cp, bifid incisor, ventral teeth smaller than dorsal teeth, and molars formed by single triangular and sharp teeth are observed in *C. sexmaculata,* which is significantly different from other zoophagous species and indicate the special adaptations for crushing and capturing prey (Forsythe 1983). In this study, two types of sensilla styloconica (Sty1 and Sty2) were found: one type of sensilla placodea (sp1) at the distal end of the maxillary palp and sensilla styloconica (sty1) at the tip of the labial palps, indicating the role of sensilla in gustatory, mechanical, and contact reception while searching for aphids. The base of sensilla styloconica (sty2) was bigger in size as compared to sty1 in *C. sexmaculata,* which indicates that these sensilla might be olfactory in nature.

In the current study, one type of sensilla placodea, one type of sensilla coeloconica, one type of sensilla campaniformia, three types of sensilla chaetica, four types of sensilla basiconica, two types of sensilla styloconica, and one type of cuticular pore are identified on the various mouthparts of *C. sexmaculata*. Interestingly*, t*he mouthparts of *C. sexmaculata* show similarities with some polyphagous and mixed feeder beetles. The results obtained in this study provide baseline information on the ultrastructure of mouthparts and sensilla of *C. sexmaculata* and provide the basis for further investigations on the role of sensilla and feeding mechanisms in the Coccinelidae family. To comprehend the feeding mechanism and the evolution of the remarkably varied feeding habits in the Coccinelidae, more research into the structural features of mouthparts and their functional significance is necessary.

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