

A study on the distribution of sensilla in indian honeybee *Apis cerana indica* (Hymenoptera: Apidae)

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Abstract

Insect sensilla are functional units working as mechanoreceptors and chemo-receptors. Various types of sensilla present on antenna and facilitates numerous functions. Three important locations, antenna, mouthparts and legs of sensilla on the bees. Sensilla trichodea, Sensilla basiconica, Sensilla coeloconica, sensilla ampullacea, Sensilla placodea, Sensilla coelocapitular were observed and responsible for the olfaction, thermo receptor, hygroreceptor, gustatoreceptor, chemoreceptor.

Keywords: *Apis cerana indica*, sensilla, flagellum

Introduction

The basic structural and functional units of insect sensilla are cuticle receptors, serving mechano and chemo-receptor functions (Chapman, 1998). Several researchers have described and illustrated the various types of antennal sense organs of honey bees, including (Lacher 1964.)

Insect antennae have different types of sensilla, each with distinct functions that are essential throughout the insect's life. Parasitic hymenopterans, in particular, have specialized sensory organs that help them in habitat searching, host localization, recognition, selection and acceptance, courtship, mating, and oviposition. The chemosensory sensilla detect chemical signals and provide information about environmental factors such as humidity, temperature, and CO₂ levels.

In bees, sensilla are primarily located on the antennae, legs, and mouthparts (Galic, 1971; Esslen and Kaissling, 1976; Whitehead and Larsen, 1976). The flagellum is the most important antennal segment carrying sensilla (Wcislo, 1995). The external morphology of antennal sensilla has been well characterized in species of different families of Apoidea (Ågren, 1989);

The current scanning electron microscope (SEM) exploration of the antenna aims to unveil the intricate array of sensilla types present on the worker of *Apis cerana indica*.

Material and methods

During the period from October 2023 to May 2024, a study was conducted involving the collection of worker honey bees from a single colony near the MJF Education Campus at RTM Nagpur University, Nagpur, India. The worker bees were carefully prepared for scanning electron microscopy (SEM) analysis by immobilizing them and removing their antennae. The specimens were then meticulously processed, including fixation in 70% alcohol, dehydration in ethanol, clearing in acetone, and air-drying. Following these preparatory steps, the antennae were mounted on metallic stubs at various angles and individually coated with gold. Subsequently, the samples were observed at the desired magnification using a Jeol scanning electron microscope

(JSM 6380A) at the SEM Centre of Visvesvaraya National Institute of Technology, Nagpur, India.

Results

The antenna of the workers of *Apis cerana indica* is divided into three parts: the scape, the pedicel, and the flagellum. The flagellum is made up of 10 segments, while the scape and pedicel each consist of a single segment (see Fig 1). The antenna is positioned like a wedge in the antennal socket on the dorsolateral side of the head, with the flagellum folded up against the scape, giving it an elbowed geniculate appearance.

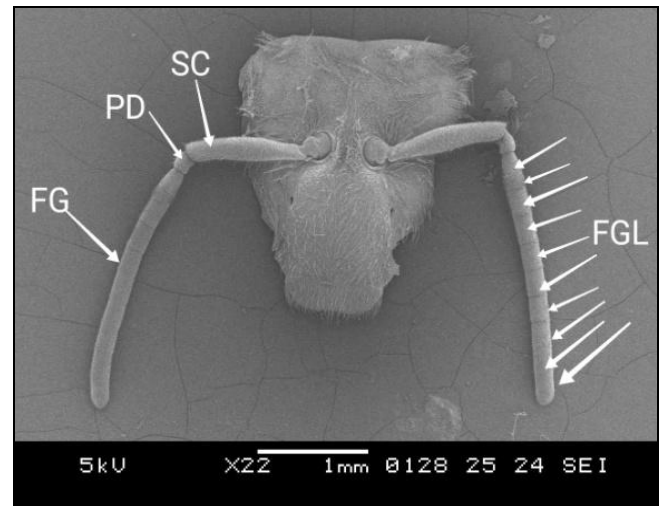


Fig 1: SEM structure of antenna of worker ant. SC - Scape, PD - Pedicel, FGL - Flagellum.

Sensilla present on scape ball

The scape is comprised of three distinct subparts, namely the scape ball, ball neck, and elongated shaft. Upon close observation of the dorsolateral side of the scape ball, three types of basiconic sensilla were identified: sensilla basiconica I (SB-I), sensilla basiconica II (SB-II), and SB-III. SB-I exhibited a smooth texture, while SB-II appeared comparatively smaller. Notably, SB-III, one of the shortest

sensilla observed on the scape ball (refer to Fig 1), displayed a perpendicular orientation to the surface.

Sensilla present on the elongated shaft of the scape

On the elongated shaft surface, two types of sensilla were observed, which are parallel to the surface: Sensilla trichodia (St) and Sensilla Trichodia curvata (STC) were found on the entire surface.

Sensilla present on pedicel

Throughout the surface of the pedicel, majorly sensilla trichodia were observed and particularly three types of Sensilla trichodia were found A, B, C and on the scape side sensilla were perpendicular, and on the flagellum side sensilla are parallel to the surface

Sensilla present on Flagellum

Sensilla trichodea type A, B, C, D, Sensilla basiconica, Sensilla coeloconica sensilla ampullaceal, Sensilla placodea, Sensilla coelocapitular were found on 1-10 flagellomere of flagellum.

Sensilla basiconica is found perpendicular to the surface and sensilla ampullaceal shows abundance towards the tip of the flagellum. Sensilla coelocapitular shows various opening and closing-like structures towards the tip of the flagellum.

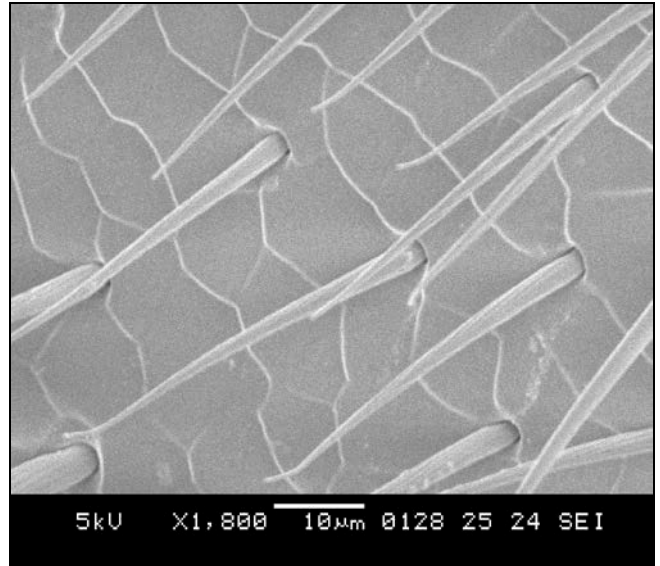


Fig 4: SCM structure shows sensilla trichodia and sensilla trichodia curvata.

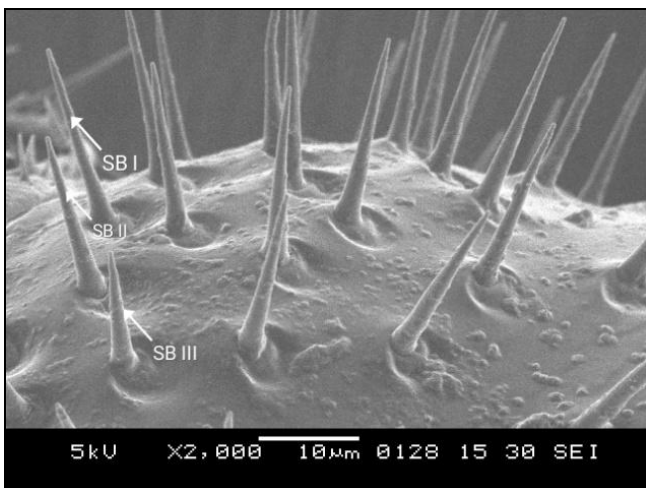


Fig 2: SCM Structure of Scape Ball and Present Sensilla

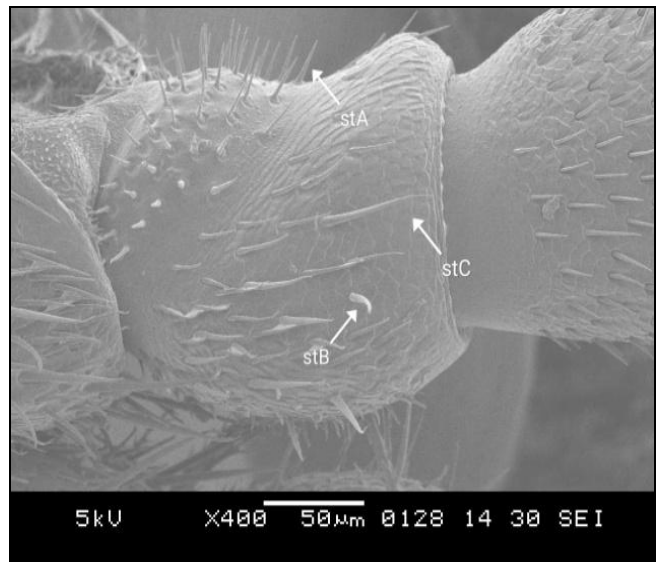


Fig 5: SCM structure shows presence of sensilla trichodia A, B, C

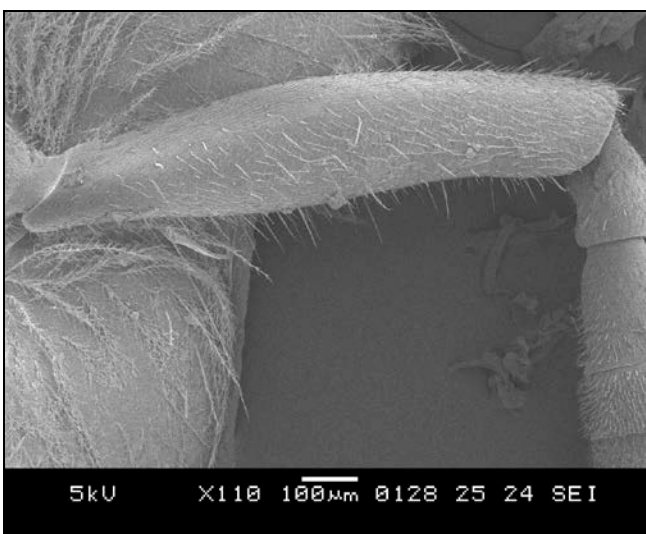


Fig 3: SCM structure of elongated shaft.

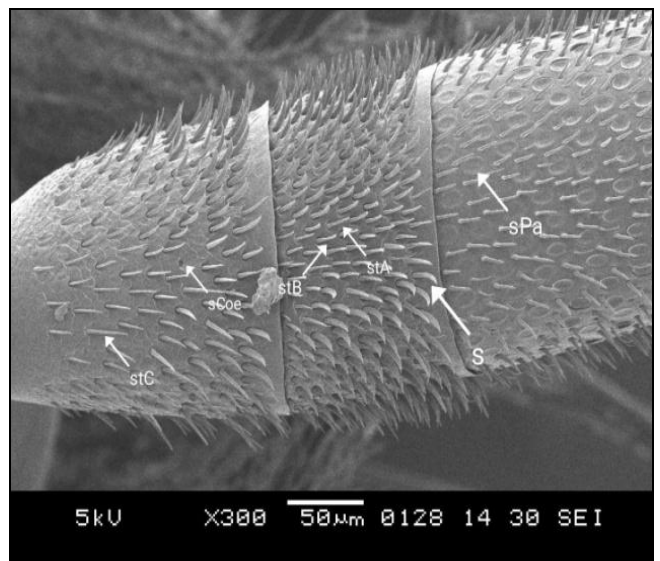


Fig 6: SCM structure shows presence of various sensilla on flagellomere (1-3)

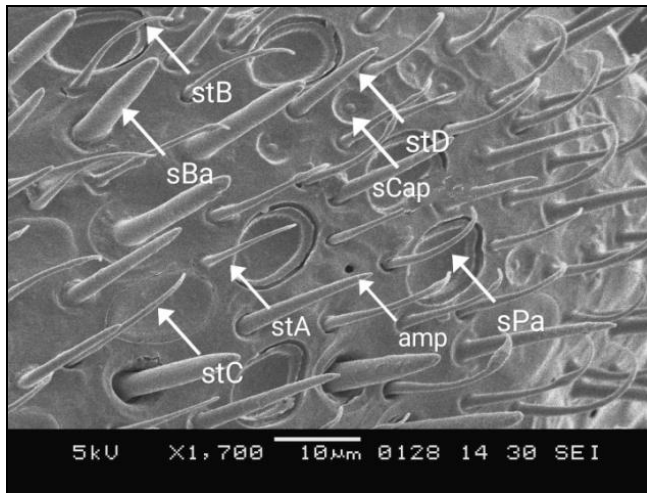


Fig 7: SCM structures show a magnified view of various sensilla present on the flagellum.

Table 1: Sensilla trichodea type A – stA, Sensilla trichodea type B – stB, Sensilla trichodea type C– stC, Sensilla trichodea type D– stD Sensilla basiconica – SBa, Sensilla coeloconica – SCoe, sensilla ampullaceal – amp, Sensilla placodea –SsPa, Sensilla coelocapitular – Scap

Parts of antenna	Type of sensilla
Scape ball	SB I, II, III
Elongated shaft	St A, B, C Stc
Pedicel	St A, B, C
Flagellum	St type A, B, C, D
	SB
	SCoe
	amp
	Spa SCap

Discussion

The structure of antenna of many well-known social Hymenoptera like the honeybee *Apis mellifera*, *Apis cerana indica*, and carpenter ant *C. compressus* is similar and has scape, a pedicel, and ten flagellar segments in the worker. [3, 6, 10] The geniculate type of antennae is found in the *Apis* genus and *Apis cerana indica* [23]. Commonly 10 flagellar segments are observed in adult workers of *Melipona quadrifasciata*, *Apis cerana indica*, and *Melipona scutellaris*. [4, 22, 23]

The number and type of antennal sensilla may vary in Hymenoptera. For example, in *A. mellifera* [25] and *Melipona scutellaris* [26] there are six and seven types of sensilla. Six types of antennal sensilla found in ant *Leptogenys chinensis* [5]. In the present study, seven main types of sensilla were observed, again divided into subtypes. In the present study Sensilla trichodea type A – stA, Sensilla trichodea type B – stB, Sensilla trichodea type C– stC, Sensilla trichodea type D– stD Sensilla basiconica – SBa, Sensilla coeloconica – SCoe, sensilla ampullacea – amp, Sensilla placodea –SsPa, Sensilla coelocapitular - SCap were noticed. Similar to the *Apis mellifera* and *M. quadrifasciata* [4, 15] in *Apis cerana indica* also Sensilla trichoid (St) is found on all over antennae which are found to be polymorphic and subdivided into four subtypes A to D. Similarly In *M. quadrifasciata* St divided in I to VI type [4]. In Emphorin St divided into IV subtypes. [14]

Sensilla basiconica (SB) shows a similar morphological structure as observed in *C. compressus* [11] on the scapeball.

In the present study the position of SB is perpendicular to the surface, so by structure and position, the sensilla may be gustatory in function.

Sensilla trichodia with subtypes A, B, and C along with trichodia curvata (Stc) were observed on elongated shafts, similar observations were reported in 2019 by Barsagade *et al.* in *leptogenys chinensis* [5]. As per the position of the sensilla which presents parallel to the surface and points towards the tip may be sensilla are olfactory which is confirmed in *L. chinensis* by Barsagade *et al* [5]

Sensilla Coe was reported only on distal flagellomere similar findings were observed by [4] in *M. quadrifasciata* According to Reboria *et. al* [27] Sensilla Coe is responsible for hygro and thermoreceptors.

Sensilla coelocapitular (Scap) was seen to mushroom-like body on the 9th and 10th flagellomere in *Apis cerana* in the hill population [22]. In ant *L. chinensis* Scap were observed on the tip of the flagellum. [5] It is also reported by Nakanishi A [9] in *Componotus japonicas*. In the present study, the sensilla coelocapitular was reported from the 3rd flagellomere to the distal end of the flagellum. In *Apis mellifera* Sensilla Scap is described as responsible for hygro and thermoreceptor so in the present study, may be the sensilla plays the same role.

Sensilla placodia (Spa) are most observed sensillas like sensilla trichodia. Similar findings are reported in *M. quadrifasciata* [4] Emphorini bees [14] It seems to be a small and deep depression plate-like structure. In *Apis cerana* the Spa was observed to have a pore plate-like structure [24]. In the present study, some Spa observed deeper than others Spa based on that observation may be the sensilla are responding to olfaction by opening and closing way.

Conclusion

In this study, the antennal sensilla of *Apis cerana indica* has been studied in detail. We conclude variations in sensilla distribution on one of the most important sensory organ antennae, which helps to understand the foraging behavior of bees. Thus, the ultrastructure study provides the platform to understand honey bee behavior, and based on sensilla by using a new AI technique and using olfactometer study further study will be planned

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