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Anatomical distribution of sensory cuticular structures on the *Myrmicaria brunnea* thorax

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Abstract

In worker ants of *Myrmicaria brunnea*, the thorax is segmented into the prothorax, mesothorax, and metathorax. The posterior part of the metathorax is fused with the first abdominal segment to form the propodeum, which bears sensillated propodeal spines. The thorax bears three pairs of legs—fore, mid, and hind legs. Two types of sensilla, Sensilla Trichodea (ST) and Sensilla Trichodea Curvata (STC), are present in the thoracic region and are likely involved in sensory perception. The distinct thoracic adaptations and rich diversity of sensilla observed in *Myrmicaria brunnea* highlight its specialized ecological roles, suggesting the need for targeted conservation efforts to preserve this functionally significant ant species and its habitat.

Keywords: Sensilla, thorax, ant, sting, *Myrmicaria brunnea*, SEM, sensilla trichodea, sensilla trichodea curvata, Hymenoptera

Introduction

The thorax, the second body segment in insects, is divided into the prothorax, mesothorax, and metathorax, each typically bearing a pair of legs—fore, mid, and hind, respectively. In ants, the anterior thorax of workers is notably enlarged to accommodate strong neck muscles that power the head and jaws, enabling them to hunt and carry prey much heavier than their own weight (Keller *et al.*, 2014) ^[1]. Precise control of head movement is critical, especially in species capable of lifting prey 30–90 times their body weight (Dejean, 2011; Dejean *et al.*, 2012) ^[2,3]. Grass-cutting ants exhibit biomechanically controlled head movements at the neck joint while transporting heavy loads to maintain balance and minimize displacement of the center of mass (Moll *et al.*, 2010) ^[4].

Insects are covered with various sensilla casing sensory neurons that detect smell, taste, sound, touch, vision, proprioception, and environmental changes such as temperature and humidity (Sheilds, Barsagade *et al.*, 2019) ^[6]. These receptors influence feeding behavior (De Boer, 2006) ^[7], aid in host plant recognition (Skiri *et al.*, 2005) ^[8], and are vital for survival and adaptation.

The present study focuses on the thoracic structure and associated sensilla in the worker ants of *Myrmicaria brunnea*.

Materials and Methods

The experiments were conducted according to the laws of the country. The worker ant *M. brunnea* was collected from a tasar silkworm rearing field at Armori (District Gadchiroli) which is 160km away from RTM Nagpur University, Nagpur. The worker ants were anesthetized with the help of chloroform fumes and preserved in 70% alcohol. The last Thoracic part was dissected out and the scanning by electron microscope was photographed at desirable magnification under a Joel scanning electron microscope (JSM 6380A) at Visvesvaraya National Institute of Technology (VNIT), Nagpur.

Observations and Results

Thoracic Morphology and Sensilla in *Myrmicaria brunnea*

The thorax or mesosoma of *M. brunnea* is well-defined, comprising three distinct segments: prothorax, mesothorax, and metathorax. The metathorax is posteriorly fused with the first abdominal segment to form the propodeum, which bears prominent propodeal spines and

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spiracles. Near this region, the metapleural gland orifice is also visible. Each thoracic segment supports a pair of legs (Table. 1, Fig.1).

Prothorax: Dome-shaped and heavily sclerotized.

Mesothorax: Elevated with a distinct scutellum forming a hump-like structure.

Metathorax: Slightly curved, forming the propodeum with spines and spiracles.

SEM Observations of Thoracic Sensilla

The thoracic surface is richly populated with various sensilla types:

Prothorax: Densely packed with Sensilla Trichodea (ST) in three variants (ST-I, II, III), and Sensilla Trichodea Curvata (STC) showing directional curvature across regions.

Mesothorax: Hosts ST-I and ST-II, with additional sensilla on the scutellum. STC are also present, particularly around the raised scutellum.

Metathorax & Propodeum: Both ST and STC were observed, including smaller variants on the propodeal spines. Sensilla exhibits structural diversity and region-specific distribution (Table 2, Fig.1).

Table 1: Length and width of thorax of *Myrmicaria brunnea*

Sr. No.	Thorax	Length (mm) ± Std. dev	Width (mm) ± Std. dev
1	Prothorax	1.02 ± 0.03	1.05 ± 0.02
2	Mesothorax	0.47 ± 0.11	1.31 ± 0.07
	Hump (Scutellum)	0.25 ± 0.03	0.187 ± 0.02
3	Metathorax	0.48 ± 0.09	1.15 ± 0.05
	Spine	0.42 ± 0.03	-
	Spiracle(D)	0.053 ± 0.02	-

D- Diameter

Table 2: Sensilla on thorax in the worker *Myrmicaria brunnea*.

Sr. No.	Type of Sensilla	Length (µm) ± Std. dev	Width (µm) ± Std. dev
1	Prothorax		
	ST-I	511.11 ± 5.01	22.12 ± 2.10
	ST-II	355.08 ± 11.02	17.6 ± 1.99
	ST-III	177.57 ± 10.09	14.33 ± 2.05
	STC-I	212.5 ± 13.01	15.1 ± 2.33
2	Mesothorax		
	ST-I	400.5 ± 6.69	17.95 ± 0.38
	ST-II	244.44 ± 6.22	10.72 ± 1.19
	STC-I	158.3 ± 9.44	8.89 ± 2.06
	Hump (Scutellum)		
	ST	312.5 ± 2.14	13.22 ± 4.3
3	STC	198.3 ± 5.05	12.12 ± 1.09
	Metathorax		
	ST-I	504.01 ± 3.22	14.99 ± 2.33
	ST-II	357.14 ± 2.13	14.28 ± 1.05
	STC-I	414.28 ± 5.77	12.42 ± 2.31
4	STC-II	214.28 ± 8.43	15.12 ± 0.98
	Spine		
	ST-I	218.75 ± 12.67	9.37 ± 1.21
	ST-II	138.70 ± 8.92	4.87 ± 1.76
	STC-I	170.96 ± 7.65	6.77 ± 2.03
4	STC-II	122.58 ± 8.33	4.83 ± 1.87

ST- Sensilla trichodea, STC- sensilla trichodea curvata, SCh- sensilla chaetica, SC- sensilla coeloconica, D- diameter.

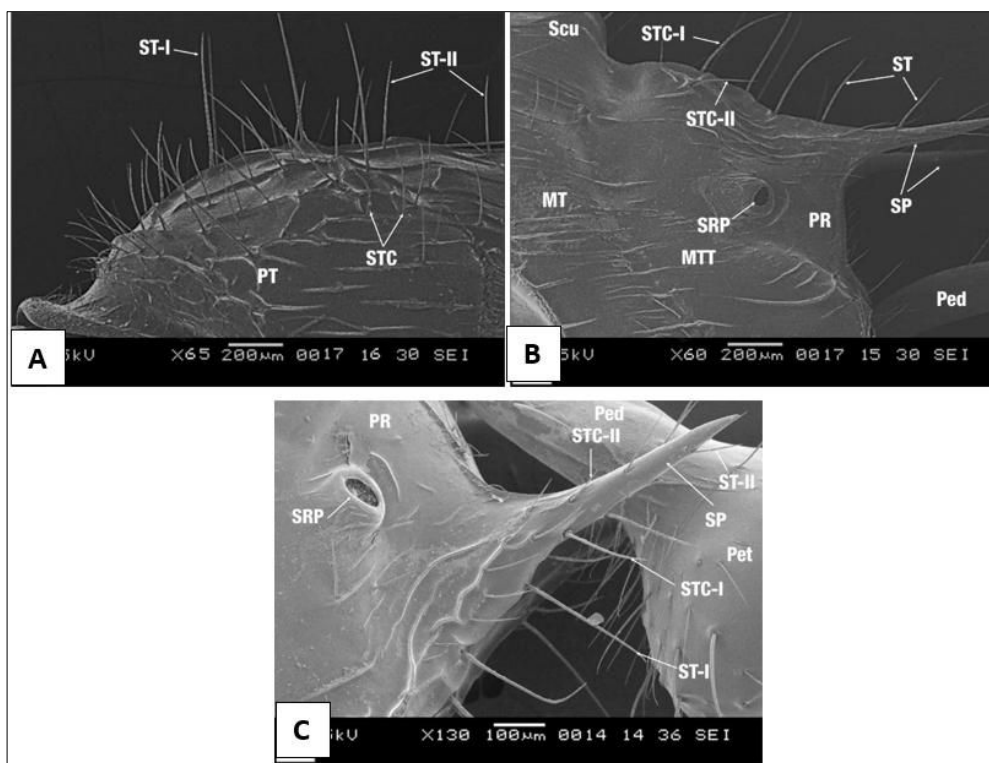


Fig 1: Scanning electron microscopic (SEM) structure of *M. brunnea*. A. SEM of magnified view of prothorax showing ST and STC of *M. brunnea*. B & C. SEM magnified view of mesothorax and metathorax showing propodeal spine, ST, STC of *M. brunnea*. PT- prothorax, MT- mesothorax, MTT- metathorax, SRP- spiracle, ST- sensilla trichodea, STC- sensilla atrichodea curvata, Aep - Anepisternum, Kep - Katepisternum, PR - Propodeum, Mgb - Metapleural gland, Pet -Petiole

Discussion

Worker of *M. brunnea* shown dome-like elevation on the mesonotum. The striated episternum, propodeal spine and spiracle, alitrunk with complete and distinct longitudinal striate were found on the thorax of *M. brunnea* were similar to the morphological character described by Bolton (1994) [2]; Yahya *et al.*, (2009) [10].

During the present study only one pair of spines was observed on the posterior part of propodeum. The spines were backwardly directed facing towards the first node of petiole. *M. brunnea* shown the presence of metapleural orifice which was a non-compressible invagination of the integument, suggesting possible presence metapleural gland. Propodeal spine observed in *M. brunnea*, might be serving as defensive apparatus. Spines were useful for arboreal life where many predators forage. Whereas workers of *Tetramorium tsushimae*, *Crematogaster osakensis*, and *Pheidole fervida* which have small propodeal spines, were frequently eaten by tree frogs (Taniguchi *et al.*, 2005b, Ito *et al.*, 2009) [11, 12]. Propodeal spines might be less defensive than petiolar spines (Ito *et al.*, 2016) [13]. Pores on the spine of *M. brunnea* were similar to the pores on petiolar spines of *Polyrhachis lamellidens* reported by Ito *et al.*, (2016) [13]. According to Ito *et al.*, (2016) [13], glandular secretion might be ejected from the spine similar function might be served by propodeal spine of *M. brunnea* which might change feeding liking of predator over other worker with same structure.

Metapleural gland (MG) was uncommon for insects; glandular secretions ooze out passively through the non-closable opening of the MG or were groomed off by the legs and applied to target surfaces (Yek and Mueller, 2011). Similar function might be assisted by the orifice found on the Worker *M. brunnea*.

Two morphologically different types of sensilla i.e. ST, STC were identified on the thorax of *M. brunnea*.

Heavy sensillation found on the prothorax of *M. brunnea* than meso- and metathorax. Maximum sensilla were covering the central band of the alitrunk. Scutellum and propodeal spine were also found to be covered with sensilla ST and STC.

Social insects such as ants and wasps respond to environmental changes using their sensillary receptors (Rutchy). Such receptors present on the alitrunk of workers of *M. brunnea* might be contributing to analyzing environmental changes and guiding behavioral changes. The specialized thoracic morphology and diverse sensillar structures in *Myrmecaria brunnea* reflect its ecological adaptability and functional importance, emphasizing the need for focused conservation strategies to protect this species and its natural habitat.

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