

A new species of *Tyrannomyrmex* Fernández 2003 (Formicidae, Myrmicinae, Solenopsidini) from Western Ghats, Kerala, India

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Abstract

A new species of *Tyrannomyrmex* (Hymenoptera, Formicidae), *T. alii* sp. nov., is described from the Western Ghats of Kerala State in southern India. This new species can be distinguished from other *Tyrannomyrmex* species using morphological characters, from *T. dux* by the petiolar shape, and from *T. legatus* and *T. rex* by surface sculpture and pilosity. The gyne of the genus is described for the first time. We provide detailed morphological descriptions of the gyne and worker castes, images from scanning electron microscopy, a key to all four known species of *Tyrannomyrmex*, and a note on the ecology of this rare genus.

Key words: Hymenoptera, ants, new species, Periyar

Introduction

Tyrannomyrmex is a rare myrmicine ant genus distributed in the Indomalayan bioregion, with its range extending from southern India and Sri Lanka to Southeast Asia (General & Alpert 2012). The genus was erected for the new species, *Tyrannomyrmex rex* Fernández, discovered from Malaysia, Negri Sembilan; Pasoh Forest Reserve (Fernández 2003). Two other species have been described, *T. dux* Borowiec from the Ponmudi Hills in the Western Ghats of Kerala State in Southern India (Borowiec 2007), and *T. legatus* Alpert from the Sinharaja Forest Reserve in Sri Lanka (Alpert 2013). Later *T. rex* was also discovered from Singapore (Jacquemin *et al.*, 2015). All three species were described from single specimens collected from leaf-litter samples in evergreen forests. Detailed information on the ecology or habitat of *Tyrannomyrmex* is still lacking. Alpert (2013) placed the genus in Solenopsidini Forel 1893, near the genus *Monomorium*, following morphological characters as per Bolton (2003). This hypothesis was partially supported by the phylogenetic analysis of Ward *et al.* (2015), which recovered *Tyrannomyrmex* within a clade containing *Epelysidris* and *Erromyrmex*, both containing species formerly placed in *Monomorium*, and all three nested within the newly defined Solenopsidini. The genus was known from the worker caste and a possible male from the Philippines (General & Alpert 2012; Alpert 2013). Here we describe a new species, *T. alii* sp. nov.. We also describe the gyne of the genus for the first time and provide much needed ecological notes. A key to all known species of *Tyrannomyrmex* is provided based on worker morphology.

Methods and terminology

Morphology was studied using Nikon SMZ 2T Stereomicroscope and measurements were taken with the ocular micrometer. Live ants were studied in the field using a 60× stereomicroscope. Photographs were taken with a Canon 7D and MPE 65 f 2.8 1—5× Lens. Types were imaged with Leica S8 Apo stereomicroscope and Images of whole ants and microsculpture of parts were obtained using a FEI Quanta 200 scanning electron microscope (SEM). Measurements and Indices follow Borowiec (2007). Taxonomy follows Bolton (2003) and Alpert (2013).

The terminology for sculpture follows Harris (1979) and the description of hair inclination from the body surface follows Wilson (1955). We describe SEM characters and setae based on Esteves and Fisher (2016).

The type series was compared with the type specimens of all the three known species of *Tyrannomyrmex*, using images available at <http://www.antweb.org>. Additional details were obtained by contacting the species authors and curators directly. All measurements are in millimeters unless specified.

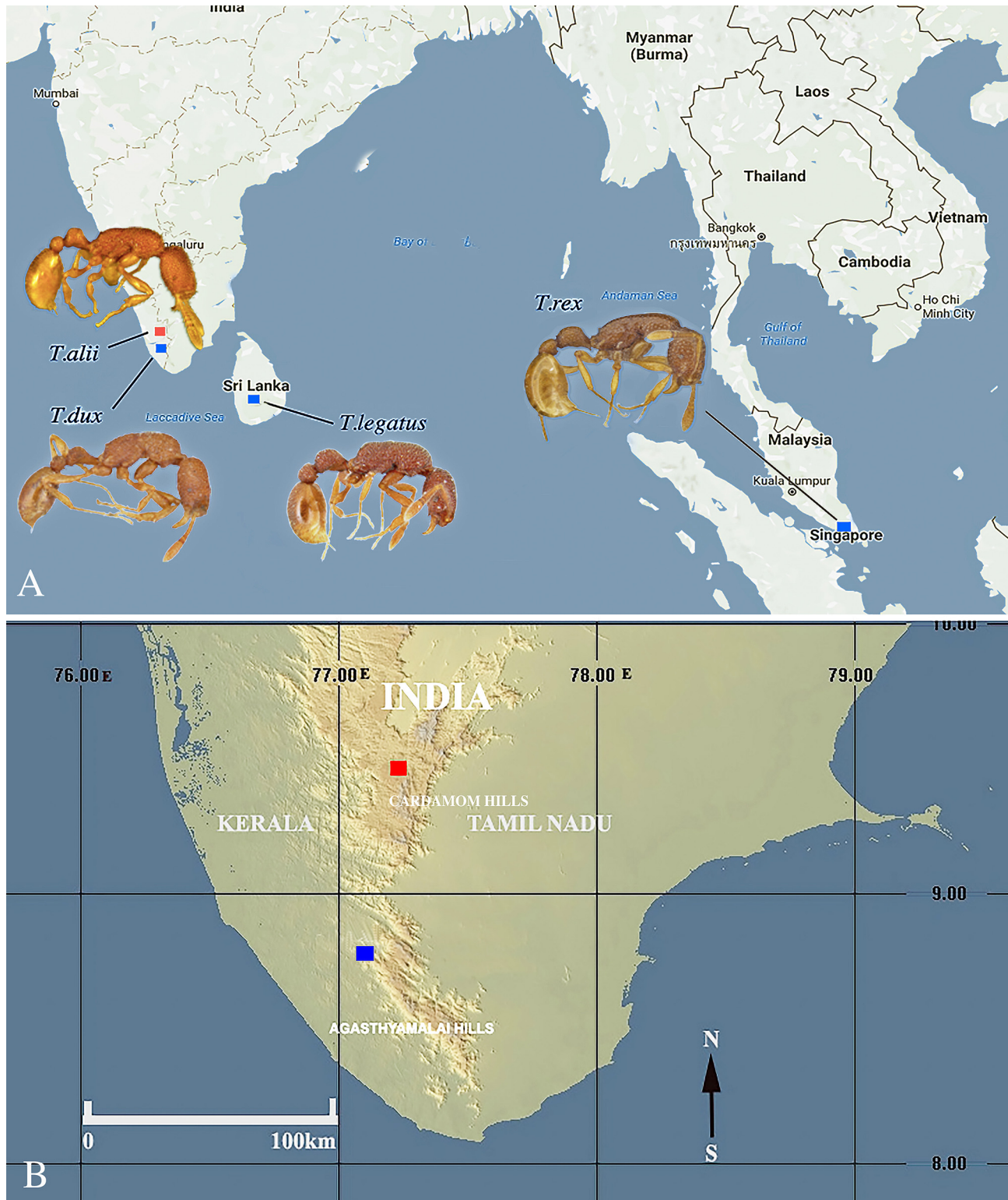


FIGURE 1. Map showing the current distribution of genus *Tyrannomyrmex* in the world (Source www.antweb.org).

Measurements:

EL—Eye Length. Maximum length of the eye measured in the same view as HL.

GL—Gaster Length. Maximum length of gaster in lateral views from the anterior most point of first gastral segment (excluding sting).

HL—Head Length. The length of the head proper, excluding the mandibles, measured in a straight line from the mid-point of the anterior clypeal margin to the midpoint of the posterior margin, in fullface view (excluding the mandibles).

HW—Head Width. The maximum width of the head in full-face view (measured excluding the eyes).

ML—Mesosoma length. In side view, maximum longitudinal distance from posteroventral corner of mesosoma to the farthest point on the anterior face of pronotum, excluding the neck.

PTH—Petiole Height. Maximum height of petiole in profile.

PTL—Petiole Length. Maximum length of petiole in dorsal view.

PTW—Petiole Width. Maximum width of petiole in dorsal view.

PPTH—Postpetiole Height. Maximum height of postpetiole in profile.

PPTL—Postpetiole Length. Maximum length of postpetiole in dorsal view.

PPTW—Postpetiole Width. Maximum width of postpetiole in dorsal view.

PRNW—Pronotal Width. The maximum width of the pronotum in dorsal view.

SL—Scape Length. The maximum straight-line length of the antennal scape excluding the basal constriction or neck close to the condylar bulb.

TL—Total Length. $HL + ML + PTL + PPTL + GL$.

CI—Cephalic Index. $(HW/HL) \times 100$.

SI—Scape Index. $(SL/HW) \times 100$.

Results

Tyrannomyrmex alii sp. nov.

(Fig. 2–11)

Material. *Holotype worker*: Vallakadavu, Periyar Tiger Reserve, Idukky District, Kerala State, India, 23 May 2016 at 1100m above M.S.L, collected by Kalesh Sadasivan, tray-sifting loose soil under a decaying log, at base of a tree in forest floor of a primary evergreen forest. Holotype number NCBS-AV849, deposited in the Research Collections Facility at the National Center for Biological Sciences (NCBS), Bangalore, India.

Paratypes: all with same data as holotype. 2 workers (NCBS-AP036 and NCBS-AV848) and a single alate gyne (NCBS-AP037) (NCBS); 1 worker (insect collection of Zoological Survey of India, Calicut, Kerala); 1 worker (Gandhi Krishi Vigyan Kendra, Bangalore).

Additional material examined: Fifteen live workers were observed and studied in the field, but not collected.

Diagnosis. *Tyrannomyrmex alii* are monomorphic, terrestrial myrmicine ants with character states of *Tyrannomyrmex* as defined by Alpert (2013) following Bolton (2003). The new species is easily distinguished from *T. dux* by its ill-defined petiolar peduncle, which occupies less than one third the length of the petiole (vs. peduncle long, occupying at least half of the total length of the petiole in *T. dux*). In *T. rex* the fovea on lateral pronotum are widely separated and in *T. legatus* the foveae are contiguous, while *T. alii* represents a state in between (Fig.12). *Tyrannomyrmex legatus* and *T. dux* both have erect setae on the entire mesosoma, while on *T. alii* erect setae are confined to the dorsal pronotum, and on *T. rex* they are only on the anterior face of the pronotum.

Measurements. Workers are monomorphic with only minor size variation.

Holotype worker: HW 0.55, HL 0.70, EL 0.05, SL 0.55, ML 0.96, PRNW 0.40, PTL 0.35, PTW 0.24, PTH 0.26, PPTL 0.20, PPTW 0.25, PPTH 0.20, GL 0.91, TL 2.90–3.15, CI 78.6, SI 100.

Paratype workers (n=3): HW 0.51–0.55, HL 0.65–0.70, EL 0.05–0.04, SL 0.50–0.55, ML 0.96–0.98, PRNW 0.40–0.42, PTL 0.35, PTW 0.23–0.24, PTH 0.26, PPTL 0.20–0.21, PPTW 0.25, PPTH 0.20–0.21, GL 0.74–0.91, TL 2.90–3.15, CI 76.9–78.5, SI 90–100.

Head: Vertically ovoid, longer than wide (CI 76.9–78.5), wider superiorly and tapering anteriorly, lateral

borders are convex, more so in the upper lateral third, vertex convex and medial aspect of the posterior margin slightly concave. Mandibles triangular, basal margin edentate and separated from the masticatory border by a distinct angle, masticatory border edentate except for two close-set teeth—the apical and pre-apical, the apical being longer and sharper than the pre-apical. Palp formula 2,2. Clypeus with anterior surface on lateral view and anterior border convex and protrudes above the mandibles, devoid of any carinae but having irregular small foveae, the posterior border is narrowly inserted between the frontal lobes. Frontal lobes are distinct and the rounded lateral border covers the antennal sockets. Antennae 11 segmented, with an ill-defined 3-segmented club, scape when extended reaches or falls just short of the posterior head margin (SI 90–100). Eyes small and consisting of only three ommatidia; each ommatidium of size of single fovea. Eyes situated just anterior to the mid-length of the lateral head border (Fig.5).



FIGURE 2. *Tyranomyrmex alii* sp. nov. worker , Holotype (NCBS-AV849).

Mesosoma: In lateral view, the dorsum of mesosoma has a continuous, weak convexity with mild depression, almost indiscernible, at the pro-mesonotal suture. It further becomes a short convexity over the metanotal region and reaches the propodeal region where it ends in a small blunt triangular tooth and then it slopes down the propodeal declivity, which is a gentle concavity, to end on the broad and rounded metapleural lobes. In dorsal view

the mesosoma is broadest just anterior to the promesonotal suture, where its anterior convex margin meets the lateral margin; this junction on the anterolateral pronotum is marked by a distinct angulation. There is a shallow constriction at the promesonotal suture and after this the mesometanotal region is almost trapezoidal in dorsal view. No sutures are evident on the mesosoma, except the promesonotal suture laterally. Propodeal spiracle is ovoid with its long axis parallel to the propodeal declivity. The metapleural gland orifice is not obvious on lateral view under low magnification. But on careful observation from the dorsal aspect at 200 x or more using SEM it was observed that a crescent shaped dorsally opening cleft was present in the propodeal lobe that probably represents the gland orifice. The end of a single, prominent dorsally directed long filiform seta, arising well below the cleft orifice, marked its anterior end. The region lying immediately anterodorsal to this cleft was devoid of sculpture, and this area extended anteriorly to the vertical level of the propodeal spiracle (Fig. 7).

Petiole: In dorsal view, the petiole is longer than wide and longer than the postpetiole. In lateral view the shape is elliptical. Petiole with ill-defined peduncle and in lateral view the anterodorsal margin curves upwards and abruptly expands into the node. The petiole bears on its ventral surface a quadrangular subpetiolar process whose thin laminar wall forms an acute angle with the peduncle anteriorly (Fig. 7).

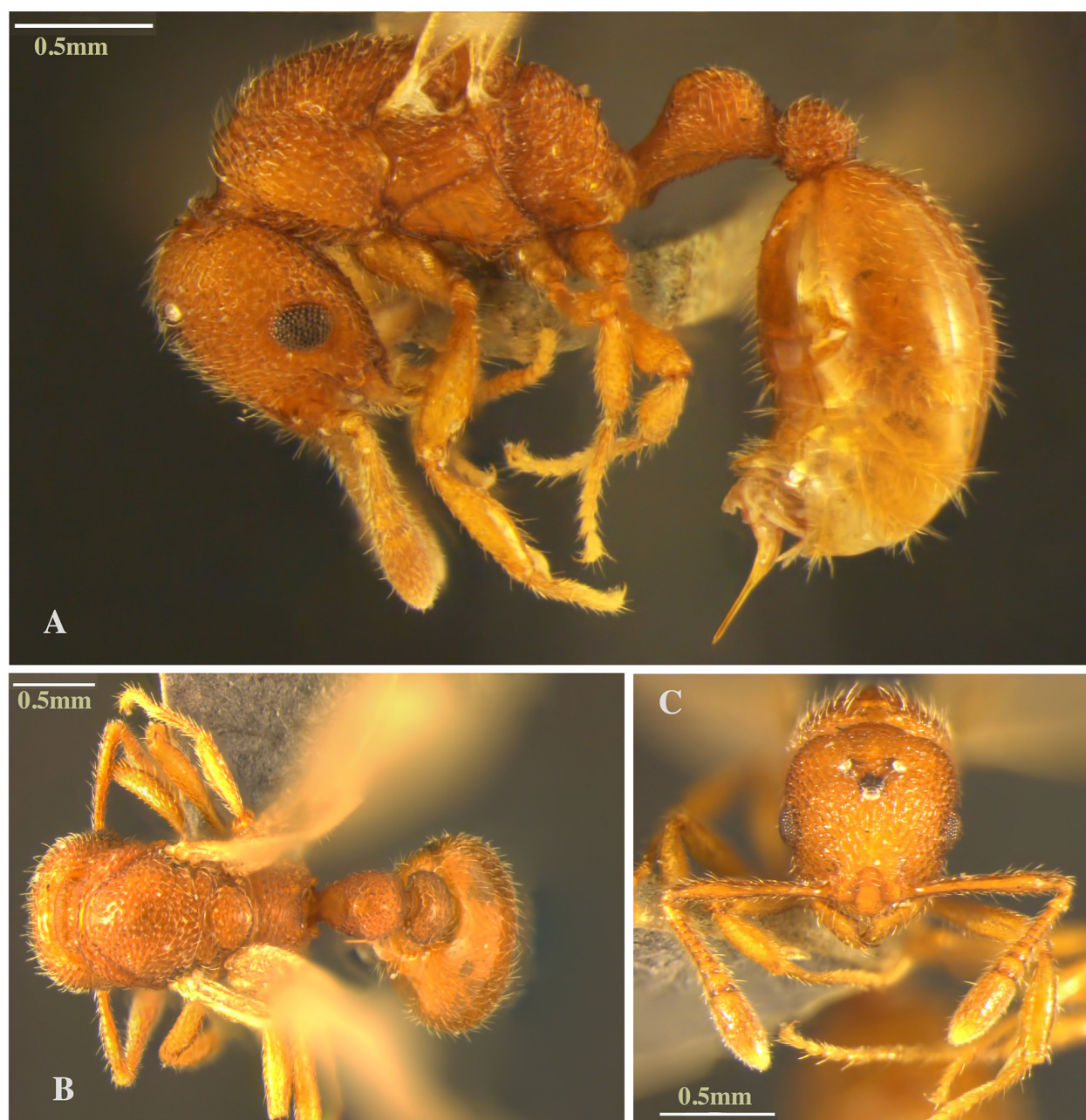


FIGURE 3. *Tyrannomyrmex alii* sp. nov. alate gyne, Paratype (NCBS-AP037).



FIGURE 4. *Tyrannomyrmex alii* sp. nov. Image of a live worker from the same colony as the types.

Postpetiole: In dorsal view shorter than the petiole, more or less as wide as long and rounded with anterior concave and posterior convex margins. In lateral view, it is shorter than the petiole and almost spherical and is dorsoventrally compressed. The postpetiolar sternite bears a transverse keel forming an acute angle anteriorly in lateral view (Fig. 7).

Gaster: Elliptical in dorsal view with concave anterior margin to accommodate the post-petiole, and flattened dorsoventrally. Tip of the abdomen bears a robust and well-developed sting (Fig. 7).

Legs: Forelegs with calcar of strigil (protibial spur) in SEM having squamiform setae on the outer half of its medial (ventral) surface, lanceolate setae on its dorsal edge and digitiform setae on its ventral cleaning edge. Comb of strigil on probasitarsus has digitiform setae on its entire cleaning edge. The middle and hind legs are without tibial spurs. Claws are furnished with arolium on all the legs (Fig. 8).

Sculpture and Pilosity: Head is heavily foveate and bears numerous short erect hairs on its entire surface. Clypeus has irregularly shaped foveae except on its upward extension between the frontal lobes. There is a median band of un-sculpted area on the head extending from the apex of the median portion of clypeus to about the mid-part of the head in full-face view.

Mesosoma is also heavily foveate throughout but more so on the lateral pronotum. The foveae are close to each other, especially on the lateral pronotum, but they never touch. On the dorsum the distance between the foveae is about the diameter of the individual foveae or slightly more. But on the lateral pronotum the distance is usually less than the diameter but more than the radius of the individual foveae. The spaces between the foveae are smooth. In the median portion of the dorsum of the mesosoma along the whole length the foveae are more distant from each other than on the lateral pronotum. The inter-foveal distance is more than the diameter of the individual foveae and sometimes twice as much. The petiolar node is foveate and the inferior half and the peduncle is areolate. The postpetiole is predominantly foveate and the ventral part is areolate. Gaster is with fine punctations where the pilosity arises but otherwise un-sculptured and smooth on the first tergite and sternite. The posterior edges of other gastric tergites have punctations from which the erect hairs arise. There is no evidence of any micro-reticulations. Microsculpture is as shown in Figures 5 and 7.

Hairs on the antennae and mandibles are mostly sub-erect to sub-decumbent. Median clypeus bears a series of 6–8 evenly spaced prominent long erect setae on the inferior margin of which two are at the level of the antennae and the rest along the inferior border. There are otherwise numerous short thin sub-decumbent bristle hairs arising from the irregular foveae on the entire mid-clypeus except its projection superiorly between the frontal lobes. Similar hairs are seen on the outer aspect of mandible. Head is otherwise covered in sub-decumbent hairs. Inner aspect of the mandible on SEM at 1500x revealed modified setae arising from circular pits in the submarginal area of the masticatory border. These are cylindrical at the base and almost fill the pits from which they originate. They become flat and later assume the shape of a scimitar towards their ends (Fig. 6).

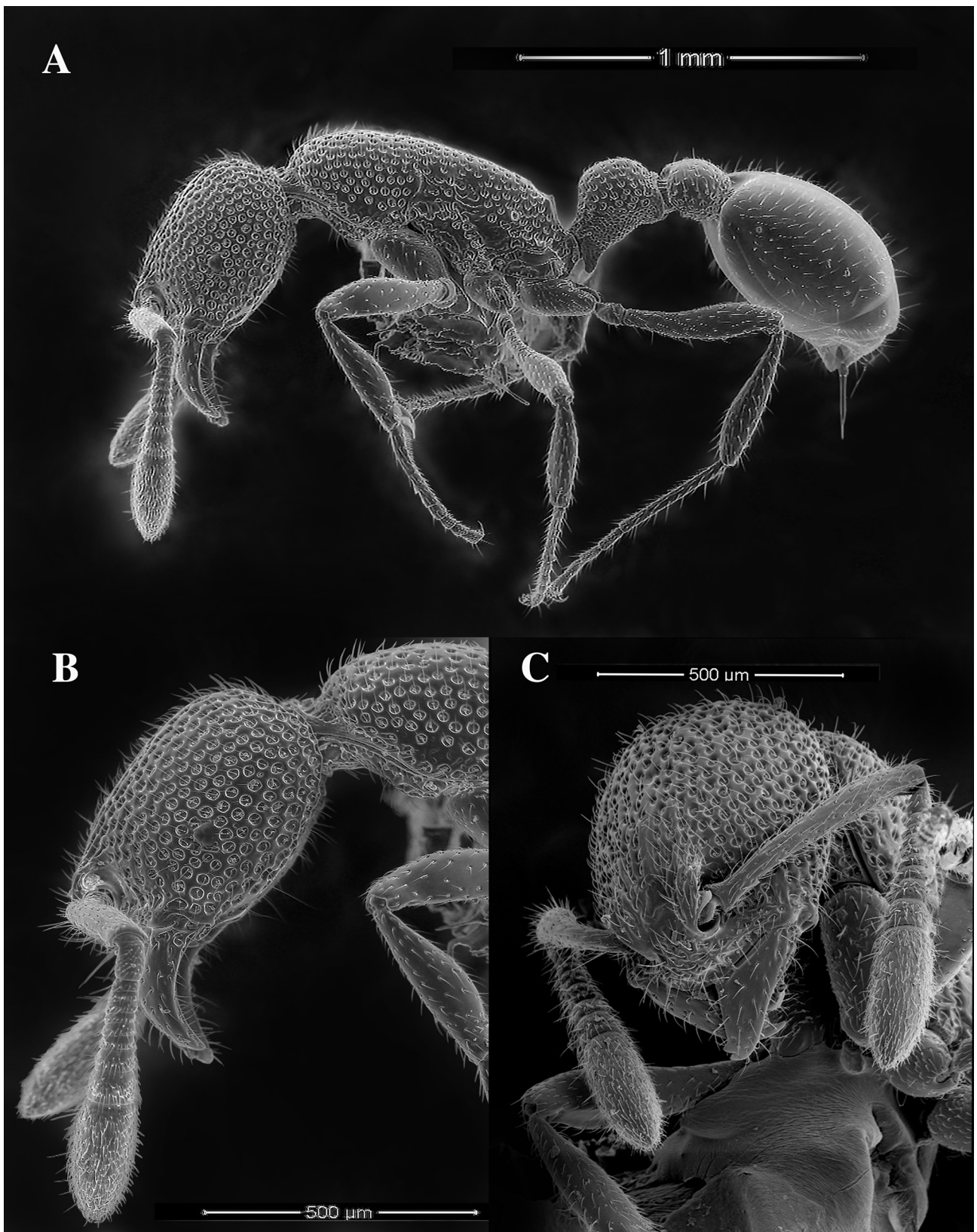


FIGURE 5. *Tyrannomyrmex alii* sp. nov. SEM images of a worker from the same colony as the types. A—lateral view and B & C—close-up of the lateral and anterior aspect of head, respectively.

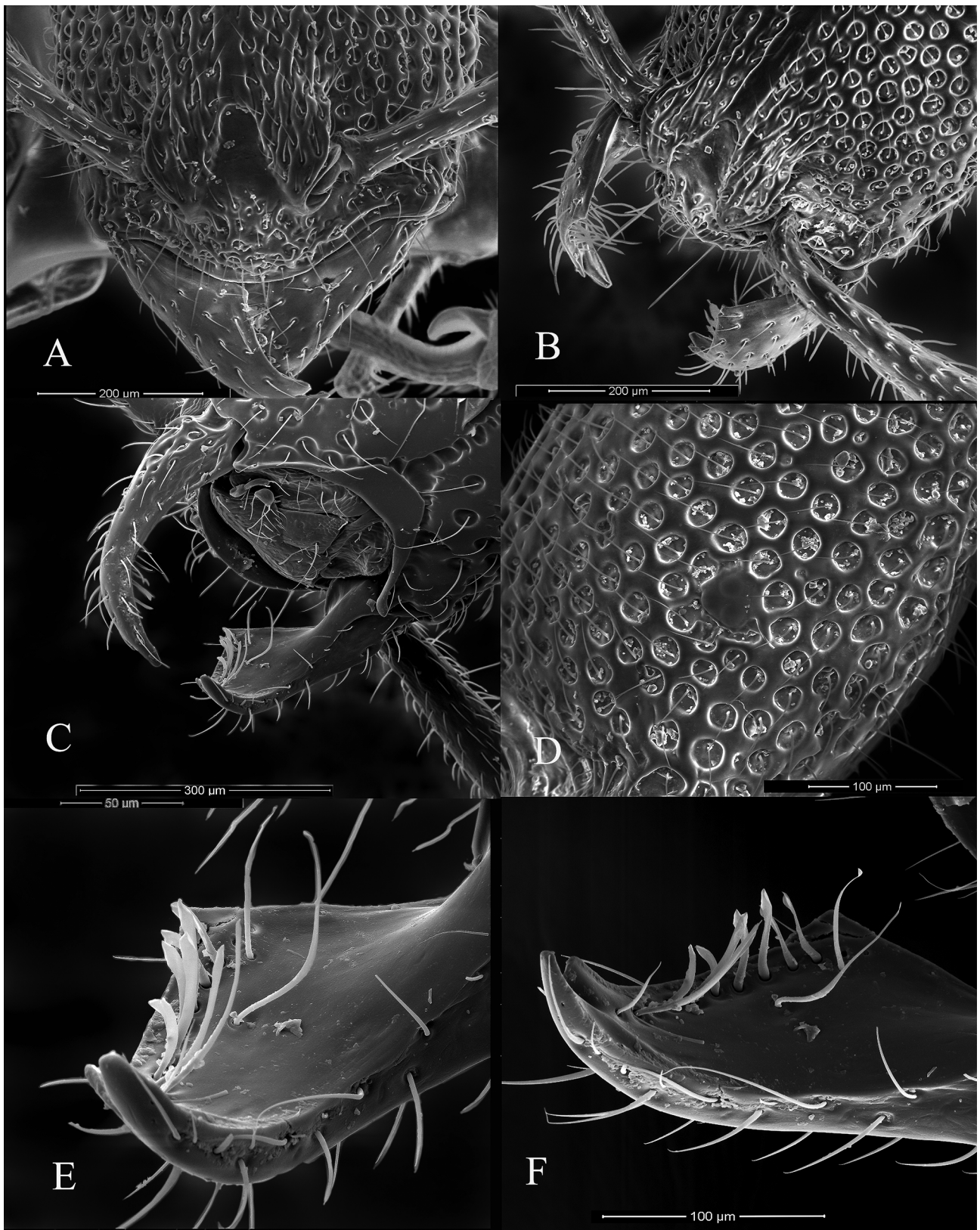


FIGURE 6. *Tyrannomyrmex alii* sp. nov. SEM images of worker. A—clypeus and mandible. B—mandibles open, showing setae along the clypeal border. C—ventral view of the mandible. D—close-up of the eyes. E & F—specialized setae on the inner surface of the mandible.

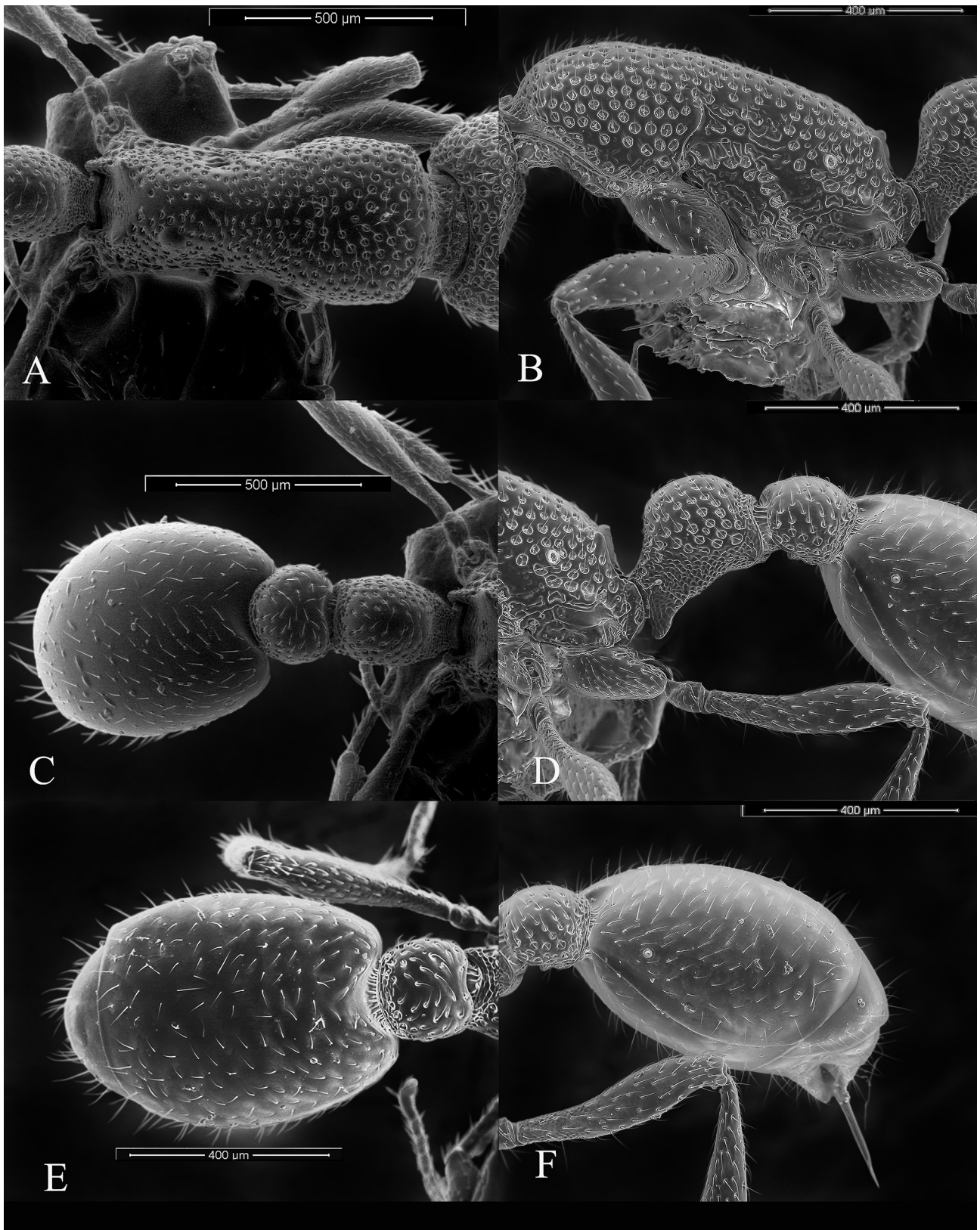


FIGURE 7. *Tyrannomyrmex alii* sp. nov. SEM images of worker A—dorsum of mesosoma, B—mesosoma lateral view, C—dorsum of petiole and postpetiole, D—lateral view of the petiole with sub-petiole process and postpetiole and E & F—dorsal and lateral views of the gaster with sting.

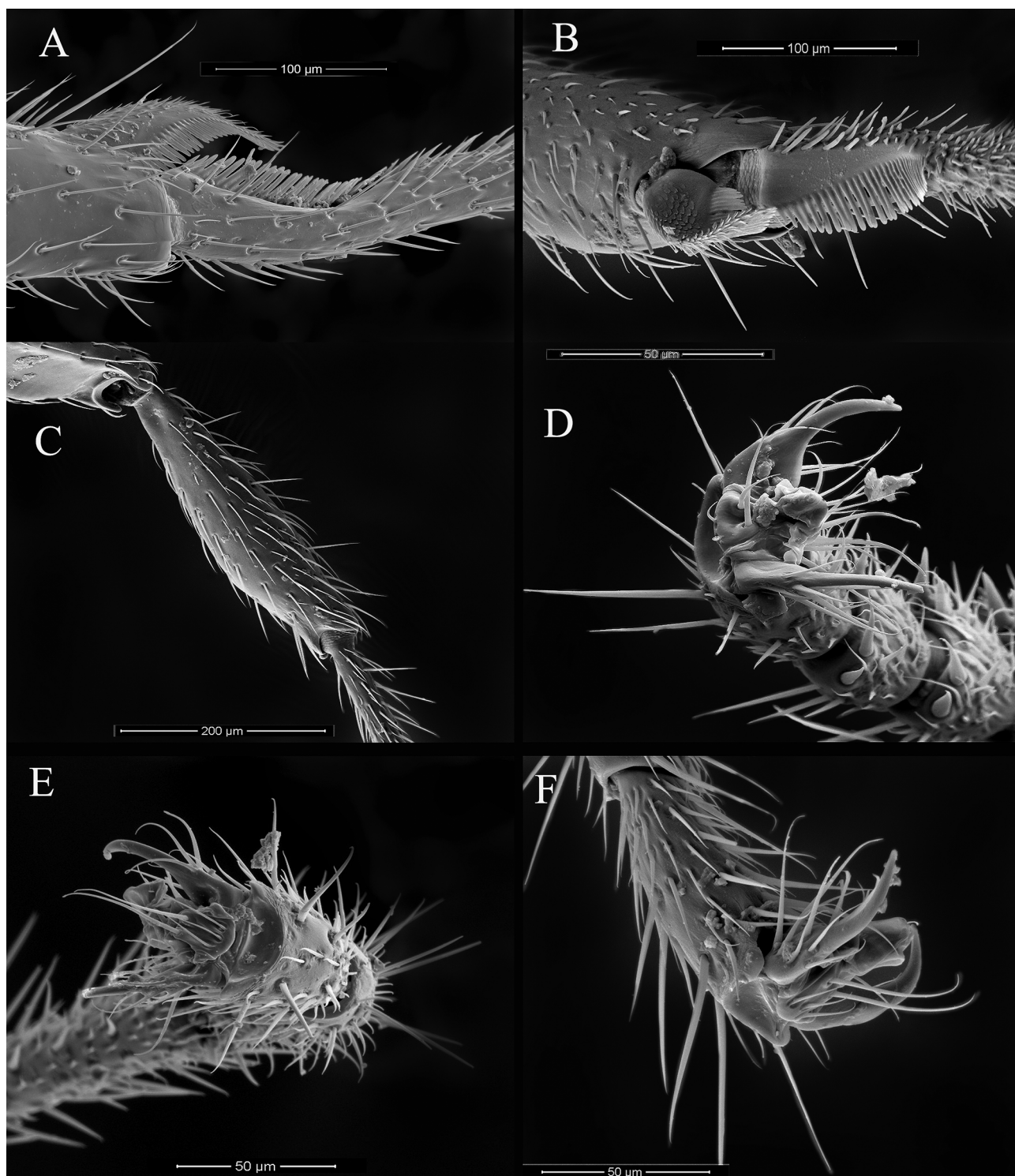


FIGURE 8. *Tyrannomyrmex alii* **sp. nov.** SEM images of worker: A & B: calcar and strigil, C—medial view of tibia and D, E & F—tarsal claws and the arolium on foreleg, midleg and hindleg.

These are very different from the normal body hairs and setae seen along the clypeal border. Whole mesosoma in workers covered in short hairs that arise from the foveae, but only those on the pronotum are erect and suberect hairs are seen towards the mesonotal region. Hairs on the mesonotum and metanotum are decumbent and appressed respectively (n=5). Short sub-decumbent to decumbent hairs are seen all over the postpetiole and legs. Gaster and postpetiole have suberect to subdecumbent hairs. Short hairs on the petiolar dorsum are not erect. Generally, the hairs on dorsum of head, mesosoma and petiole are regularly arranged and all other regions have irregularly directed hairs.

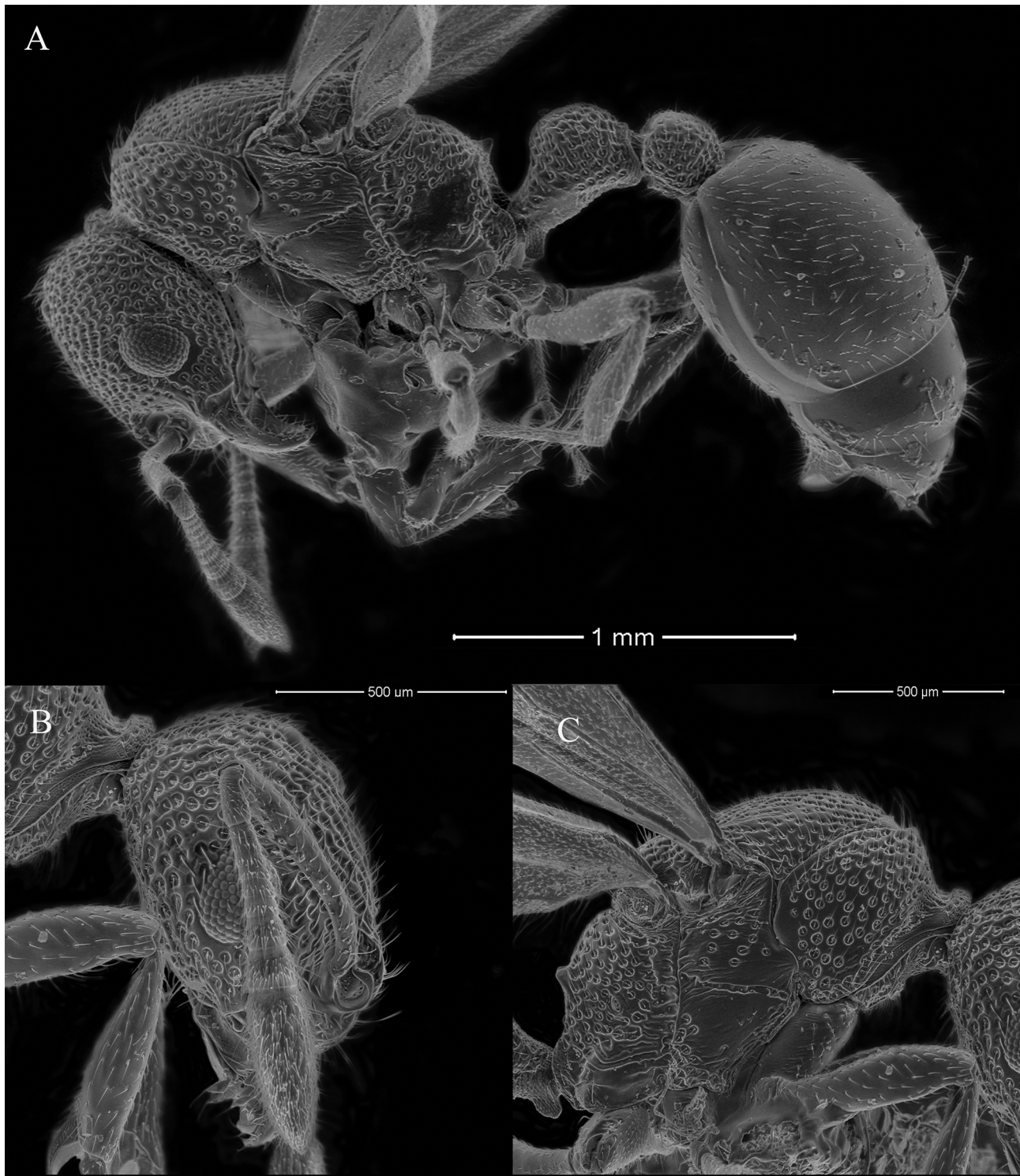


FIGURE 9. *Tyrannomyrmex alii* sp. nov. SEM images of alate gyne: A—lateral view, B—lateral view of head and antennae and C—lateral view of the mesosoma.

Color: Orange red, the head and pronotum is darker; mesonotum and metanotum are brownish. Petiole, postpetiole and gaster are more yellowish. Legs, mandible and antennae are yellowish orange. All hairs are white (Fig. 2 and 4).

Paratype Gyne

(Fig. 3, 9, 10 and 11)

Measurements HW 0.65, HL 0.72, EL 0.20, SL 0.65, ML 1.32, PRNW 0.62, PTL 0.52, PTW 0.31, PTH 0.33, PPTL 0.22, PPTW 0.33, PPTH 0.26, GL 1.20, TL 3.98, CI 90.28, SI 100.

Head: In shape and structure similar to the worker except for the larger size. Structure of the mandible, clypeus and frontal lobes is same as in the worker. Mandibles are triangular with basal border simple and apex of the masticatory border with the typical pair of teeth as in the worker. Frontal lobes are distinct and the rounded lateral border covers the antennal sockets. Antennae 11 segmented bearing an ill-defined 3-segmented club. Scape when extended just falls short of the vertex. Eyes are large, bearing numerous ommatidia (more than 100), unlike the workers. The eyes are situated just anterior to the mid-length of the lateral head border and form about 40 percent of the lateral head convexity (Fig. 9).

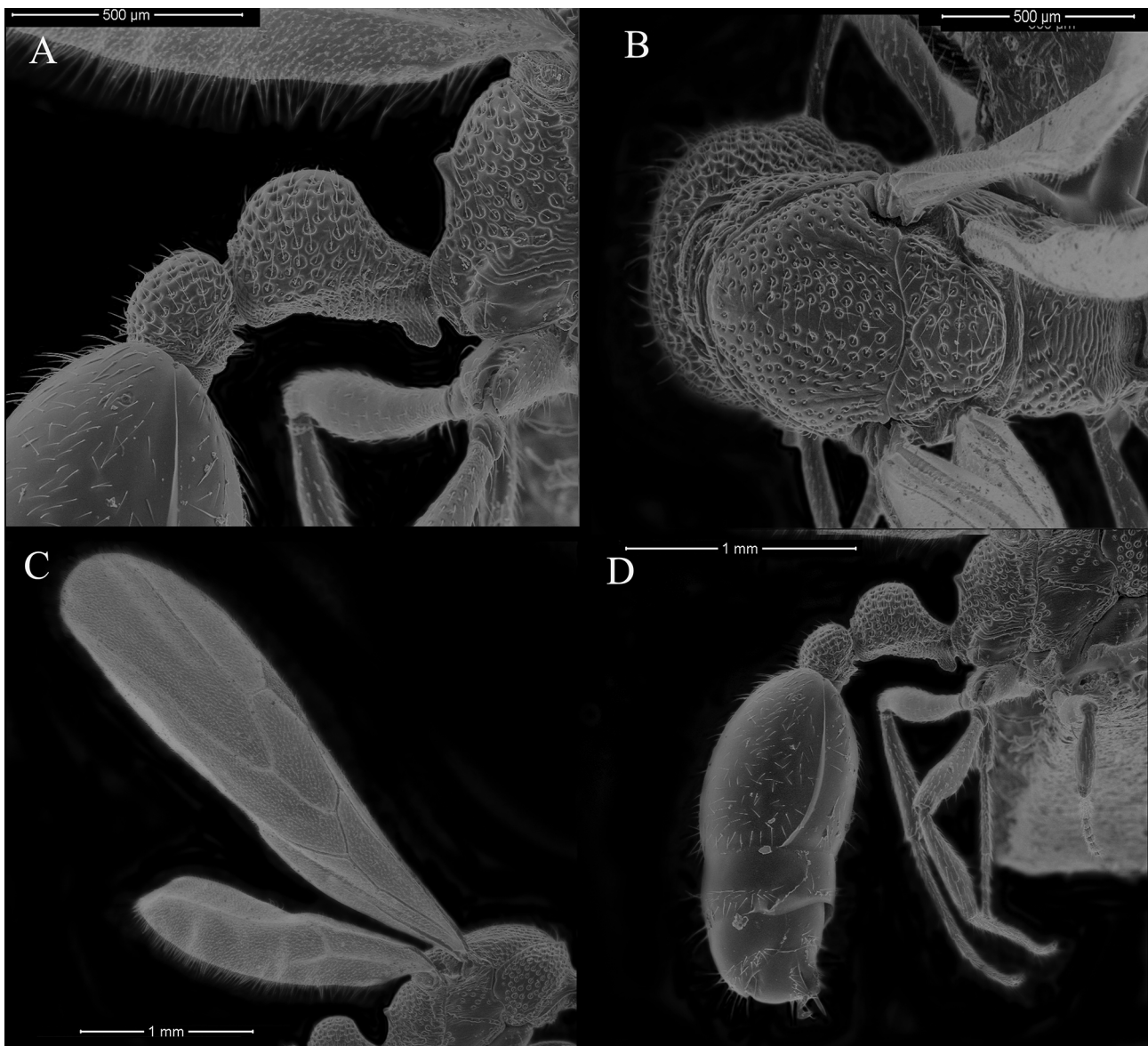


FIGURE 10. *Tyrannomyrmex alii* sp. nov. SEM images of alate gyne A: lateral view of the petiole and with sub-petiole process and the postpetiole, B—dorsal view of the mesosoma, C—venation and D lateral view of gaster.

Mesosoma: In lateral view, the mesosomal dorsum is convex and is mildly depressed at the meso-metanotal region. It further becomes a short convexity over the metanotum and reaches the propodeal region where it ends in a small triangular tooth and then it slopes down the propodeal declivity, to end on the broad and rounded

metapleural lobes, like the worker. In dorsal view the mesosoma is broadest anteriorly, the anterolateral pronotum is without distinct angulation in contrast to the worker. Promesonotal and meso-metanotal sutures are distinct. The anepisternum and katepisternum are well defined compared to the worker. Venation as in Figure 11.

Petiole, Postpetiole and Gaster: These are structurally similar to the worker except for the larger size. Petiole has an ill-defined peduncle occupying the anterior-third of its length. Sub-petiolar process is well developed. Gaster is larger but otherwise similar to the worker (Fig. 10).

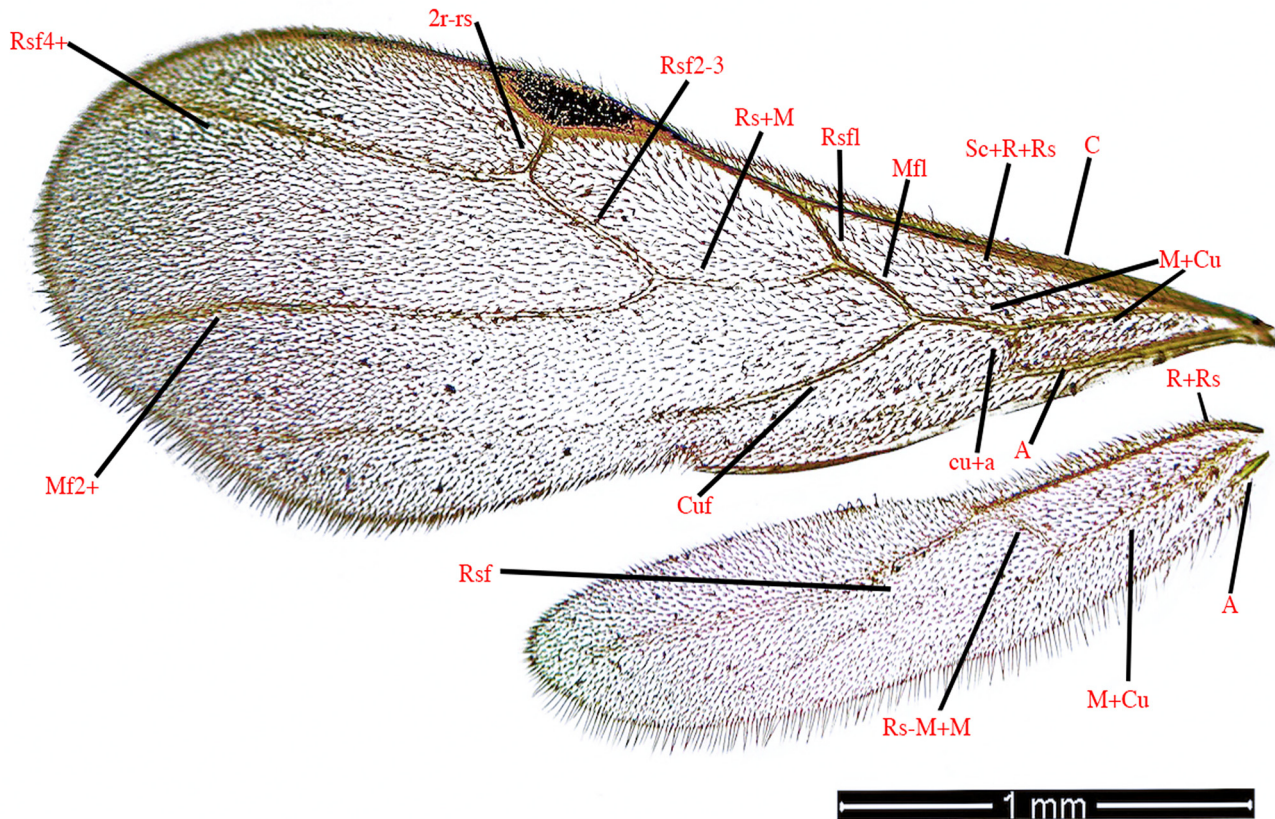


FIGURE 11. *Tyrannomyrmex alii* sp. nov. gynes venation.

Color, sculpture and Pilosity: Color and pilosity same as for the worker. The sculpture is similarly foveate, but on the head, foveae are denser, regular, and arranged in a radial fashion arising from the frontoclypeal suture region. The sculpture on mesosoma is same as in the worker but the inferior third of the anepisternum, superior two-third of the katepisternum, and the posteroventral aspect of the propodeum including the lobes lack any foveae. The propodeal declivity is rugose and devoid of foveae. Sculpture of the petiole, postpetiole and gaster is as in the worker.

Male. Unknown

Etymology. The species is named after Prof. Musthak Ali, an eminent Indian myrmecologist, and mentor to the authors.

Ecological Notes. The type series, consisting of monomorphic workers and alate gynes, was obtained from tray-sifting dry soil under a rotting log in a primary evergreen forest in the Western Ghats of Southern Kerala, at an elevation of 1100 m M.S.L. The log was on the forest floor in a shady part of the forest near a buttress of a tree at the lower end of the slope of a hill. The colony was probably located in the dry soil and the wood interface. Ants were collected by tray sifting the dry soil underneath the log. They were not very fast and could be picked up with ease. Approximately 52 individuals were observed in a 50 cm² area of sifted soil. The sample had a mature dealate queen with normal gaster (possibly as an alate that lost her wings prematurely), 16 mature alate-gynes, and about 35 workers, both immature and mature. Males were not observed in the colony. Pupae, larvae, or eggs were also not observed. This suggests that the alates were being moved to the surface in preparation for release from the nest. Leaf litter was sparse in the sifted soil and in the area where the colony was located. When the soil surrounding the

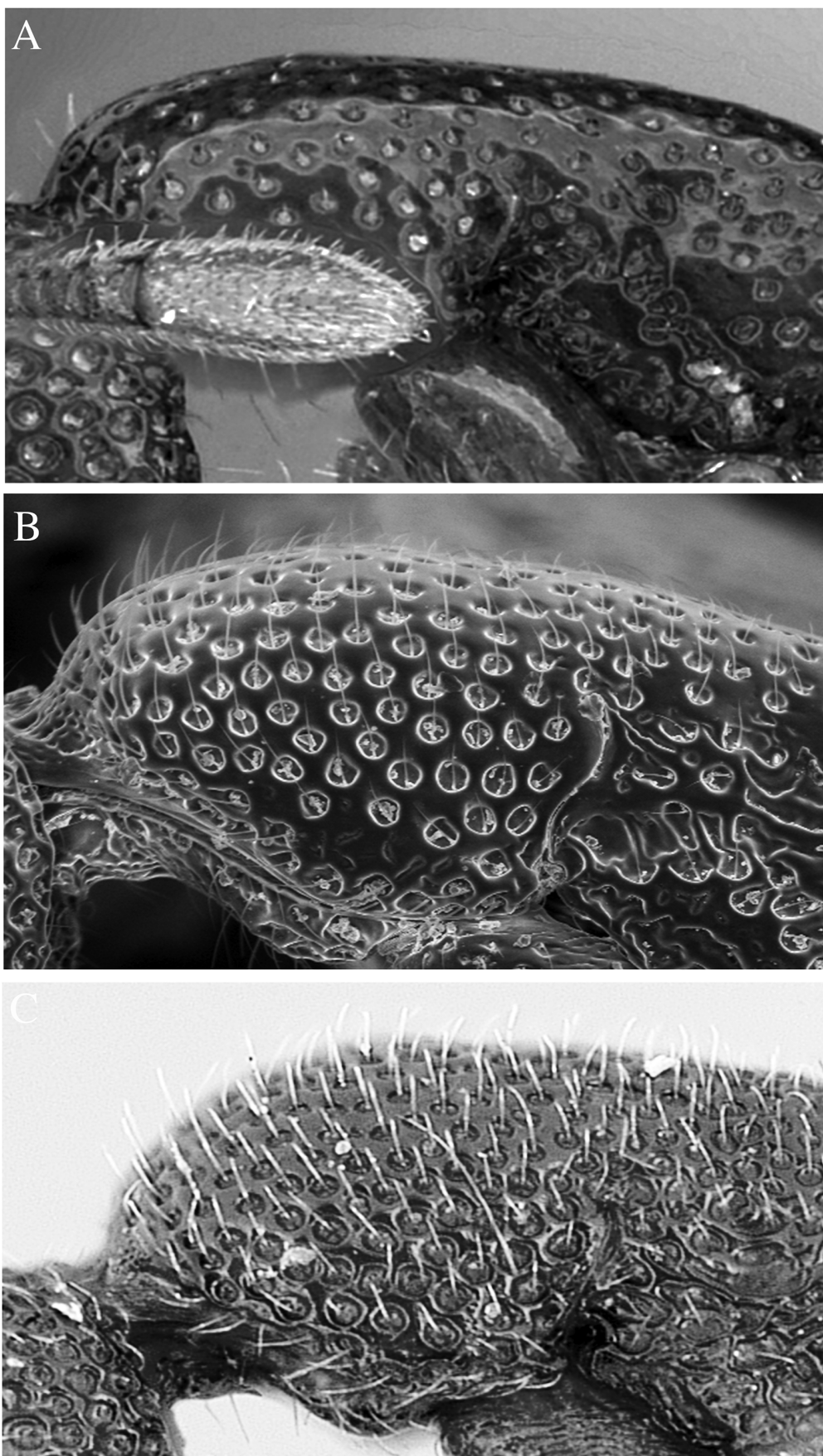


FIGURE 12. Foveae on lateral pronotum: A—*T. rex*, B—*T. alii* and C—*T. legatus*.

log was sifted no ants were observed. We hypothesize that the colony was not located in leaf-litter but in the soil under the rotting log. This ant is probably subterranean in habit, nesting in the soil under rotting logs and using the soil-leaf litter interface for foraging. This explains why all the other species described for the genus are known from single foragers from leaf-litter samples. The small eyes, specialized mandibular hairs and the general color suggest such a microhabitat.

Discussion

We studied the collected workers ($n = 7$) and 15 randomly taken live workers (not collected) from the site. We observed that pilosity and petiole shape are stable and dependable characters, within our sample. Regarding mesosomal pilosity, it is most reduced in *T. rex*, while *T. dux* and *T. legatus* have the entire mesosoma covered in erect setae. With respect to pilosity the new species is intermediate between these two states, with erect setae occupying the entire pronotum but grading to decumbent and appressed towards the propodeum. The weak differentiation of the petiolar peduncle is a stable character shared by *T. alii*, *T. rex*, and *T. legatus*. In contrast, the peduncle of *T. dux* is well developed, forming almost half of the anterior structure of the petiole.

The spacing of foveae varies in different parts of the same specimen. The region that most reliably separates species is the side of the pronotum. In *T. rex* the foveae are small with most interspaces equal to or wider than their diameter. The other three species have more closely spaced foveae (see key). Fovea are very closely spaced in *T. dux*, with interfoveal distance less than one third the diameter of individual foveae (Borowiec 2007), and in *T. legatus* the foveae are nearly contiguous (Alpert 2013). In *T. alii* the foveae are close but not contiguous; distances between edges of adjacent foveae are usually less than their diameter but more than the radius of the individual foveae. Thus, in this character the new species is a grade between *T. rex* and the other two species. The propodeal spine is a small blunt triangular tooth in all the four known species. The specialized setae on ventral surface of the mandible could be useful for generic identification, but this has to be verified by detailed assessment of mandibular setae in related genera.

This species is the fourth one of this rare genus and the second one from India. The Western Ghats complex is one of the worlds' major biodiversity Hotspots (Myers *et al.* 2000) and it is interesting to note that both the *Tyrannomyrmex* species described from India are known from this mountain range in Kerala state. Colonization of the Indian peninsular region by oriental fauna in the late Pliocene was demonstrated in Rhopalocera (Holloway 1974). *Tyrannomyrmex* and *Indomyrma* are myrmecological examples of such east to west faunal dispersal (Zryanin 2012).

Key to known species of *Tyrannomyrmex* based on worker caste (Fig.12)

1. In lateral view, petiolar peduncle clearly differentiated from the node, peduncle forming anterior half of the petiole; foveae dense and contiguous on side of pronotum. Agasthyamalais, Kerala, India. *T. dux*
- Petiolar peduncle not clearly differentiated from the node 2
2. Foveae on lateral pronotum widely separated, sparse and irregularly placed; inter-foveal distance more than diameter of foveae (Fig. 12); erect hairs restricted to the anterior pronotum, rest of the mesosoma devoid of any hair. Peninsular Malaysia ... *T. rex*
- Foveae on lateral pronotum more closely spaced, denser and more regular; inter-foveal distance less than the diameter of the individual foveae; whole mesosoma bearing hairs 3
3. Foveae on lateral pronotum contiguous (Fig. 12); whole mesosoma covered in erect hairs. Sri Lanka *T. legatus*
- Foveae on lateral pronotum never contiguous, inter-foveal distance less than foveal diameter but more than the radius of the individual foveae; erect hairs occupying the entire pronotum and grading to decumbent and appressed towards the propodeum. Periyar, Kerala, India. *T. alii*

Acknowledgments

We are thankful to Kerala Forest and Wildlife Department for collection permits (WL-10-1259/2015) and logistical support and help from Kerala State Biodiversity Board is gratefully acknowledged. We thank Harikumar IFS, Principal Chief Conservator of forests; Krishen Kumar IFS Wildlife Warden, Periyar Tiger Reserve; Pradeep.KI

DCF, Jayachandran Range Officer Vallakadavu Range; Joshy Research Range officer and Reney Pillai of the Kerala Forest and Wildlife Department. The authors are grateful to Prof. Musthak Ali, Flavia A. Esteves, Brian L. Fisher, Brendon Boudinot and James Trager, who helped us in the various stages of preparation of this paper. We would like to thank Krushnamegh Kunte, Prathapan.KD, Ullassa K and Freerk M for their support. We acknowledge help with imaging the species from Satya Krishna Prakash, Dipendra Nath, Yeshwant HM, Nishad KV and Shamim MK. We thank our colleagues Gaurav. A, Jayakumar.K, Ramesh MB, Baiju K, Vinay Krishnan, Anzil S, Ajith Kumar, Kiran MR, Santhosh Indeevaram, and Sandeep Das from Travancore Natural History Society Ant research group (TARG), Trivandrum for their support and encouragements.

References

- Alpert, D.G. (2013) A new species of *Tyrannomyrmex* (Hymenoptera: Formicidae) from Sri Lanka. *Zootaxa*, 3721, 286–290.
<https://doi.org/10.11646/zootaxa.3721.3.5>
- AntWeb (2017) Available from: <https://www.antweb.org/images.do?subfamily=myrmicinae&genus=tyrannomyrmex&rank=genus&project=allantwebants> (accessed 11 March 2017)
- Bolton, B. (2003) Synopsis and Classification of Formicidae. *Memoirs of the American Entomological Institute*, 71, 1–370.
- Borowiec, M. (2007) A new species of *Tyrannomyrmex* (Hymenoptera: Formicidae: Myrmicinae) from India. *Zootaxa*, 1642, 65–68.
- Esteves, F.A. & Fisher, B.L. (2016) Taxonomic revision of *Stigmatomma* Roger (Hymenoptera: Formicidae) in the Malagasy region. *Biodiversity Data Journal*, 4, e8032.
<https://doi.org/10.3897/BDJ.4.e8032>
- Fernández, F. (2003) A new myrmicine ant genus from Malaysia with uncertain affinities (Hymenoptera: Formicidae). *Zootaxa*, 341 (1), 1–6.
<https://doi.org/10.11646/zootaxa.341.1.1>
- General, D.M. & Alpert, G.D. (2012) A synoptic review of the ant genera (Hymenoptera, Formicidae) of the Philippines. *ZooKeys*, 200, 1–111.
<https://doi.org/10.3897/zookeys.200.2447>
- Harris, R. A. (1979) A glossary of surface sculpturing. *Occasional Papers in Entomology*, California Department of Food Agriculture, 28, 1–31.
- Holloway, J.D. (1974) The biogeography of the Indian butterflies. In: Mani, M. (Ed.), *Ecology and Biogeography in India*. Springer, The Hague, pp. 473–499.
https://doi.org/10.1007/978-94-010-2331-3_15
- Jacquemin, J., Sonet, G., Bourguignon, T., Evans, T.A. & Delsinne, T. (2015) Second record and DNA barcode of the ant *Tyrannomyrmex rex* Fernández (Hymenoptera: Formicidae: Myrmicinae). *Sociobiology*, 62, 276–280.
<https://doi.org/10.13102/sociobiology.v62i2.276-280>
- Myers, N., Mittermeier, R.A., Mittermeier, C.G., Da Fonseca, G.A. & Kent, J. (2000) Biodiversity hotspots for conservation priorities. *Nature*, 403, 853–858.
<https://doi.org/10.1038/35002501>
- Ward, P.S., Brady, S.G., Fisher, B.L. & Schultz, T.R. (2015) The evolution of myrmicine ants: phylogeny and biogeography of a hyperdiverse ant clade (Hymenoptera: Formicidae). *Systematic Entomology*, 40, 61–81.
<https://doi.org/10.1111/syen.12090>
- Wilson, E.O. (1955) A monographic revision of the ant genus *Lasius*. *Bulletin of the Museum of Comparative Zoology*, 113, 1–201.
<https://doi.org/10.1086/401086>
- Zryanin, V.A. (2012) A new species of the genus *Indomyrma* Brown, 1986 (Hymenoptera: Formicidae: Myrmicinae) from Vietnam. *Russian Entomological Journal*, 21, 223–228.