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Taxonomic overview of the *Tetramorium tortuosum* group (Hymenoptera, Formicidae) in India and Sri Lanka, with descriptions of three new species from the Western Ghats biodiversity hotspot

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Three new species in the *Tetramorium tortuosum* group, *T. alii*, *T. binghami* and *T. hitagarciai*, are described and illustrated from the Western Ghats, India. In addition, information on the remaining six known species in this group — *T. belgaense* Forel, 1902, *T. keralense* Sheela & Narendran, 1998, *T. pilosum* Emery, 1893, *T. tortuosum* Roger, 1863, *T. urbanii* Bolton, 1977 and *T. yerburyi* Forel, 1902 — is provided along with the key to all the taxa in the group. The *tortuosum* group is the largest of the species group with workers characterized by 11-segmented antenna from the region. Morphology and group affinities of the species are discussed, along with their distribution. However, due to sampling constraints and still insufficient taxonomic knowledge the actual diversity is yet to be properly explored.

Introduction

The hyperdiverse myrmicine ant genus *Tetramorium* is predominately an Old World tropical and subtropical genus, currently represented by 587 extant species, 9 subspecies, and 2 fossil species (see <https://antcat.org>). The Afrotropical region remains a centre of diversity for the genus with nearly half of the known species, followed by the diversity-rich Indomalayan region (Janicki *et al.* 2016, Guénard *et al.* 2017). The genus in

India is represented by 42 species making it one of the most diverse in Asia, but the region has been largely under-sampled. Considering diverse landscapes, climate zones and ecosystems, the true diversity can certainly be multifold (Bharti *et al.* 2016). In India, *Tetramorium* is the third most speciose ant genus preceded only by *Camponotus* and *Polyrhachis*. The 42 known Indian *Tetramorium* species are placed in 13 species groups, most of which are widespread in the Indomalayan and Australasian regions, while several are locally

<http://zoobank.org/References/869D40A4-C562-4F75-B52C-7379AE20EF93>

endemic (*T.inglebyi*, *T.fergusoni*, *T.mixtum* and *T.obesum* groups) (Agavekar et al. 2017).

The *T. tortuosum* group is one of the most species-rich and widespread groups within the genus (Hita Garcia & Fisher 2013), currently represented by about 50 species with nearly half of them reported from the Malagasy region (Hita Garcia & Fisher 2012, 2013). The group includes eight species from the Indomalayan region, with six known from India. It is the main group with 11-segmented antenna from the Indomalayan and Indo-Australian regions (Bolton 1977). *Tetramorium angulinode* group, represented by a single species, is the only other group in India in which species have 11-segmented antenna but it can be easily distinguished from the species in the *T. tortuosum* group by the presence of dense, appressed to decumbent pubescence and pilosity on first gastral tergite which is not found in the species of the *T. tortuosum* group (Hita Garcia & Fisher 2012, 2013).

While the monophyletic nature of the *T. tortuosum* group is still unclear, the overall status of the group remains stable for most of the bioregions around the world. Bolton (1977) studied the fauna of the Indomalayan and Indo-Australian regions, Vásquez-Bolaños et al. (2011) the New World species, Hita Garcia and Fisher (2012, 2013) the Malagasy and Afrotropical faunas. From India, Information on the Indian *T. tortuosum* group can be found in Sheela and Narendran (1998), Bharti and Kumar (2012), Bharti et al. (2016), and Agavekar et al. (2017). The six known Indian species belonging to the *T. tortuosum* group are all considered endemic to India and Sri Lanka, with a few dubious records existing from other regions (Agavekar et al. 2017, Guénard et al. 2017). Here, we describe three new species belonging this group from the Western Ghats, India, and review the information on other known six species (Fig. 1). A key to species is provided along with a discussion of their distribution.

Material and methods

Specimens for this study were collected during ant inventories carried out in the Western Ghats, India, between 2011 and 2013, with considera-

tions as stated in Dad et al. (2019). Morphological analysis was conducted using a Nikon SMZ 1500 stereo zoom microscope. The terminology for ant morphology follows Bolton (1980), Hita Garcia and Fischer (2014), body sculpture Harris (1979), pilosity Wilson (1955), and the measurements and indices Hita Garcia and Fischer (2014) as illustrated in Agavekar et al. (2017). For digital images, an MP Evolution digital camera was used on the same microscope, coupled with the Auto-Montage software (Syn-croscopy, Division of Synoptics, Ltd.). Images were subsequently processed using Adobe Photoshop CS6. Morphometric measurements of the physical specimens were performed with a Nikon SMZ 1500 stereo zoom microscope equipped with an orthogonal pair of micrometres at magnifications ranging from 80× to 150×. All measurements are in millimetres and given as the minimum–maximum ranges. Images of holotype, syntype, or non-type workers available on AntWeb were examined and measured, and morphometric data from the original descriptions were also used.

Abbreviations of measurements and indices (following Hita Garcia & Fischer 2014) used in this paper are listed below:

HL = Head length: maximum distance from the midpoint of the anterior clypeal margin to the midpoint of the posterior margin of the head, measured in full-face view.

HW = Head width: width of the head directly behind the eye measured in full-face view.

SL = Scape length: maximum scape length excluding basal condyle and neck.

EL = Eye length: maximum diameter of the compound eye measured in oblique lateral view.

PH = Pronotal height: maximum height of the pronotum measured in lateral view.

WL = Weber's length: diagonal length of the mesosoma in lateral view from the posteroventral margin of the propodeal lobe to the anteriormost point of the pronotal slope, excluding the neck.

PW = Pronotal width: maximum width of the pronotum measured in dorsal view.

PTH = Petiolar node height: maximum height of

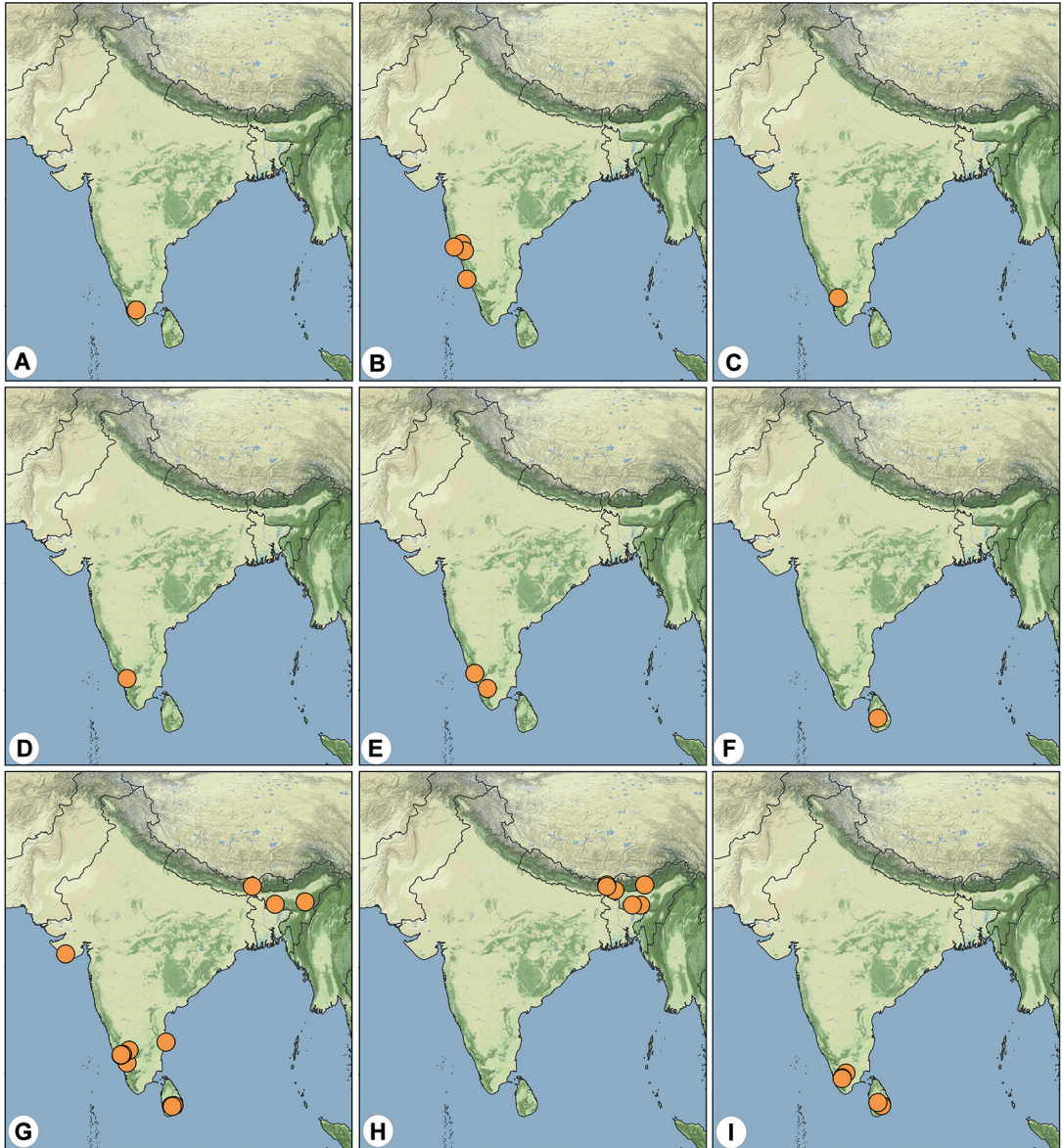


Fig. 1. Distribution of the *Tetramorium tortuosum* group species in India and Sri Lanka. — **A:** *T. alii* *sp. nov.* — **B:** *T. belgaense*. — **C:** *T. binghami* *sp. nov.* — **D:** *T. hitagarciai* *sp. nov.* — **E:** *T. keralense*. — **F:** *T. pilosum*. — **G:** *T. tortuosum*. — **H:** *T. urbanii*. — **I:** *T. yerburyi*.

the petiolar node measured in lateral view from the highest (median) point of the node to the ventral outline.

PTL = Petiolar node length: maximum length of the dorsal face of the petiolar node from the anterodorsal to the posterodorsal angle, measured in dorsal view excluding the peduncle.

PTW = Petiolar node width: maximum width of

the dorsal face of the petiolar node measured in dorsal view.

PPH = Postpetiole height: maximum height of the postpetiole measured in lateral view from the highest (median) point of the node to the ventral outline.

PPL = Postpetiole length: maximum length of the postpetiole measured in dorsal view.

PPW = Postpetiole width: maximum width of

the postpetiole measured in dorsal view.

PSL = Propodeal spine length: in dorsofrontal view, the tip of the measured spine, its base, and the center of the propodeal concavity between the spines must all be in focus.

CI = Cephalic index: $HW/HL \times 100$.

OI = Ocular index: $EL/HW \times 100$.

SI = Scape index: $SL/HW \times 100$.

PSLI = Propodeal spine index: $PSL/HL \times 100$.

LMI = Lateral mesosoma index: $PH/WL \times 100$.

DMI = Dorsal mesosoma index: $PW/WL \times 100$.

PeNI = Petiolar node index: $PTW/PW \times 100$.

LPeI = Lateral petiole index: $PTL/PTH \times 100$.

DPeI = Dorsal petiole index: $PTW/PTL \times 100$.

PpNI = Postpetiolar node index: $PPW/PW \times 100$.

LPPi = Lateral postpetiole index: $PPL/PPH \times 100$.

DPPI = Dorsal postpetiole index: $PPW/PPL \times 100$.

PPI = Postpetiole index: $PPW/PTW \times 100$.

The following abbreviations of institutions are used in this paper: DZCU = Department of Zoology, University of Calicut; MHNG = Muséum d'histoire naturelle de la Ville de Genève, Switzerland; MNHU = Museum für Naturkunde der Humboldt-Universität, Berlin; MSNG = Natural History Museum, Genoa, Italy; NHMB = Naturhistorisches Museum, Basel, Switzerland; NHMUK = Natural History Museum of London, UK; and PUAC = Punjabi University Patiala Ant Collection, Punjab, India.

Holotype and paratypes of the new species are deposited in PUAC.

Results

Tetramorium alii sp. nov. (Fig. 2)

MATERIAL EXAMINED. **Holotype:** worker, India, Kerala, Periyar Tiger Reserve, Manalar, $9^{\circ}35'00.0''N$, $77^{\circ}18'00.0''E$, 1630 m a.s.l., 24 October 2011, collected by hand, leg. Shahid A. Akbar. **Paratypes:** 6 workers, same data as for the holotype.

ETYMOLOGY: The species epithet honours late Dr. Mushtaq Ali, pioneer and renowned ant taxonomist of India.

DIAGNOSIS. A blackish species characterized by unsculptured, smooth and shining postpe-

tiolate, petiole rugulose, clypeus longitudinally rugulose, with three rugulae, median rugula well developed, mesosoma dorsally and laterally irregularly rugose, sides of head strongly reticulate-rugose, propodeal spines raised divergent in profile, propodeal lobes rounded, reduced, peduncle of petiole long, petiolar node nodiform with anterior and posterior margins approximately parallel and posterodorsal margin slightly higher than anterodorsal margin. In terms of its colouration it resembles *T. binghami* and *T. hitagarciai* (see below). It can be easily distinguished from the former by having a well-developed median clypeal rugula, while it differs from the latter by its much smaller size, as well as having a much weaker sculpturing and a sparser pilosity on the dorsal surface of the mesosoma.

WORKER MEASUREMENTS AND INDICES (7 specimens, 1 colony, 1 locality): HL = 0.77–0.82, HW = 0.66–0.70, SL = 0.55–0.59, EL = 0.17–0.20, PH = 0.35–0.37, WL = 0.82–0.84, PW = 0.49–0.52, PTH = 0.29–0.31, PTL = 0.23–0.25, PTW = 0.21–0.23, PPH = 0.32–0.35, PPL = 0.18–0.20, PPW = 0.31–0.33, PSL = 0.25–0.26, CI = 83–86, OI = 25–30, SI = 80–86, PSLI = 30–33, LMI = 42–45, DMI = 58–63, PeNI = 40–46, LPeI = 77–86, DPeI = 84–96, PpNI = 61–66, LPPi = 53–58, DPPI = 163–174, PPI = 141–152.

DESCRIPTION. Head longer than broad (CI = 83–86), sides straight, posterolateral corners rounded; posterior head margin straight. Anterior clypeal margin straight, without a distinct median notch. Mandible triangular, masticatory margin with 6 teeth; large apical and preapical teeth followed by 4 smaller teeth. Frontal lobes developed and elevated laterally, frontal area distinct, frontal carinae strongly developed; antennal scrobes well defined fading posteriorly. Eye large (OI = 25–30) located laterally and at mid-length of the head, composed of ca. 35–36 ommatidia. Antenna slender, 11-segmented, scape just surpassing the posterior margin of head (SI = 80–86). Mesosoma broader anteriorly; dorsum strongly convex forming continuous sloping downward arch posteriorly; pro-mesonotal suture and metanotal groove inconspicuous. Propodeal spines well developed (PSLI = 30–33), long acute and pointed, and slightly up-curved apically. Propodeal lobes reduced, tri-

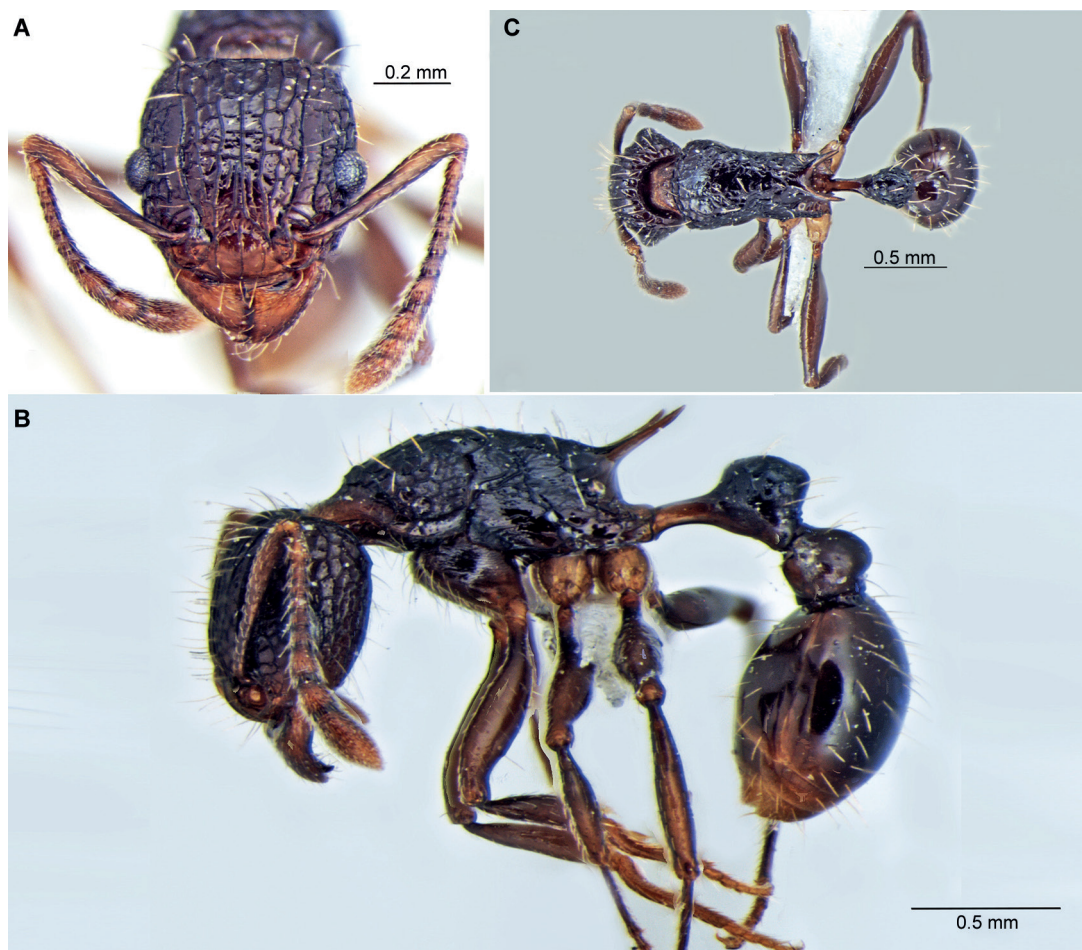


Fig. 2. *Tetramorium alii* sp. nov. — A: Head, frontal view. — B: Habitus, lateral view. — C: Habitus, dorsal view.

angular; dorsum of propodeum slightly convex with declivity almost straight. Peduncle of petiole long, petiolar node in profile nodiform, anterodorsal angle low and rounded, posterodorsal angle high and bluntly angled ($LPeI = 77-86$), anterior and posterior faces almost parallel, posterodorsal margin higher than anterodorsal margin, anterodorsal and posterodorsal angles relatively rounded, petiolar dorsum convex; node in dorsal view longer than wide ($DPeI = 84-96$). In profile view, the postpetiole globular, higher than long ($LPpI = 53-58$); in dorsal view, wider than long ($DPpI = 163-174$). Postpetiole globular in profile appears approximately as voluminous as the petiolar node and in dorsal view wider than the petiolar node ($PPI = 141-152$); the base of first gastral tergite straight behind the postpetiole; anterolateral corners rounded;

gaster oval shaped. Head with longitudinal rugae forming a loose network; spaces between rugae having smooth to granulate appearance at places; antennal scrobes smooth and shining; lateral sides of head rugulose; frontal carinae well developed reaching posterior margin of head; mandible mostly smooth; clypeus with three prominent longitudinal rugae; surfaces in between rugae smooth and shining; dorsum of the mesosoma with loose rugae; surfaces in between smooth and shining; lateral margins of mesosoma with rugulose sculpture; petiole rugulose, postpetiole smooth and shining; propodeum and gaster smooth. Pilosity consists of long, erect hairs distributed sparsely throughout the body surface; appendages with subdecumbent pubescence. Body blackish with appendages lighter brown.

HABITAT. Workers of this species were collected while foraging on the ground near tea plantations in Manalar, part of Periyar Tiger Reserve, a green hilly site at 1630 m, bordering the states of Kerala and Tamil Nadu. The climate in the region is subtropical with mean average daytime temperatures of about 28 °C.

REMARKS. *Tetramorium alii* resembles *T. hitagarciai* (see below) which, however, is larger, with apex of propodeal spines weakly down-curved apically in lateral view and convergent in dorsal view, and petiolar node with bluntly angled anterodorsal corner in lateral view; while in *T. alii*, the propodeal spines are weakly up-curved apically in lateral view and divergent in dorsal view, and petiolar node with rounded anterodorsal corner in lateral view. In *T. hitagarciai*, the dorsum of mesosoma and the mandible are strongly sculptured, the clypeus is characterized by a median notch, the postpetiole larger and has a distinct subpetiolar process, the pilosity on mesosoma and gaster more pronounced; while in *T. alii*, the dorsum of mesosoma and mandible are weakly sculptured, the clypeus does not have a median notch, the smaller postpetiole does not have a distinct subpetiolar process and pilosity on mesosoma and gaster is comparatively less. The shape of the petiole is also different as stated in the descriptions of these species.

Tetramorium belgaense Forel, 1902 (Fig. 3)

Tetramorium (Xiphomyrmex) belgaense Forel 1902: 238. TYPE LOCALITY: India (Karnataka: Belgaum) [holotype MHNG; images of holotype queen examined].

WORKER MEASUREMENTS AND INDICES (10 specimens, 1 colony, 1 locality; from Bolton 1979): HL = 0.74–0.80, HW = 0.66–0.70, SL = 0.58–0.64, EL = 0.18–0.19, PH = 0.41–0.43, WL = 1.00–1.04, PW = 0.52–0.58, PTH = 0.24–0.25, PTL = 0.22–0.23, PTW = 0.25–0.26, PPH = 0.30–0.32, PPL = 0.20–0.21, PPW = 0.34–0.35, PSL = 0.23–0.25, CI = 88–89, OI = 27, SI = 88–91, PSLI = 31, LMI = 41, DMI = 52–56, PeNI = 45–48, LPeI = 92, DPeI = 113–114, PpNI = 60–65, LPpI = 66–67, DPpI = 167–170, PPI = 135–136.

REMARKS. *Tetramorium belgaense* is endemic to India. It has been reported from Goa, Karnataka and Kerala. The species was first described by Forel (1902) based on a queen collected from Karnataka, Belgaum. Bolton (1979) subsequently described the worker specimens from Mysore 23 km south of Haliyal (housed in NHMUK). No other finding of this species has ever been reported, with the exception of a sample collected by John Longino on 7 July 2001 using Winkler sampling from scrub vegetation on a slope above rice paddies in Goa, Saligao, India (AntWeb specimen identifier code: JTLC000000405) and recent report of Rajesh *et al.* (2020) from Kasaragod District in the north Malabar part of Kerala. The *T. belgaense* record from West Bengal by Bharti *et al.* (2016) attributed to Tiwari (1999) is incorrect.

Tetramorium belgaense is most similar to Sri Lankan *T. yerburyi*, which however is much larger and is characterized by relatively longer antennal scape, long stout hairs projecting from the dorsal surface of the hind tibiae, and low and blunt propodeal lobes, which are very obtusely triangular at most. Relatively smaller *T. belgaense* has shorter antennal scape, only short pubescence, and narrowly and acutely elongate-triangular propodeal lobes (see Bolton 1979).

Tetramorium binghami sp. nov. (Fig. 4)

MATERIAL EXAMINED. **Holotype:** worker. India, Kerala, Salim Ali Bird Sanctuary, 10°45'00.0"N, 76°44'00.0"E, 118 m a.s.l., 10 October 2011, collected by hand, Shahid A. Akbar. **Paratypes:** 4 workers, same data as for the holotype.

ETYMOLOGY: The species is named after the Irish entomologist and naturalist Charles Thomas Bingham (1848–1908) for his valuable contribution to the knowledge of Indian ants.

DIAGNOSIS. This species is blackish and small, characterized by sculptured petiole and postpetiole laterally but dorsally smooth and shiny, clypeus with two rugulae but lacking the median rugula, mesosoma dorsally and laterally strongly rugose, sides of head reticulate-rugose, propodeal spines thick and raised, propodeal lobes reduced, petiolar node rectangular and nodiform, with posterodorsal margin slightly higher than anterodorsal margin. This is the only species in



Fig. 3. *Tetramorium belgaense* (CASENT0280882 from www.antweb.org; photos by Estella Ortega). — **A:** Head, frontal view. — **B:** Habitus, lateral view. — **C:** Habitus, dorsal view.

the region that combines blackish pigmentation and the absence of a median clypeal rugula. Its pigmentation resembles that of *T. alii* and *T. hitagarcai* (see below), which further differ from *T. binghami* by having a more developed sculpture on the dorsum of the petiole. Light coloured species with a weakly developed or absent medial clypeal rugula such as *T. belgaense* and *T. pilosum* also differ from *T. binghami* by a strong sculpture on the petiolar dorsum, while *T. urbanii* differs by uniquely short propodeal spines.

WORKER MEASUREMENTS AND INDICES (4 specimens, 1 colony, 1 locality): HL = 0.67–0.70, HW = 0.59–0.61, SL = 0.52–0.54, EL = 0.11–0.15, PH = 0.31–0.33, WL = 0.79–0.81, PW = 0.45–0.48, PTH = 0.28–0.30, PTL =

0.21–0.23, PTW = 0.20–0.21, PPH = 0.26–0.28, PPL = 0.17–0.19, PPW = 0.29–0.31, PSL = 0.20–0.22, CI = 86–90, OI = 19–25, SI = 87–90, PSLI = 29–31, LMI = 39–42, DMI = 56–61, PeNI = 43–45, LPeI = 75–82, DPeI = 87–95, PpNI = 63–67, LPpI = 61–70, DPpI = 163–182, PPI = 143–155.

DESCRIPTION. Head longer than broad (CI = 86–90), posterolateral corners rounded, converging posterolaterally; posterior head margin concave. Anterior clypeal margin weakly convex without a distinct median notch. Mandible triangular with masticatory margin having 6–8 small teeth; large apical teeth followed by series of smaller teeth. Frontal lobes well developed and elevated laterally, frontal area distinct; antennal



Fig. 4. *Tetramorium binghami* sp. nov. — **A:** Head, frontal view. — **B:** Habitus, lateral view. — **C:** Habitus, dorsal view.

scrobes well defined. Eye large (OI = 19–25) located laterally and at mid-length of the head, composed of ca. 35–36 ommatidia. Antenna slender, 11-segmented, scape just reaching posterior margin of head (SI = 87–90). Mesosoma broader anteriorly; dorsum strongly convex; pro-mesonotal suture and metanotal groove inconspicuous. Propodeal spines well developed (PSLI = 29–31), long acute and slightly up-curved apically. Propodeal lobes reduced, triangular; propodeum convex with declivity almost straight. Petiolar node in profile rectangular nodiform, higher than long (LPEI = 75–82), anterior and posterior margins almost parallel, anterodorsal margin higher than posterodorsal margin, dorsum convex; node in dorsal view longer than wide (DPEI = 87–95). In pro-

file, postpetiole subglobular, higher than long (LPPI = 61–70); in dorsal view wider than long (DPPi = 163–182). In profile, postpetiolar node weakly inclining anteriorly with rounded anterodorsal margin, and in dorsal view, wider than the petiolar node (PPI = 143–155); the base of first gastral tergite slightly curved behind the postpetiole; gaster oval shaped. Head with longitudinal rugae at places forming loose network; spaces between rugae smooth; antennal scrobes smooth and shining; lateral sides of head rugulose; frontal carinae well developed reaching posterior margin of head; mandible weakly striate; clypeus with two prominent lateral longitudinal rugae, medial clypeal carinae absent; dorsum of mesosoma rugulose; surfaces in between smooth and shining; lateral margins of mesosoma with rugu-

lose sculpture; petiole with rugulose sculpture, postpetiole smooth and shining; propodeum and gaster also smooth. Pilosity consists of long, thick, erect white hairs distributed throughout the body surface; appendages with subdecumbent pubescence. Body black with appendages light brown.

HABITAT. This species seems a rare occurrence as it was encountered only once, with only a few specimens collected during the extensive surveys. The specimens were hand-picked from the Salim Ali Bird Sanctuary, a lowland evergreen forest area, located along the the Periyar River.

REMARKS. *Tetramorium binghami* resembles *T. belgaense* but has head longer than broad, posterior margin weakly concave, anterodorsal margin of petiolar node in profile weakly higher than posterodorsal margin, postpetiolar node weakly inclining anteriorly, and black body; while in *T. belgaense* head is as broad as long, posterior margin straight, anterodorsal margin of petiolar node in profile as high as posterodorsal margin, postpetiolar node erect, and body brownish-yellow with darker gaster.

Tetramorium hitagarciai sp. nov. (Fig. 5)

MATERIAL EXAMINED. **Holotype:** worker. India, Kerala, Silent Valley National Park, 11°05'38.0"N, 76°26'46.3"E, Kerala, India, 900 m a.s.l., 25 September 2011, collected by hand, leg. Shahid A. Akbar. **Paratypes:** 5 workers, same data as for the holotype.

ETYMOLOGY: The species is named after myrmecologist and friend Francisco Hita Garcia for his important contribution to the taxonomy of *Tetramorium* ants.

DIAGNOSIS. This species is large and blackish with petiole and postpetiole unsculptured, clypeus with three rugulae, median rugula well developed, mandible strongly striate, mesosomal dorsum strongly rugose, sides of head reticulate-rugose, propodeal spines thick and down-curved, propodeal lobes reduced, triangular, petiolar node rectangular nodiform, longer than high and posterodorsal margin slightly higher than anterodorsal margin.

WORKER MEASUREMENTS AND INDICES (6 specimens, 1 colony, 1 locality): HL = 0.90–0.94, HW = 0.79–0.84, SL = 0.68–0.73, EL = 0.14–0.16, PH = 0.38–0.40, WL = 1.10–1.18, PW =

0.59–0.62, PTH = 0.33–0.34, PTL = 0.29–0.32, PTW = 0.27–0.29, PPH = 0.34–0.35, PPL = 0.17–0.19, PPW = 0.33–0.34, PSL = 0.34–0.37, CI = 88–92, OI = 17–19, SI = 82–87, PSLI = 38–41, LMI = 33–35, DMI = 50–55, PeNI = 45–49, LpeI = 85–94, DpeI = 90–97, PpNI = 55–56, Lppi = 49–54, Dppi = 179–194, PPI = 114–122.

DESCRIPTION. Head almost as long as broad (CI = 88–92), sides converging posteriorly; posterior margin straight, posterior corners narrowly rounded. Anterior clypeal margin weakly convex but medially slightly notched. Mandible triangular with 6-teeth, apical tooth large followed by five smaller, irregular teeth. Frontal lobes developed and elevated laterally, frontal area distinct; antennal scrobes well defined. Eye large (OI = 17–19), located laterally and at mid-length of the head, composed of ca. 30–35 ommatidia. Antenna slender, 11-segmented, scape reaching and barely surpassing posterior head margin (SI = 82–87). Mesosoma broader anteriorly; dorsum strongly convex; pro-mesonotal suture and metanotal groove conspicuous. Propodeal spines well developed (PSLI = 38–41), long acute. Propodeal lobes reduced, triangular; dorsum of propodeum weakly convex, declivity weakly concave. Petiolar node in profile rectangular nodiform, longer than high (LPeI = 85–94), anterior and posterior faces parallel, posterodorsal margin slightly higher than anterodorsal margin, dorsum weakly convex; node in dorsal view longer than wide (DPeI = 90–97). In profile postpetiole subglobular, higher than long (LPpI = 49–54); in dorsal view wider than long (DPpI = 179–194). Postpetiole in profile lower than petiolar node and generally appearing slightly more voluminous, in dorsal view wider than petiolar node (PPI = 114–122); the base of first gastral tergite with anterolateral corners rounded; gaster oval shaped. Head with longitudinal rugae at places forming loose network; spaces between rugae granulate; antennal scrobes smooth and shining; lateral sides of head rugulose; frontal carinae well developed reaching posterior margin of head; mandible striate; clypeus with two prominent lateral longitudinal rugae, and a medium clypeal carinae; dorsum of mesosoma rugulose; surfaces in between granulate; lateral margins of mesosoma with rugulose

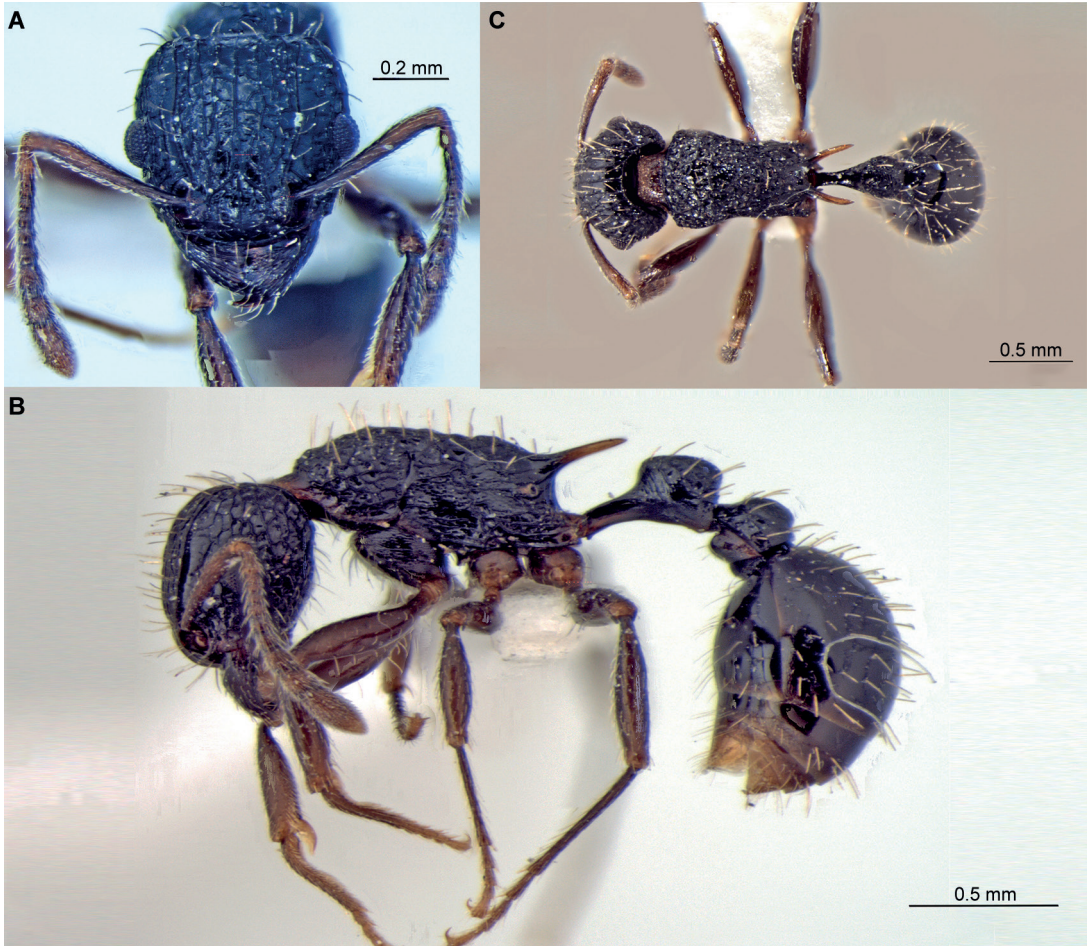


Fig. 5. *Tetramorium hitagarciai* *sp. nov.* — **A:** Head, frontal view. — **B:** Habitus, lateral view. — **C:** Habitus, dorsal view.

sculpture; petiole rugulose, postpetiole smooth and shining; propodeum rugulose and gaster smooth. Pilosity consists of long, erect white hairs distributed throughout the body surface; appendages with subdecumbent pubescence. Body black with appendages reddish-brown.

HABITAT. The specimens were collected by hand in the Silent Valley National Park, a primary tropical rainforest in Kerala. The park is one of the last undisturbed tropical moist evergreen forests in India. The species appears rare and with a restricted distribution.

REMARKS. *Tetramorium hitagarciai* is one of the largest species in the group. In terms of its blackish pigmentation, it resembles *T. alii* and *T. binghami*. It differs from the former by its larger size, as well as much stronger surface sculpturing

and more abundant pilosity on the dorsum of the mesosoma and petiole, and can be easily separated from the latter due to its pronounced median clypeal rugula. It has relatively short scape like *T. pilosum*, and it bears some morphometric resemblance to *T. keralense*, yet it differs from both in its pigmentation, it has much shorter and stouter pilosity than the former, and a distinctively different petiole shape than the latter.

***Tetramorium keralense* Sheela & Narendran, 1998**

Tetramorium keralense Sheela & Narendran 1998: 39, figs. 4–7. **TYPE LOCALITY:** India (Kerala: Peruvannamuzhi) [holotype DZCU; hand drawings of holotype worker examined].



Fig. 6. *Tetramorium pilosum* (CASENT0280881 from www.antweb.org; photos by Estella Ortega). — **A:** Head, frontal view. — **B:** Habitus, lateral view. — **C:** Habitus, dorsal view.

WORKER MEASUREMENTS AND INDICES (1 specimen, 1 colony, 1 locality; from Sheela & Narendran 1998): HL = 0.80, HW = 0.74, SL = 0.65, EL = 0.18, PH = 0.27, WL = 0.53, PW = 0.59, PTH = 0.25, PTL = 0.20, PTW = 0.20, PPH = 0.23, PPL = 0.13, PPW = 0.23, PSL = 0.28, CI = 93, OI = 24, SI = 88, PSLI = 35, LMI = 51, DMI = 111, PeNI = 34, LPeI = 80, DPeI = 100, PpNI = 39, LPpI = 57, DPpI = 177, PPI = 115.

REMARKS. *Tetramorium keralense* is a ferrugino-testaceous species reported from two localities in Kerala. Sheela and Narendran (1998) compared it with larger *T. yerburyi*, from which it differs by its punctate petiole and postpetiole versus rugose and reticulate in *T. yerburyi*, and the anterior and dorsal surfaces of petiole node

not meeting in a sharply defined right angle as opposed to them meeting in a sharply defined right angle in *T. yerburyi*. Sheela and Narendran (1998) studied only two specimens, of which only the holotype was described. No photographs of this species are available.

***Tetramorium pilosum* Emery, 1893 (Fig. 6)**

Tetramorium pilosum Emery 1893: 247. TYPE LOCALITY: Sri Lanka (Kandy) [holotype MSNG; images of holotype worker examined].

WORKER MEASUREMENTS AND INDICES (6 specimens, 1 colony, 1 locality): HL = 0.94–0.98, HW = 0.90–0.94, SL = 0.76–0.82, EL = 0.17–



Fig. 7. *Tetramorium tortuosum* (CASENTO280879 from www.antweb.org; photos by Estella Ortega). — **A:** Head, frontal view. — **B:** Habitus, lateral view. — **C:** Habitus, dorsal view.

0.19, PH = 0.47–0.49, WL = 1.23–1.25, PW = 0.66–0.72, PTH = 0.33–0.34, PTL = 0.32–0.33, PTW = 0.30–0.31, PPH = 0.32–0.34, PPL = 0.28–0.30, PPW = 0.32–0.33, PSL = 0.30–0.31, CI = 96, OI = 18–20, SI = 84–87, PSLI = 32, LMI = 38–39, DMI = 54–58, PeNI = 43–45, LPeI = 97, DPeI = 94, PpNI = 46–48, LPpI = 88, DPpI = 110–114, PPI = 106–107.

REMARKS. *Tetramorium pilosum* is endemic to Sri Lanka and its records from India should be considered dubious. The only mention of *T. pilosum* from India was made by Pajni and Suri (1978). However, they provide no accurate details about the species, and the way it was identified may indicate misidentification. The reports of the species from Zhejiang, China (Tang *et al.* 1985,

Guénard & Dunn 2012) are also considered dubious (*see* Agavekar *et al.* 2017).

***Tetramorium tortuosum* Roger, 1863**
(Fig. 7)

Tetramorium tortuosum Roger 1863: 181. TYPE LOCALITY: Sri Lanka [holotype unknown; probably in MNHU].

Tetramorium (Xiphomyrmex) tortuosum var. *bellii* Forel 1902: 239. TYPE LOCALITY: India: (Karnataka: Kanara) [syntype MHNG; images of syntype worker examined].

Tetramorium tortuosum ethica Forel 1911: 225. TYPE LOCALITY: Sri Lanka [syntype MHNG; images of syntype worker examined].



Fig. 8. *Tetramorium urbanii* (CASENT0901068 from www.antweb.org; photos by Will Ericson). — **A:** Head, frontal view. — **B:** Habitus, lateral view. — **C:** Habitus, dorsal view.

specimens, 8 colonies, 8 localities; from Bolton 1977): HL = 0.82–0.92, HW = 0.78–0.86, SL = 0.70–0.80, EL = 0.25–0.28, PH = 0.37–0.39, WL = 1.12–1.19, PW = 0.60–0.70, PTH = 0.27–0.29, PTL = 0.23–0.25, PTW = 0.24–0.25, PPH = 0.28–0.30, PPL = 0.21–0.23, PPW = 0.25–0.26, PSL = 0.25–0.27, CI = 93–95, OI = 32–33, SI = 90–93, PSLI = 29–30, LMI = 33, DMI = 54–59, PeNI = 36–40, LPeI = 85–86, DPeI = 100–104, PpNI = 37–42, LPpI = 75–77, DPpI = 113–119, PPI = 104.

REMARKS. *Tetramorium tortuosum* is alleged to have a broad distribution range in the Indomalayan region (see <https://antmaps.org/?mode=species&species=Tetramorium.tortuosum>), encom-

passing different parts of India, Indonesia, Philippines and Sri Lanka. Sri Lankan specimens are reported to differ from the Indian ones by having usually shorter and stouter hairs on the dorsal surface of the head and mesosoma (Bolton 1977). However, conspecificity of the populations in the geographic range should be assessed. The species is close to *T. yerburyi* and *T. pilosum* but can be easily distinguished from the two using the characters listed in the key.

***Tetramorium urbanii* Bolton, 1977 (Fig. 8)**

Tetramorium urbanii Bolton 1977: 84. TYPE LOCALITY:

Bhutan (Phuntsholing) [holotype NHMB; images of holotype worker examined].

ADDITIONAL MATERIAL EXAMINED. 4 workers, 2 queens, India, Arunachal Pradesh, Dirang, 27°19'51.5"N, 92°17'38.2"E, 1635 m a.s.l., 25 September 2013, collected by hand, leg. Joginder Singh; 1 worker, Sikkim, Gangtok, 27°19'55.9"N, 88°36'47.5"E, 1530 m a.s.l., 21 May 2012, collected by hand, leg. Shahid A. Akbar; 3 workers, Rorathang, 27°11'45.0"N, 88°36'41.8"E, 587 m a.s.l., 4 June 2012, collected by hand, leg. Joginder Singh; 2 workers, Meghalaya, Shillong, 25°34'35.6"N, 91°53'43.7"E, 20 May 2003, collected by hand, leg. Himender Bharti.

WORKER MEASUREMENTS AND INDICES (10 specimens, 4 colonies, 4 localities): HL = 0.78–0.87, HW = 0.72–0.75, SL = 0.68–0.74, EL = 0.16–0.18, PH = 0.40–0.43, WL = 1.01–1.13, PW = 0.56–0.70, PTH = 0.32–0.34, PTL = 0.28–0.31, PTW = 0.27–0.30, PPH = 0.34–0.36, PPL = 0.31–0.34, PPW = 0.34–0.37, PSL = 0.06–0.07, CI = 86–95, OI = 22–24, SI = 93–99, PSLI = 7–9, LMI = 35–42, DMI = 52–65, PeNI = 40–50, LPeI = 85–97, DPeI = 87–103, PpNI = 49–64, LPpI = 86–97, DPpI = 106–119, PPI = 113–133.

REMARKS. *Tetramorium urbanii* is a very distinct species characterized by short propodeal spines. It is reported from the northeastern Indian states of Arunachal Pradesh, Meghalaya and Sikkim. The species was originally described from Phuentsholing, a border town with neighbouring Bhutan. Bharti and Kumar (2012) reported the species for the first time from India and provided a revised description of its workers. This species can easily be identified in the Indian fauna based on the 11-segmented antenna, propodeal spines short, dorsal surface of promesonotum smooth and shiny, with weakly developed sculpture towards the sides, and antennal scape long and narrow, almost reaching the posterior margin of the head (see Bharti & Kumar 2012).

Tetramorium yerburyi Forel, 1902 (Fig. 9)

Tetramorium (Xiphomyrmex) pilosum r. *yerburyi* Forel 1902: 238. TYPE LOCALITY: Sri Lanka [holotype MHNG; images of holotype worker examined].

WORKER MEASUREMENTS AND INDICES (11 specimens, 2 colonies, 2 localities; from Bolton 1977): HL = 1.01–1.02, HW = 0.94–1.04, SL = 0.94–1.02, EL = 0.26–0.28, PH = 0.45–0.46, WL =

1.47–1.51, PW = 0.70–0.74, PTH = 0.30–0.33, PTL = 0.30–0.31, PTW = 0.25–0.27, PPH = 0.31–0.33, PPL = 0.29–0.30, PPW = 0.27–0.28, PSL = 0.32–0.33, CI = 92–95, OI = 27–28, SI = 98–100, PSLI = 30–31, LMI = 30–31, DMI = 48–49, PeNI = 36, LPeI = 94–100, DPeI = 83–87, PpNI = 38–39, LPpI = 91–94, DPpI = 93, PPI = 103–108.

REMARKS. *Tetramorium yerburyi* is reported from the southern Indian states of Kerala and Tamil Nadu, as well as from parts of Sri Lanka. Among the species of the *T. tortuosum* group, *T. yerburyi* and *T. pilosum* are the only two species having the postpetiole sculptured, but the two have distinctly different shapes of the pedicel. In *T. tortuosum* this sclerite is smooth. The reports of species from Xizang, Yunnan, China (Huang & Zhou 2007, Guénard & Dunn 2012) are considered dubious (see Agavekar et al. 2017).

Key to the Indian and Sri Lankan species of *Tetramorium tortuosum* group species based on the workers

1. Propodeum armed with a pair of short triangular spines which are only slightly longer than their basal width and only marginally longer than the propodeal lobes *T. urbanii*
1. Propodeum armed with a pair of long spines which are much longer than their basal width and considerably longer than the propodeal lobes 2
2. Dorsum of postpetiole sculptured 3
2. Dorsum of postpetiole unsculptured, smooth and shining 6
3. Body pilosity abundant, very long (ca. 0.30 mm in length on the dorsal surface of the head and mesosoma), long erected hairs projecting from the extensor margin of the hind tibiae 4
3. Body pilosity sparser and much shorter (> ca. 0.15 mm in length), hind tibiae only with short pubescence 5
4. In profile view, petiolar node rounded, with a gradual transition between the anterior and dorsal faces, and the dorsal profile gently convex *T. pilosum*
4. In profile view, the anterior and dorsal faces of the petiolar node are almost perpendicular, forming a sharp angle, while the dorsal profile is roughly straight *T. yerburyi*
5. Ferruginous-testaceous with gaster blackish brown, petiole minutely punctuate, dorsum with few faint reticulations, propodeal lobes are low and blunt *T. keralense*
5. Light brown with appendages yellow, petiole dorsum reticulate-rugose, propodeal lobes narrowly and acutely elongate *belgaense*
6. Comparatively smaller, dark black coloured species, clypeus without distinct median carinae *T. binghami*



Fig. 9. *Tetramorium yerburyi* (CASENT0280880 from www.antweb.org; photos by Estella Ortega). — **A:** Head, frontal view. — **B:** Habitus, lateral view. — **C:** Habitus, dorsal view.

6. Comparatively larger, lighter ferruginous testaceous species with clypeus having a distinct median carinae 7
7. Propodeal lobes acute, pointed, anterior face of petiole forming blunt but distinct angle with petiolar dorsum *T. tortuosum*
7. Propodeal lobes reduced, truncate to rounded not as pointed as above, petiolar node nodiform, anterior face and dorsum of petiole smoothly rounded not forming a blunt distinct angle as above 8
8. Mandible striate, propodeal spines with apex down curved and converging, dorsum of mesosoma strongly sculptured *T. hitagarciai*
8. Mandible mostly smooth, propodeal spines raised and diverging, mesosoma weakly sculptured *T. alii*

Discussion

India is situated on the northern end of the Indian Plate (Briggs 2003, Kumar *et al.* 2007),

having mixture of northern (Laurasian) and southern (Gondwanan) faunal and floral elements (*see* <https://www.cbd.int/countries/profile/?country=in#facts>). It is a place with various physical environments offering a perfect conditions biological evolution (Hughes 2016). The Himalayas, the Indo-Burma region, the Western Ghats, and Sundaland (Nicobar Islands) are the four widely-recognized biodiversity hotspots in the country (Myers *et al.* 2000, Mittermeier *et al.* 2004), harboring ca. 7%–8% of known global species biodiversity (*see* <https://www.cbd.int/countries/profile/?country=in#facts>).

The Western Ghats (between 8°19'08''–1°16'24'N and 72°56'24'–78°19'40'E; <http://www.westernghatsindia.org/pdf>), account for about 5% of India's land area but harbour about

40%–45% India's biodiversity (Nair 1991). A total of 455 ant species from 75 genera have so far been recorded from the region, mostly from the forests that host a great variety of microhabitats suitable for ant colonization in the canopy, leaf litter, rotten logs, crevices, etc. (Ali & Ganeshiah 1998). Several species were indeed discovered in the last decade (Bharti & Akbar 2013a, 2013b, 2014a, 2014b, 2014c, 2014d, 2015, Bharti *et al.* 2015, Akbar & Bharti 2015, 2017, 2020, Akbar *et al.* 2017, 2021, 2023). As a bioregion, the Indian Western Ghats are strongly associated with Sri Lanka, even though the Sri Lankan island has been able to maintain largely distinct fauna compared with that of mainland India (Bossuyt *et al.* 2004).

The Western Ghats appear to be one of the most *Tetramorium*-rich regions in India which is highly likely to be under-sampled (Agavekar *et al.* 2017). Except for the *Tetramorium ciliatum* species group, all other species groups occur in the region. Of the nine known species of the *T. tortuosum* group presented in this paper, all except *T. yerburyi* are primarily distributed in the Western Ghats.

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