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A new ant species from Borneo closely resembling *Tetramorium flagellatum* Bolton, 1977 (Hymenoptera: Formicidae)

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ABSTRACT. *Tetramorium lucyae* sp. nov. from Gunung Murud (Kelabit Highlands), Sarawak, Borneo is described and recognized as a member of the *Tetramorium ciliatum*-species group. The species closely resembles *Tetramorium flagellatum* Bolton, 1977. A discussion of the discrimination of the two species is presented.

Keywords: ants, Formicidae, *Tetramorium*, *ciliatum*-group, *Tetramorium flagellatum*, new species, Borneo

INTRODUCTION

The myrmicine ant genus *Tetramorium* includes 459 species worldwide (Bolton *et al.* 2007) and is one of the few genera that can be found throughout temperate to tropical climates (others are *Camponotus*, *Dolichoderus* and *Tapinoma*; see Guénard *et al.* 2010). *Tetramorium* often represents a challenge to morphological taxonomists as differences between species can be difficult to detect. In some cases only the combination of molecular and morphological approaches allows species to be clearly distinguished (see Bolton 1977: 117; Schlick-Steiner *et al.* 2006, 2010; Seifert 2009). Only 23 *Tetramorium* species have been recorded from Borneo: *T. adelphon* Bolton, 1979, *T. adpressum* (Bolton, 1976), *T. aptum* Bolton, 1977, *T. bicarinatum* (Nylander, 1846), *T. chepocha* (Bolton, 1976), *T. curtulum* Emery, 1895, *T. flagellatum* Bolton, 1977, *T. kheperra* (Bolton, 1976), *T. lanuginosum* Mayr, 1870, *T. laparum* Bolton, 1977, *T. meshena* (Bolton, 1976), *T. noratum* Bolton, 1977, *T. obtusidens* Viehmeyer, 1916, *T. ocothrum* Bolton, 1979, *T. pacificum* Mayr, 1870, *T. palaense* Bolton, 1979, *T. parvispinum* Emery, 1893, *T. parvum* Bolton, 1977, *T. simillimum* (Smith, 1851), *T. smithi* Mayr, 1879, *T. tonganum* Mayr, 1870, *T. tylinum* Bolton, 1977 and *T. indicum* Forel, 1914 (Bolton *et al.* 2007; AntWeb; Pfeiffer *et al.* 2011). In addition, I found two species which are new records from the region when studying the collection of the Natural History Museum, London (BMNH) in February 2010: *T. insolens* (Smith, 1861) and *T. seneb* Bolton, 1977. Yet the current total of 25 *Tetramorium* species from Borneo may be lower than the true figure. Here I report on a new species which both adds to our understanding of the diversity of *Tetramorium* and suggests the extent to which more species may be revealed with even modest sampling.

On a recent collecting trip, the use of a range of collecting methods (Winkler sampling, baiting, trapping and hand collection) led to the collection of what superficially appeared to be as many as 12 different species of *Tetramorium*, at altitudes between 1800 and 2076 m from Gunung Mulu and Gunung Murud (Kelabit Highlands) (Pfeiffer, unpublished data). Yet, when using Bolton's identification keys to *Tetramorium* (1976, 1977) on these 12 species, several distinct morphospecies reached the same terminal taxon, which strongly implies that knowledge of the local fauna is incomplete. It was concluded that reliable identification requires reference to type material. For instance, two of these 12 as yet unidentified

morphospecies differed conspicuously in the length of the hairs on head, mesosoma and tibiae, but in Bolton (1977) they both keyed out as *T. flagellatum* even though they clearly represent two different species.

During a research visit to the Natural History Museum, London in February 2010, I was able to study type material of *T. flagellatum* and, in doing so, to distinguish more clearly the two above-mentioned species; one could clearly be assigned to *T. flagellatum* and the other represents a species new to science described below. Both species belong to the *ciliatum*-group established by Bolton (1977).

MATERIALS AND METHODS

Specimens used for measurements were dry-mounted on card squares or triangles; all other material was in ethanol (100%). Examination of specimens was carried out with a Leica Wild M10 binocular microscope; measurements were taken at magnifications of up to 50×. Digital photographs were taken with a Leica DFC camera attached to a Leica MZ16 binocular microscope with the help of Image Manager IM50, and stacked and processed with the Helicon 5.0 and Adobe Photoshop 7.0 programs, respectively.

Acronyms of repositories

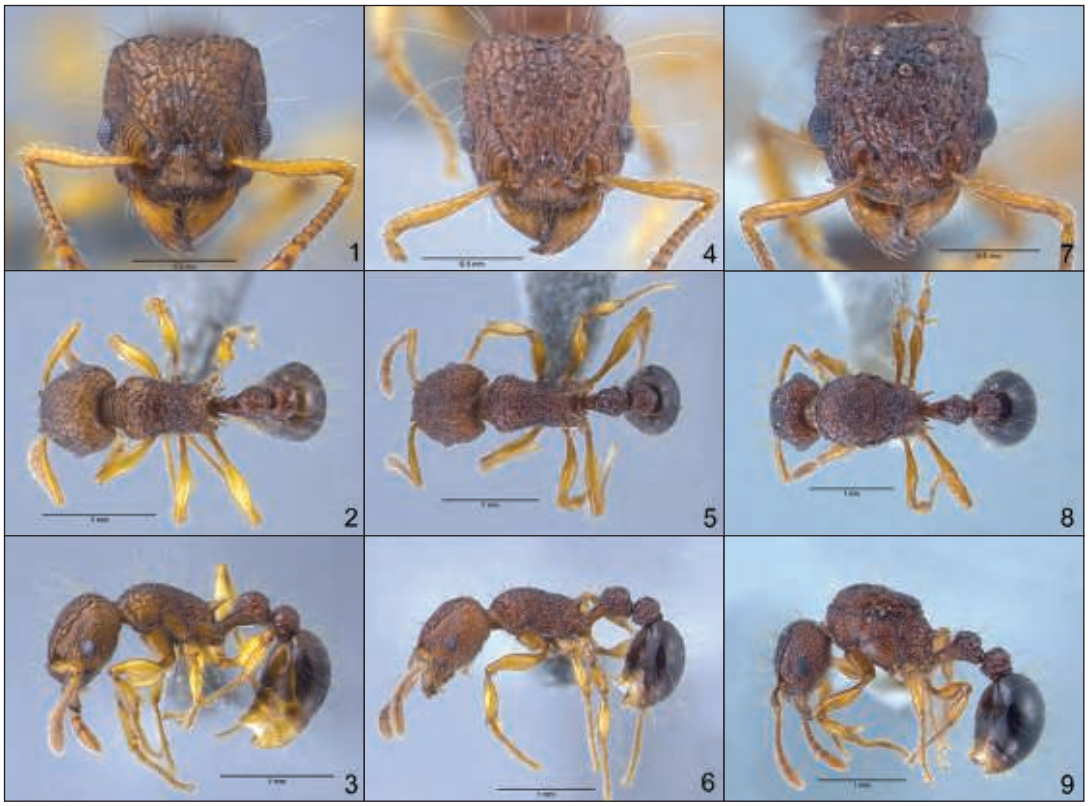
ABNC	AntBase.Net Collection, Landau, Germany
BMNH	Natural History Museum, London, Great Britain
CSW	Collection D.M. Sorger, Vienna, Austria
NHMW	Natural History Museum Vienna, Austria
SFDC	Sarawak Forest Department Collection, Kuching, Borneo

Measurements and indices

HL	Head length, in full-face view, excluding mandibles, measured at full-face view along midline, from anterior clypeal margin to posterior margin of occiput.
HW	Head width. Maximum width of head, in full-face view behind eyes (excluding eyes).
MHLH	Maximum hair length on head. Measured as a straight line from integument to tip of hair, perpendicular to integument, in lateral view: longest hair by this definition (regardless of curvature) measured (see Fig. 10).
MHLM	Maximum hair length on mesosoma. Measured as for MHLH.
MHLT	Maximum hair length on metatibiae. Measured as for MHLH.
ML	Mesosoma length. Diagonal length of mesosoma in lateral view, from frontal-most point of declivitous area of pronotum to posterior-most point of apex of propodeal lobe.
PW	Pronotal width. Maximum width of pronotum in dorsal view. In gynes, measured immediately anterior to fore wing insertions.
SI	Scape index. SL/HW × 100.
SL	Scape length. Length of antennal scape, measured in straight line, excluding basal condyle.
TL	Total length. Length of outstretched ant measured from apex of closed mandibles to apex of gaster.

All measurements are taken in millimetres.

RESULTS



Figs. 1–3. *Tetramorium flagellatum*, worker (ABNC): (1) Head, full-face view. (2) Habitus, dorsal view. (3) Habitus, lateral view. © www.antbase.net, published with permission.

Figs. 4–6. *Tetramorium lucyae* sp. nov., paratype worker (ABNC): (4) Head, full-face view. (5) Habitus, dorsal view. (6) Habitus, lateral view. © www.antbase.net, published with permission.

Figs. 7–9. *Tetramorium lucyae* sp. nov., paratype gyne (ABNC): (7) Head, full-face view. (8) Habitus, dorsal view. (9) Habitus, lateral view. © www.antbase.net, published with permission.

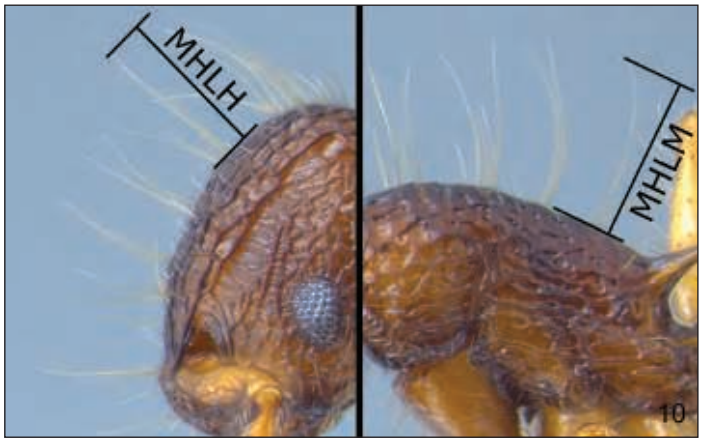


Fig. 10. *Tetramorium flagellatum* showing MHLH and MHLM.

***Tetramorium lucyae* sp. nov.**
(Figs. 4–9)

TYPE MATERIAL

Holotype (worker: NHMW) and paratypes (202 workers: ABNC, BMNH, CSW, NHMW, SFDC; 2 gynes: BMNH, NHMW) from one locality: Borneo, Sarawak, Gunung Murud, "Joy Bridge", Jambatan Sukacita, 03°56.157′N, 115°32.337′E, 2076 m, 28.xi.2008, leg. M. Pfeiffer.

DESCRIPTION OF WORKER

Measurements: Holotype worker: HW 0.84; HL 0.86; CI 98; SL 0.67; SI 80; PW 0.60; ML 1.04; TL 3.76; MHLH 0.46; MHLT 0.30; MHLM 0.50.
Paratype workers (range of 20 workers): Worker with smallest HW: HW 0.79; HL 0.82; CI 96; SL 0.64; SI 81; PW 0.58; ML 1.00; TL 3.60; MHLH 0.40; MHLT 0.26; MHLM 0.48. Worker with largest HW: HW 0.86; HL 0.86; CI 100; SL 0.68; SI 80; PW 0.60; ML 1.04; TL 3.80; MHLH 0.46; MHLT 0.32; MHLM 0.51.
Mean values of 20 workers: TL 3.73; MHLH 0.48; MHLT 0.30; MHLM 0.51.

Head, mesosoma, petiole and postpetiole reddish brown, gaster dark brown, legs yellowish brown, antennae similar to legs but slightly darker (Figs. 4–6).

Entire body (Figs. 4–6) (except antennae) with some very conspicuous and extremely long curved, whitish, yellow setae (0.40– 0.59 mm MHLH, 0.22–0.34 mm MHLT, 0.46–0.58 mm MHLM), also setae of varying length and appression present.

Head (Fig. 4) slightly longer than wide, sides anteriorly and posteriorly convergent; with coarse rugoreticulum (very uneven, wavy rugae), underlying microsculpture slightly reticulate, but appearing smooth and shiny overall. Occipital margin broadly concave in frontal view, anterior clypeal margin complete, without median indention. Mandibles striate. Antennal scrobes present, outlined by change in sculpture; few horizontal rugae running along frontal carinae, more distinct at anterior part, fine rugoreticulum with few cross-meshes, microsculpture punctate. Frontal carinae reaching almost to occiput.

Mesosoma (Figs. 5 and 6) in side view evenly convex, in dorsal aspect broadest at level of pronotum, where it is strongly rounded, appearing somewhat inflated; with coarse rugoreticulum, coarsest on pronotum dorsally, rugoreticulum on sides of mesosoma slightly more longitudinally oriented. Propodeal spines short, acute and straight, never reaching the petiole in lateral aspect (Fig. 6), in dorsal view diverging, forming a ventrally rounded V. Propodeal lobes (Figs. 5 and 6) long and acute (in a few specimens slightly rounded apically), more than half as long as propodeal spines.

Petiole (Figs. 5 and 6) pedunculate, peduncle more than half as long as petiole node; with coarse and distinct rugoreticulum. Petiole in dorsal view subtrapezoidal, petiolar node rounded, in side view roughly rectangular and stout. Postpetiole in profile slightly shorter than petiole, in dorsal aspect about quarter broader than petiole; also with coarse rugoreticulum, but somewhat less distinct than on petiole. Gaster (Figs. 5 and 6) smooth and shining, microsculpture with very fine isodiametric reticulum.

DESCRIPTION OF GYNE

Measurements of 2 paratype gynes: Gyne 1: HW 0.84; HL 0.86; CI 98; SL 0.66; SI 79; PW 0.86; ML 1.36; TL 4.30; MHLH 0.50; MHLT 0.36; MHLM 0.44. Gyne 2: HW 0.84; HL 0.86; CI 98; SL 0.65; SI 77; PW 0.86; ML 1.34; TL 4.28; MHLH 0.47; MHLT 0.30; MHLM 0.44.

Gynes (Figs. 7–9) differ from workers in the following characters (besides characters related to wings): metapleura with longitudinal striation, no cross-meshes present, larger eyes, three ocelli present.

ETYMOLOGY

The collector of the type specimens, Dr Martin Pfeiffer, suggested dedicating this ant species to Lucy Chong (Forest Research Center, Sarawak Forestry Corporation), which I readily accepted.

She has been supporting the studies of a large number of local and international biologists for a long time. This honour is also given to her as a representative of all Malaysian officials who are active in biological research and the conservation of the splendid natural heritage of Malaysia.

DISTRIBUTION

Only known from type locality.

BIOLOGY

This species nests in the ground (upper montane forest) and appears polygynous. All available specimens were collected using the Winkler extraction method. The sampled type series comprises part or all of a nest consisting of 203 workers, two gynes, five pupae at a very advanced stage (closely resembling the imago), 13 pupae at an earlier stage (imago not fully recognizable), 33 large larvae (ca. 2.5 mm) and six small larvae (ca. 1.5 mm)—transitions between all stages present.

NOTES

Tetramorium lucyae is a member of Bolton's (1977) *ciliatum*-group defined by the following characters: "Antennae with 12 segments. Sting appendage triangular or dentiform. Anterior clypeal margin entire, not notched or indented medially. Frontal carinae extending back well beyond the level of the posterior margins of the eyes, ranging in development from feeble in *curvispinosum* to very strong in *ciliatum*. Propodeal spines long and usually strongly developed, never downcurved along their length. Gaster without modification as shown in *mixtum* group." (Bolton 1977: 120). Bolton established this group as a "convenience group" and he mentioned several species within the group that he considered more closely interrelated than others, including *T. ciliatum*, *T. flagellatum* and *T. tylinum*; *T. lucyae* obviously also belongs in this species-complex. The remaining members of the *ciliatum*-group are: *T. chapmani*, *T. curvispinosum*, *T. khnum* and *T. zypidum*. All of the species of this group are distributed in the Oriental and Indo-Australian regions.

***Tetramorium flagellatum* Bolton, 1977**
(Figs. 1–3)

TYPE MATERIAL EXAMINED

2 paratype workers (on one pin) from North Borneo labelled: "49", "Kiduk Arok\ Trus Madi\ Massif 1500 m", "Cambridge N\ Borneo Exped.\ IX 1956\ P.W. Bryant", "Paratype", "*Tetramorium*\ *flagellatum*\ Bolton\ det. B.Bolton, 1976".

ADDITIONAL MATERIAL EXAMINED

Sarawak: 18 workers (BMNH), Gunung Mulu National Park (NP), montane forest, 1800 m, 6.iii.1978, leg. N.M. Collins; 14 workers, 1 gyne (BMNH), Gunung Mulu NP, v–viii.1978, leg. P.M. Hammond & J.E. Marshall; 11 workers, 1 gyne (BMNH), Gunung Mulu NP, 1800–1900 m, v–viii.1978, leg. P.M. Hammond & J.E. Marshall; 132 workers (ABNC), Gunung Mulu, 04°02.650′N, 114°54.831′E, 1482 m, 3.xi.2008\ leg. M. Pfeiffer; 11 workers (NHMW, CSW), 163 workers (ABNC), Gunung Mulu, Upper Mountain Forest, 4°2′25″ N, 114°54′21″ E, tuna baits, 25.x.2009, leg. D.M. Sorger. **Sabah:** 1 worker (BMNH), Crocker Range NP, Kota Kinabalu–Tambunan, 1270 m, 17.v.1987, leg. Burckhardt & Löbl; 2 workers (BMNH), Mt. Kinabalu, nr. Park HQ, 1600 m, 2.ix.1997, leg. T. Kikuta.

DESCRIPTION OF WORKER

Tetramorium flagellatum is described in Bolton (1977: 122). Below, I add additional details relevant for species distinction.

Measurements of workers (range of 20 workers). Worker with smallest HW: HW 0.71; HL 0.76; CI 93; SL 0.57; SI 80; PW 0.52; ML 0.92; TL 3.34; MHLH 0.36; MHLT 0.17; MHLM 0.41. Worker with largest HW: HW 0.83; HL 0.90; CI 92; SL 0.64; SI 77; PW 0.62; ML 1.08; TL 3.80; MHLH 0.33; MHLT 0.19; MHLM 0.44.
Mean values of 20 workers: TL 3.55; MHLH 0.35; MHLT 0.17; MHLM 0.41.

DISTRIBUTION

Borneo: Sarawak, Sabah.

NOTES

Bolton (1977: 122) notes the longest hairs in *T. flagellatum* to be 0.45–0.50 mm which deviates from the measurements I recorded; in my measurements hairs are shorter than that. I suspect this to be due to a different measurement technique; for instance, hairs might have been straightened out for measurement by Bolton.

DISCUSSION

Distinguishing between *Tetramorium lucyae* sp. nov. and *Tetramorium flagellatum*

Differentiation between *T. lucyae* and *T. flagellatum* is difficult, and careful examination and measurements are necessary in order to successfully and reliably identify these species.

There are three distinguishing characters: maximum hair length (on head, mesosoma and tibiae), frons sculpture and total length (although the latter can be used only with a larger nest sample: at least 20 specimens). None of these characters should be used for identification in isolation; only a combination of all characters provides a clear picture of the distinctions between the species. A combination of MHLH, MHLM and MHLT is vital for identification; in addition, it is recommended to use a nest sample of more than 5 specimens where possible, given variation among individuals.

All measurements are in millimetres and presented as minimum-mean-maximum values.

MAXIMUM HAIR LENGTHS ON HEAD, MESOSOMA AND TIBIAE

T. lucyae (0.40–0.48–0.59 MHLH; 0.46–0.51–0.58 MHLM; 0.22–0.30–0.34 MHLT) has longer hairs than *T. flagellatum* (0.30–0.35–0.40 MHLH; 0.34–0.41–0.44 MHLM; 0.10–0.17–0.22 MHLT) overall. Two single specimens in the studied sample overlap at a single value each: (MHLT: 0.40 mm; MHLT: 0.20 mm).

FRONS SCULPTURE

Sculpture on head frons is more longitudinally oriented in *T. flagellatum* (see Figs. 1 and 4). However, this differential character is subtle—longitudinal rugae on frons (right at medial depression) are more irregular ("shaky") in *T. lucyae* whereas, in comparison, rugae are rather straight in *T. flagellatum*.

TOTAL LENGTH

T. flagellatum (3.28–3.55–3.80 TL) is smaller than *T. lucyae* (3.60–3.73–3.86 TL) overall. However, since the mean TL of *T. lucyae* lies within the overlapping range (3.60 to 3.80 mm TL) of the two species, a nest series of at least 20 specimens is necessary in order to calculate a mean value.

CONCLUDING REMARKS

The new species described here represents one of several species likely to result from a single set of collections in one elevational band in Borneo. Undoubtedly, more species of *Tetramorium* remain to be discovered in other areas. As they are, the Bornean species of *Tetramorium* may be a good candidate for molecular work in addition to morphological work. The subtle distinctions between the species considered here may reflect a more general reality in *Tetramorium* that the morphological differentiation that occurs with speciation is often subtle or even invisible to visual study alone. In other words, the single species description here, along with the other as yet unnamed species from this collection, should serve as a reminder of the need for more, large-scale revisionary taxonomic work still necessary on the ants of species-rich Borneo.

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