

Descriptions of a new species and the gyne in the rarely collected arboreal genera *Paratopula* and *Rotastruma* (Hymenoptera: Formicidae) from Hong Kong, with a discussion on their ecology

YING Y. LUO AND BENOIT GUÉNARD*

School of Biological Sciences, The University of Hong Kong, Pok Fu Lam Road, Hong Kong

*Corresponding author: zeroben@gmail.com

ABSTRACT. Despite its relatively large size among the Myrmicinae of the Indomalayan region, collection events of *Paratopula* Wheeler are rare. Here we discuss the discovery of *Paratopula* in Hong Kong and present *Paratopula bauhinia* **sp. nov.** as a new species. This addition brings the number of globally described species for the genus to twelve species, four of which are known only from the reproductive caste. *Paratopula bauhinia* **sp. nov.** can be distinguished from previously described species by the combination of the following features: 10 teeth on the masticatory margin of mandibles, apically acute hairs, a rounded median portion of the anterior margin of the pronotum, postpetiole broader than long, and straight, blunt propodeal spines. A revised key for the eight species of *Paratopula* known from the worker caste is provided. Additionally, the female caste of *Rotastruma stenoceps* Bolton is described for the first time. The rarity of these two genera are also discussed on the basis of their potentially nocturnal and arboreal habits.

Keywords: *Paratopula bauhinia*, *Rotastruma stenoceps*, Myrmicinae, Hong Kong, arboreal, nocturnal, rarity

INTRODUCTION

Paratopula Wheeler is a rare genus of ants, whose type species, *P. ceylonica* (Emery, 1901), was first described as part of the genus *Atopomyrmex* by Emery (1901), and later erected as *Paratopula* by Wheeler (1919). In 1988, Bolton revised the genus, bringing the total number of *Paratopula* species at the time to nine, with four species known only from the reproductive caste - *P. andamensis* Forel, *P. longispina* Stitz, *P. oculata* Smith and *P. sumatrensis* Forel, with *P. andamensis* described only from the male caste. Since then, two additional species have been described, *P. intermedia* Sheela & Narendran (1998) from Kerala (India) and *P. zhengi* Xu & Xu (2011) from Xizang (China). The discovery

of *P. bauhinia* sp. nov. from Hong Kong brings the total number of *Paratopula* species to twelve.

The ecology of *Paratopula* remains enigmatic due to the rarity of collection events. In the past, three species (*P. demeta* Bolton 1988; *P. intermedia* Sheela & Narendran 1998; *P. zhengi* Xu & Xu 2011) were described on the basis of a single worker specimen only. The rarity of *Paratopula* collection translates into an absence of knowledge on the ecology of the genus, although the genus is thought to possess an arboreal or sub-arboreal lifestyle (Bolton 1988; Eguchi *et al.* 2011).

The distribution of *Paratopula* is restricted to the Indomalayan biogeographic region, with a patchy and largely incomplete distribution ranging from Pakistan to the West

and the Philippines to the East and from Shanghai to Sulawesi along a North-South axis (antmaps.org) (Janicki *et al.* 2016). *Paratopula* diversity peaks in Borneo with five species recorded, most other regions include a single species recorded with the exception of the Philippines and the Peninsular Malaysia, both with three species recorded (antmaps.org).

Rotastruma is another rarely collected arboreal genus belonging to the same clade as *Paratopula* (Ward *et al.* 2015). This small genus contains only two species which exhibit a limited distribution in the Indomalayan region. *Rotastruma recava* Bolton 1991 is known from Borneo and the Malaysian Peninsula, and *R. stenoceps* Bolton 1991 is reported from China (Hubei, Hunan, Guangdong, Yunnan) (antmaps.org). The latter was described in 1991 from Guangdong (China) on the basis of the worker caste, with virtually no information reported on its ecology since its original description. Recently, during attempts to collect additional *Paratopula* specimens, a single queen identified as *Rotastruma stenoceps* was collected. Here, we describe the queen of *R. stenoceps* from Hong Kong, found less than 200 kilometres South East from the site of the holotype (Bolton 1991).

We present the first record of the genus *Paratopula* in Hong Kong, which also represents a new species, *P. bauhinia*. A revised key to the global species of *Paratopula* based on worker caste is provided. A description of the female caste of *Rotastruma stenoceps* is also included. Finally, we address potential reasons why *Paratopula* and *Rotastruma* are so scarcely collected.

MATERIAL AND METHODS

Materials and specimens examined

The type specimens for this study were hand collected, and have been deposited in the University of Hong Kong collection, located within the School of Biological Sciences.

To confirm the new *Paratopula* species and to prepare a revised species key, we referred to previous *Paratopula* publications: Bolton (1988), Sheela & Narendran (1998) and Xu & Xu (2011). Images of the holotype specimens from the

genus were also examined on AntWeb.org when available, for *P. ankistra* (CASENT0901741), *P. catocha* (CASENT0901743), *P. ceylonica* (CASENT0908985), *P. demeta* (CASENT0901742) and *P. macta* (CASENT0901740). New digital images of the holotype of *P. zhengi* were provided to us thanks to Dr. Zheng Hui Xu (Southwest Forestry University, Yunnan).

For *R. stenoceps*, we referred to the only available publication on the taxonomy of *Rotastruma*, Bolton (1991), and compared our specimen to a worker specimen of *R. stenoceps* collected in Hong Kong, which was identified using the original description and images of the holotype on AntWeb.org (CASENT0901994).

Terminology

Worker morphological terminology follows Bolton (2004). Queen morphological terminology follows Serna & Mackay (2010).

Methods

The specimens were imaged with an incorporated Leica DFC450 digital camera mounted on a Leica M205C dissecting microscope through the Leica Application Suite V4 software. A total of 25 to 45 images were taken per view and were processed. For each measurement, specimens were imaged in the optimum position to take the measurement. Measurements of specimens were taken in mm (accurate to 0.001mm) and rounded to the nearest 0.01mm for presentation, using the Measure Tools function of the Leica Application Suite V4 software on specimen images. Images were collated using Adobe Photoshop ver. CS6.

The following measurements and indices follow Bolton (1988), Longino (2013) and Fischer *et al.* (2014). The abbreviations used are as follows:

- HW Head Width. Maximum width of head in full-face view excluding the eyes.
- HL Head Length. Maximum length of head from the anterior median clypeal margin to the median posterior margin of the cephalic capsule measured along the midline as a straight line.

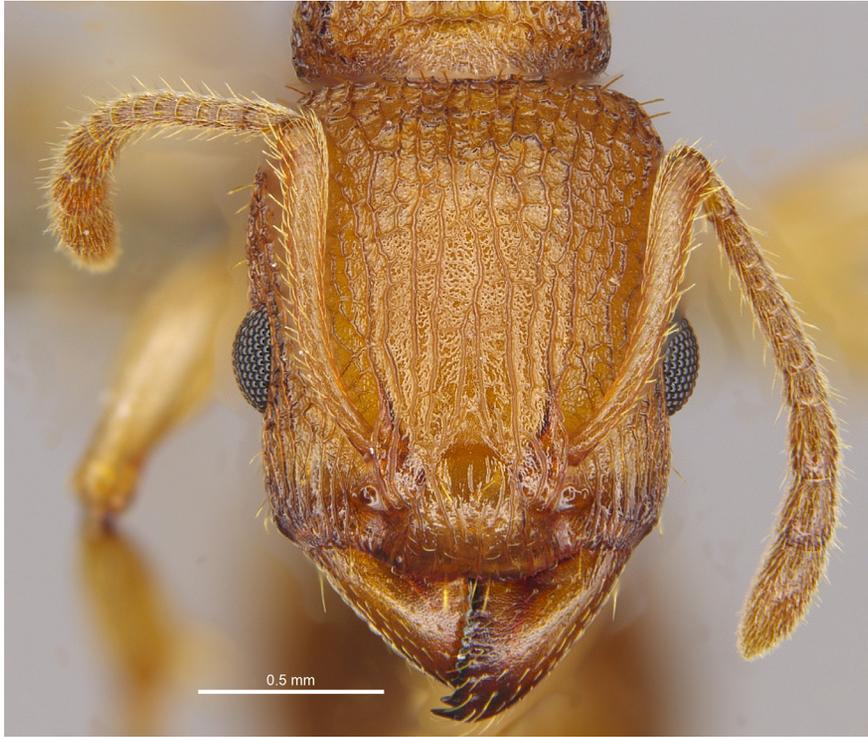


Fig. 1. Full face view of *P. bauhinia* sp. n. (holotype). Note the abundant setae on the scape.



Fig. 2. Full face view focusing on the mandibles of *P. bauhinia* sp. n. (holotype).

MaL	Mandible Length. Maximum length of mandible from the anterolateral margin of clypeus at outer side of mandibular insertion to mandibular apex.	PTH	Petiole Height. Maximum height of petiole, measured in lateral view from the highest (median) point of the node, orthogonally to the ventral outline of the node.
SL	Scape Length. Maximum measurable length of scape, from the proximal point of scape shaft, not including the condyle, to the distal end of scape.	PTW	Petiole Width. Maximum width of the petiole in dorsal view.
EL	Eye Length. Maximum diameter of eye measured in lateral view.	PPL	Postpetiole Length. Maximum length of postpetiole, measured in lateral view.
TL	Total Length. Maximum length of specimen measured from the tip of the mandibles to the tip of the last abdominal segment, not including sting. Due to the position of the specimen, total length was measured as the sum of head length + thorax, petiole and postpetiole length + gaster length.	PPH	Postpetiole Height. Maximum height of postpetiole, measured in lateral view from the highest point of the node.
WL	Weber's Length of Mesosoma. Maximum diagonal distance in lateral view, from base of anterior slope of pronotum to the posterior margin of the metapleural lobe.	PPW	Postpetiole Width. Maximum width of the postpetiole in dorsal view.
PNH	Pronotum Height. Maximum height of pronotum, measured in profile from the posterior base of the lateral sides of pronotum, where procoxa is attached, to the highest point of the pronotum.	CI	Cephalic Index. Calculated as: $HW / HL \times 100$.
PNW	Pronotal Width. Maximum width of pronotum measured in dorsal view.	SI	Scape Index. Calculated as: $SL / HW \times 100$.
MW	Mesonotal Width. Maximum width of the mesonotum measured in dorsal view.	MaI	Mandibular Index. Calculated as: $MaL / HW \times 100$.
SPL	Propodeal spine length. Measured from the tip of the propodeal spine to the closest point on the outer rim of the propodeal spiracle.	PI	Petiolar Index. Calculated as: $PTW / PTL \times 100$.
PTL	Petiole Length. Maximum diagonal length of petiole, measured in lateral view, from most anteroventral point of the peduncle, at or below the propodeal lobe, to most posterodorsal point at the junction with helcial tergite.	PPI	Postpetiolar Index. Calculated as: $PPW / PPL \times 100$.

Abbreviations of the type depositories are as follows:

SBSHKU Insect Biodiversity and Biogeography Laboratory, School of Biological Sciences, The University of Hong Kong, Hong Kong SAR.

RESULTS

Description of new species

Paratopula bauhinia Luo & Guénard, **sp. nov.**

Holotype. A worker collected from HONG KONG, Lung Fu Shan Country Park, N22.281056 E 114.137985, elevation 147m, collected by hand at approximately 20:30 h, 30.ix.2015 (*Ying Y. LUO*), label "ANTWEB1009012" deposited in SBSHKU.



Fig. 3. Profile view of *P. bauhinia* sp. n. (holotype).



Fig. 4. Dorsal view of *P. bauhinia* sp. n. (holotype).

Paratypes. Two workers collected from HONG KONG, Lung Fu Shan Country Park. One worker found at N 22.278592 E 114.13817 (approximately 275m away from where the holotype was found), elevation 272m, collected by hand at approximately 21:00 h, 06.i.2016 (*Gordon YONG*), label “ANTWEB1009013” deposited in SBSHKU. The second was collected near the location of the other paratype, at N 22.279139 E 114.136755, elevation 273m, hand collected at approximately 21:00 h, 21.iv.2016 (*Ying Y. LUO*), label “ANTWEB1009014” deposited at SBSHKU.

Worker description

Holotype. HL 1.34 mm; HW 1.13 mm; MaL 0.68 mm; SL 0.92 mm; EL 0.29 mm; WL 1.90 mm; PNW 0.84 mm; PNH 0.66 mm; MW 0.45 mm; SPL 0.50 mm; PTL 0.84 mm; PTW 0.45 mm; PTH 0.44 mm; TL 6.40 mm; PPL 0.50 mm; PPW 0.56 mm; PPH 0.48 mm; CI 84; SI 81; MaI 61; PI 54; PPI 112

Paratypes (n=2). HL 1.29-1.31 mm; HW 1.08-1.10 mm; MaL 0.60-0.65 mm; SL 0.90-0.92 mm; EL 0.26-0.30 mm; WL 1.73-1.84 mm; PNW 0.75-0.78 mm; PNH 0.58-0.60 mm; MW 0.41-0.42 mm; SPL 0.47 mm; PTL 0.78-0.82 mm; PTW 0.39-0.41 mm; PTH 0.35-0.41 mm; TL 6.21-6.78 mm; PPL 0.44-0.45 mm; PPW 0.52-0.54 mm; PPH 0.43-0.45 mm; CI 84-86; SI 84; MaI 56-60; PI 50; PPI 116-123

Head. In full face view, head longer than broad (CI 84-86), rectangular in shape (Figure 1). Occipital margin with median portion slightly concave. Posterior corners of head rounded. Sides of head straight and parallel. Eyes oval-shaped, in the longest dimension with a dozen ommatidia and located roughly anterior to the midpoint of the head. Antennal insertion covered by frontal lobes. Frontal carinae extending from the frontal lobes and nearly reaching the posterior margin of head; roughly as long as the scape. Parallel lines of faintly reticulate rugae present between the frontal carinae. Anterior clypeal margin convex with anteromedian portion slightly concave. Mandibles short relative to head (MaI 56-61). Mandibles large and triangular, with masticatory

margin armed with 10 teeth (Figure 2). Apical tooth large and acute followed by smaller triangular teeth decreasing in size progressively. Mandibles with fine appressed hairs, with a few decumbent hairs present on the apical margin of mandibles and oriented ventrally. Antenna with 12 segments and terminated by an incrassate 3-segmented club. In profile view, scape slightly bent and slightly increasing in diameter from base to apex. In full face view, antennal scapes not reaching the occipital margin (SI 81-84).

Mesosoma. In profile view, promesonotum slightly convex (Figure 3). In dorsal view, pronotal humeri round in appearance, pronotum broader than long with its anteromedian portion convex and progressively rounded (Figure 4). Promesonotal suture clearly visible in profile view but indistinct in dorsal view. Metanotal groove conspicuous in profile and dorsal view. In profile view, metanotal groove deeper than half of length of the longest hair present on the dorsal surface of the propodeum. In profile view, propodeal declivity forming a 120° angle with the dorsal surface of propodeum. Propodeal spines straight and well developed, not extending beyond the propodeal lobes. When viewed dorsally, propodeal spines are rounded blunt in appearance, and not tapering. Propodeal spiracle opening conspicuous and round in shape. Propodeal lobes developed and broadly rounded.

Metasoma. In profile, peduncle of petiole long, ventrally with a small denticle near base. In profile, petiole node roughly trapezoidal in shape, and dorsum of postpetiole broadly convex. Anterior 2/3 of subpostpetiolar process margin convex when viewed in profile. In dorsal view, petiole roughly oval in shape (Figure 5), longer than broad (PI 50-54). Postpetiole broader than long (PPI 112-123), more narrow at the anterior edge than the posterior edge, roughly trapezoidal in shape. Gaster not sculptured (smooth), with short hairs present. First gastral tergite large, covering 2/3 of the gaster with longitudinal striae at the base.

Sculpture. Cuticle thick, strongly sculptured on all surfaces except the antenna, legs, peduncle of petiole and gaster. Frons with parallel, faintly reticulate rugae.



Fig. 5. View of the petiole and postpetiole of *P. bauhinia* sp. n. in dorsal view (holotype).

Pubescence. All dorsal surfaces (except peduncle) with short, erect, acute hairs, gold in colour. Hairs on first gastral tergite and dorsal surfaces of the head, mesosoma and metasoma acute and almost spearlike in appearance. Subpostpetiolar process with a few thin erect hairs. Antenna covered in short appressed hairs, with additional short sub-erect hairs present.

Colouration. Body relatively uniform in golden-brown colour, legs lighter in colouration. Apical portion of mandibles with darker reddish coloration.

Castes. Female and male caste unknown.

Etymology

This species is named after the genus of the tree species *Bauhinia blakeana* Dunn, also known as the Hong Kong Orchid Tree, an emblem of Hong Kong. The flower of *Bauhinia blakeana* appears on the Hong Kong flag, and is commonly known by Hong Kong inhabitants as the “Bauhinia”,

which refers to the type locality of the new *Paratopula* species described. It also indirectly refers to the suspected arboreal habits of the new species. The name is a noun and is thus invariant.

Distribution

This species is known only from the type localities, both located in Lung Fu Shan Country Park, on Hong Kong Island in Hong Kong.

Ecology

The holotype specimen of *P. bauhinia* was found foraging in sparse leaf litter on a man-made concrete structure raised at about 1.8m above ground level (see Figure 6), and located under the tree species *Syzygium jambos* Alston and *Litsea monopetala* Persoon. The surrounding habitat is the edge of a young secondary forest close to a well-used hiking trail in Lung Fu Shan Country Park, Hong Kong. It was found at approximately 20:30 h.

Both paratype specimens were found approximately 275m further up the trail, on a railing adjacent to the concrete hiking trail (see Figure 6). This part of the trail is surrounded by a monoculture plantation of the tree *Lophostemon confertus* Wilson & Waterh. They were both found at approximately 21:00h at three months interval.

Remarks

Two other species of *Paratopula* have been recorded in China: *P. zhengi* and *P. ceylonica*, but *P. bauhinia* is morphologically distinct from these two species. The propodeal spines of *P. bauhinia* are distinct to those of *P. zhengi* and *P. ceylonica*; in *P. bauhinia* the propodeal spines are straight and apically truncate, while the propodeal spines of *P. zhengi* are described as “slender and acute, slightly curved upwards apically” (Figure 2 in Xu & Xu 2011). In *P. ceylonica*, the propodeal spines are described as being “straight to very feebly down curved” (Bolton 1988) in profile view - examination of the type specimen (CASENT0908985) on Antweb.org, confirms this. The hairs on the dorsum of *P. zhengi* are also described as “short blunt erect hairs”, but in *P. bauhinia* the hairs are apically acute. Additionally, the postpetiole of *P. ceylonica* is squarish in appearance (see Figure 5 in Bolton 1988) in dorsal view, whereas in *P. bauhinia* the postpetiole is broader than long, appearing roughly trapezoidal.

Paratopula bauhinia differs from *P. catocha* in that *P. bauhinia* has a trapezoidal shaped postpetiole when viewed dorsally, whereas *P. catocha* has a round shaped postpetiole when viewed dorsally (see Figure 4 in Bolton 1998). *Paratopula catocha* is described to only have 8-9 teeth (Bolton 1988), while *P. bauhinia* has 10 teeth. Additionally, *P. catocha* has been recorded only from Sulawesi (antmaps.org) and thus its presence in Hong Kong seems rather unlikely.

When comparing *P. bauhinia* and *P. demeta*, the most conspicuous differences can be observed in the dorsal view. In dorsal view the median portion of the anterior margin of the pronotum is angular in *P. demeta*, whereas in *P. bauhinia* the margin is broadly rounded. *Paratopula demeta* also has angular pronotal humeri, but *P. bauhinia* has rounded pronotal

humeri (Figure 8). Additionally, the pubescence of *P. bauhinia* differs to *P. demeta*, in *P. bauhinia* the hairs are apically acute while in *P. demeta* the hairs are apically truncated.

In Eguchi *et al.* (2011) there is mention of an unidentified *Paratopula* worker (labelled as *Paratopula* sp, eg-1) found in Nam Cat Tien, Vietnam. While it is difficult to conclude what species this specimen may be, it is distinct from *P. bauhinia* in that it has 9 teeth, and based on the pictures the propodeal spines appear to be much longer than *P. bauhinia*; extending beyond the propodeal lobes (see Figure 112 and text in Eguchi *et al.* 2011). Hairs of *Paratopula* sp. eg-1 are also described as “short and blunt apically” (Eguchi *et al.* 2011), while the hairs of *P. bauhinia* are apically acute.

Paratopula bauhinia is distinct from other species of *Paratopula* in that no other species is described as having the following combination of features: 10 teeth on the masticatory margin of the mandibles, apically acute hairs, a rounded median portion of the anterior margin of the pronotum, a broader than long postpetiole and straight, blunt propodeal spines. These features, combined with other characteristics establishes *P. bauhinia* as a unique species within this genus.

Synoptic species list of global Paratopula species

Paratopula andamensis Forel, 1903 (Andaman Is.) – known from male only

Paratopula ankistra Bolton, 1988 (Brunei)

Paratopula catocha Bolton, 1988 (Sulawesi)

Paratopula ceylonica Emery, 1901 (Bangladesh, India, Myanmar, Pakistan, Sri Lanka, Taiwan)

Paratopula demeta Bolton, 1988 (Indonesia, E. Malaysia)

Paratopula longispina Stitz, 1938 (E. Malaysia) – known from female only

Paratopula macta Bolton, 1988 (Brunei, Malaysia, Philippines, Thailand)



Fig. 6. Locations specimens for *P. bauhinia* sp. n. were collected for A) the holotype and B) the two paratypes. Arrows indicates exact location of *P. bauhinia* sp. n. collection.

Paratopula oculata Smith, 1857 (Borneo, W. Malaysia, Singapore) – known from male and female only

Paratopula sumatrensis Forel 1913 (Philippines, Sumatra) - known from female only

Paratopula intermedia Sheela & Narendran, 1998 (India)

Paratopula zhengi Xu & Xu, 2011 (Xizang, China)

Paratopula bauhinia sp. nov. (Hong Kong)

3b) In dorsal view, pronotal humeri not angular in appearance. Median portion of the anterior margin of the pronotum round. (Figure 8b) 4

4a) In dorsal view, postpetiole round or squarish in shape (Figure 9a). Propodeal spines straight - if curved they are slightly curved downwards.5

4b) In dorsal view, postpetiole broader than long or longer than broad, not round or squarish (Figure 9b). Propodeal spines straight- if curved they are slightly curved upward 6

Updated key to global *Paratopula* species

The key to global *Paratopula* species is modified and updated based on the keys and species descriptions provided in Bolton (1988), Sheela & Narendran (2008) and Xu & Xu (2011).

1a) Dorsal surfaces of middle and hind tibiae with short stout erect to suberect hairs and short decumbent to appressed pubescence (see Figure 2 in Bolton 1988) (Borneo: Brunei & E. Malaysia, Philippines, Thailand) *P. macta* Bolton

1b) Dorsal surfaces of middle and hind tibiae lacking standing hairs, at most with short decumbent to appressed pubescence 2

2a) In profile view, propodeal spines long stout, downcurved along their length. Propodeal lobes sharply hooked upwards apically, their apices directed vertically (see Figure 1 in Bolton 1988) (Borneo: Brunei) *P. ankistra* Bolton

2b) In profile view, propodeal spines either straight or weakly curved. Propodeal lobes not sharply hooked, if hooked, only slightly so3

3a) In dorsal view, pronotal humeri angulate. Median portion of the anterior margin of the pronotum angular (Figure 8a) (Indonesia, E. Malaysia) *P. demeta* Bolton

5a) In dorsal view, postpetiole more nearly globular (see Figure 4 in Bolton 1988). In profile view, propodeal spines straight. Postpetiole in profile with tergite relatively long low and shallowly convex. Sternite of postpetiole elongate and narrow in profile (Indonesia: Sulawesi) *P. catocha* Bolton

5b) In dorsal view, postpetiole squarish (see Figure 5 in Bolton 1988). In profile view, propodeal spines straight to feebly down curved. Postpetiole in profile view with tergite relatively short and more strongly convex. Sternite of postpetiole short and deep in profile. (Bangladesh, China, India, Myanmar, Pakistan, Sri Lanka, Taiwan)..... *P. ceylonica* (Emery)

6a) In dorsal view, postpetiole longer than broad (see Figure 4 in Sheela & Narendran 2011). In full face view frontal carinae indistinct behind frontal lobes. Propodeal lobes angulated apically. (India) *P. intermedia* Sheela & Narendran

6b) In dorsal view, postpetiole broader than long (Figure 5), trapezoidal in shape. In full face view frontal carinae fine and continuous, about as long as scapes. Propodeal lobes truncated apically ...7

7a) In profile view, propodeal spines slender and acute, slightly curved upwards (see Figure 2 in Xu & Xu 2011). In dorsal view, propodeal spines tapering to a point (Figure 7a). Mandibles with 9 teeth. Dorsum of body with short, blunt hairs (China) *P. zhengi* Xu & Xu

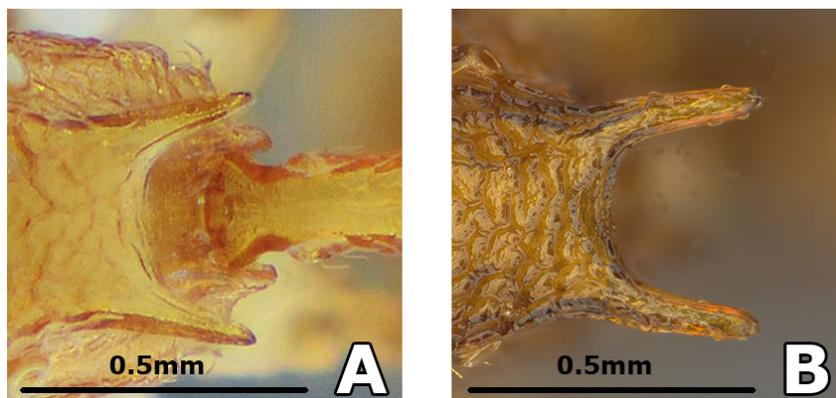


Fig. 7. A dorsal view comparison of the propodeal spines in A) *P. zhengi* (from pers. comm., holotype, photographed by Zheng Hui Xu). Propodeal spines taper B) *P. bauhinia* (holotype). Propodeal spines rounded.

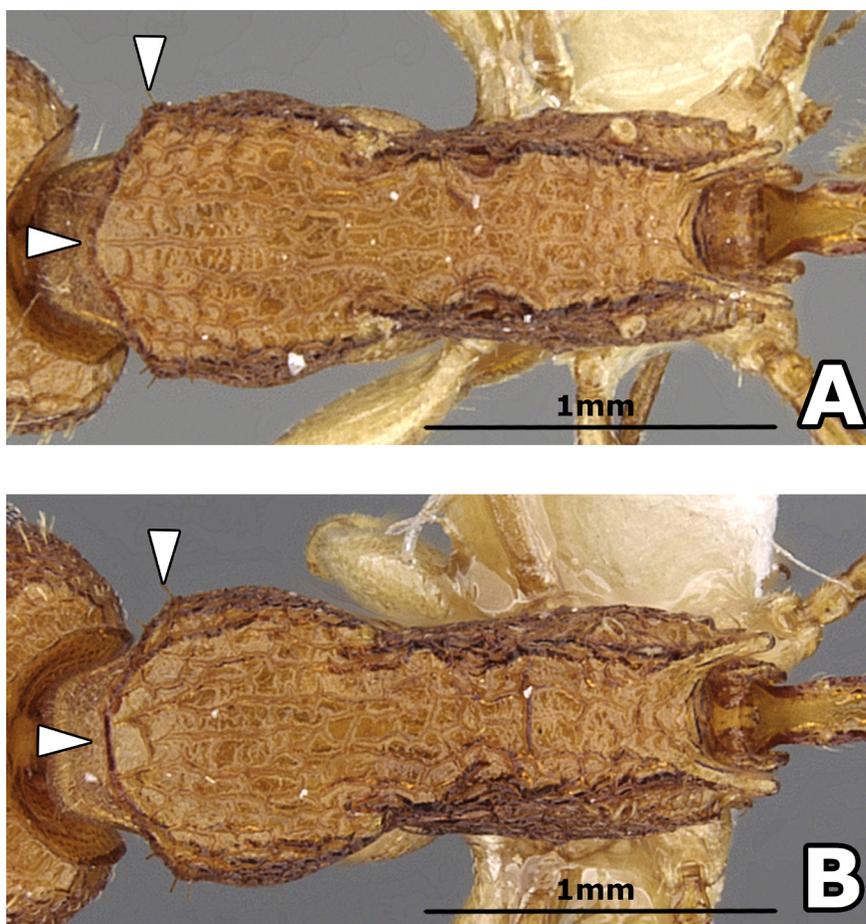


Fig. 8. A dorsal view comparison of the anterior margin the pronotum in A) *P. demeta* (from AntWeb 2016, CASENT0901742, photographed by Will Ericson), pronotal humeri and the median portion of anterior margin of the pronotum angular. B) *P. catocha* (from AntWeb 2016 CASENT0901743, photographed by Ryan Perry). Pronotal humeri and the median portion of anterior margin of the pronotum round.

7b) In profile view, propodeal spines straight. In dorsal view, propodeal spines not tapering and round at the tip (Figure 7b). Mandibles with 10 teeth. Dorsum of body with apically acute hairs. (Hong Kong) *P. bauhinia* **sp. nov**

Description of female caste
Rotastruma stenoceps Bolton

Material examined. An individual collected in HONG KONG, Lung Fu Shan Country Park, at N 22.279139 E 114.136755, elevation 273m, hand collected at approximately 21:00 h, 21.iv.2016 (Ying Y. LUO), label “ANTWEB1009015” deposited at SBSHKU.

Female description

Material examined. HL 0.72 mm; HW 0.85 mm; MaL 0.41 mm; SL 0.59 mm; EL 0.25 mm; WL 1.21 mm; PNW 0.62 mm; PNH 0.48 mm; MW 0.56 mm; SPL 0.31 mm; PTL 0.61 mm; PTW 0.28 mm; PTH 0.31 mm; TL 4.33 mm; PPL 0.31 mm; PPW 0.28 mm; PPH 0.30 mm; CI 85; SI 81; Mal 56; PI 46; PPI 118

Head. In full face view, head rectangular in shape, slightly wider than long (CI 85). Posterior margin of head straight and posterior corners of head rounded as in worker (see figure 15 in Bolton 1991). Sides of head straight and parallel. Eyes large, in the longest dimension with a dozen ommatidia. Median ocellus level with the posterior margin of the compound eye. Frontal carinae extending to the occipital margin. Mandibles triangular, masticatory region of mandibles with 6 teeth. Antenna with 12 segments and terminated with a 3-segmented club.

Mesosoma. In profile view, dorsum of mesonotum broadly rounded. Propodeal spiracle round and near the anterior margin of the metapleural gland bulla. Wing scars clearly visible. Propodeal spines slightly downcurved, almost straight, apically acute, and marginally extending beyond the propodeal lobes. In dorsal view, mesosoma longer than wide, with anterior margin longer than the posterior margin.

Metasoma. In profile view, petiole pendunculate with an ill-defined node, postpetiole roughly square in shape. A small denticle is present on the ventral side of the penducle, located near the propodeum. In dorsal view, petiole rectangular in shape, and postpetiole trapezoidal in shape, with anterior margin of postpetiole shorter than the posterior margin. No sting visible.

Sculpture. Cuticle thick, all surfaces except for the antenna, legs, penduncle and gaster sculptured. Frons with distinct parallel lines of sculpture. In profile view, sides of mesosoma laterally costate. In dorsal view, scutum and scutellum laterally costate, petiole and postpetiole rugose to rugose-reticulate. Ventral sides of peduncle conspicuously smooth. First gastral tergite smooth, with some short basigastral costulae.

Pubescence. All dorsal surfaces of head, mesosoma and metasoma with short sub-erect, apically acute hairs, gold in colour. Antenna with abundant hair, oriented to the apex. Coxa, femur and tibia covered in short suberect hairs, oriented towards the tarsus. Subpostpetiolar process with a few thin erect hairs.

Colouration. Whole body a uniform golden-brown colour, mandibles slightly darker in colouration. Gaster darker, light-brown.

Castes. For worker description refer to Bolton (1991). Male caste is unknown.

Distribution

Rotastruma stenoceps is known from Hong Kong and the following Chinese provinces: Guangdong, Hubei, Hunan and Yunnan.

Ecology

Very little is known of the ecology of *Rotastruma*. The specimen was found walking on a railing adjacent to a hiking trail at approximate 21:00 h. The surrounding area of the hiking trail is a monoculture plantation of the tree *Lophostemon confertus* Wilson & Waterh. Whether or not *R. stenoceps* is actually nocturnal is unknown at this point because the female may have performed a nuptial flight earlier in the day and could have been looking for a suitable location to start a colony.

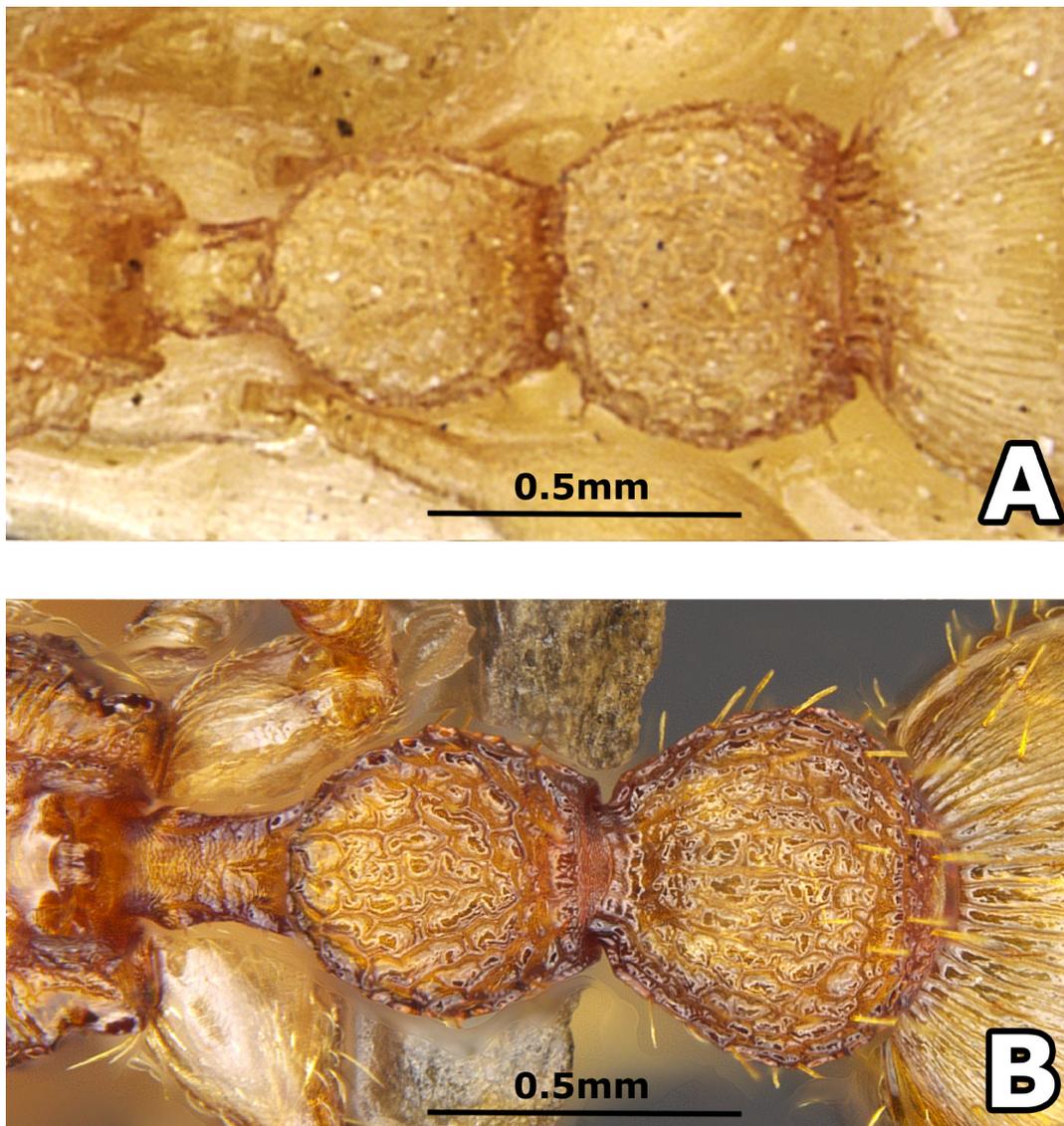


Fig. 9. A dorsal view comparison of the postpetiole in A) *P. ceylonica* with globular-shaped postpetiole (from AntWeb 2016, CASENT0908985, photographed by Zach Lieberman), B) *P. bauhinia* (holotype) with roughly trapezoidal-shaped postpetiole, and anterior margin shorter than the posterior margin.

Remarks

Previously, two worker specimens of *R. stenocephs* were found in Hong Kong in past studies, both with features as described by Bolton (1991).

In general, the morphology of the queen is similar to the worker, as discussed by Bolton (1991), unless otherwise stated.

This specimen is distinct from *R. recava* and is similar to *R. stenocephs* due to the following features: lack of concave occipital margin, sides of head with projecting hairs, relatively straight propodeal spines and propodeal spiracle near the metapleural gland bulla.

DISCUSSION

Paratopula bauhinia represents the first record of this genus in Hong Kong and only the third record of this genus for China (others are from Shanghai and Xizang). All specimens were found in Lung Fu Shan Country Park, a protected country park located close to the highly urbanized city centre of Hong Kong Island. The holotype worker was found foraging in shallow leaf litter on a man-made structure in a highly disturbed young secondary forest, along a hiking trail (Figure 6). This particular part of the trail has abandoned construction work; trash and glass litter the ground. The paratypes were found further up the trail, where the trail is more developed, on a railing (Figure 6). This part of the trail is located within a monoculture plantation and has thus experienced important disturbance in the past. While *P. bauhinia* has been collected from only two sites, the level of disturbance of these sites has led us to conclude that this species is not a mature forest specialist but could be a species associated with young or disturbed forested habitats.

Despite *Paratopula*'s relatively large size (it is the largest Myrmicinae known from Hong Kong), it is still rarely collected. Previous *Paratopula* specimens had been collected either on or near trees; which suggests an arboreal or sub-arboreal lifestyle (Bolton 1988, Eguchi *et al.* 2011). *Rotastruma* is also thought to be arboreal, as nests of *R. recava* have been collected near trees or from dead twigs (Bolton 1991). The collection times for all the specimens in this study were at night, approximately 2 to 3 hours after sunset. The collection of these species at night, on raised man-made structures, suggests they may forage near the ground nocturnally, potentially to limit competition with dominant species more active during daytime.

Our collection events suggest that *Paratopula* is crepuscular or nocturnal in behaviour. This is also the first collection event for the genus *Rotastruma* for our research team (previous specimens found in Hong Kong have been caught by other research groups), although whether or not it is nocturnal remains unknown (we haven't seen any *R. stenoceps* workers active at night) and our discovery of the dealate queen may just be due to the timing of the nuptial flight for the species.

Their presumed nocturnal ecology is supported by the absence of *Paratopula* and *Rotastruma* specimens from diurnal sampling despite an intensive sampling program conducted in Hong Kong over the past year which utilizes multiple approaches (hand collection, baiting, pitfall traps and Winkler extractors).

Collection during diurnal hours versus nocturnal hours can cause separate communities to be sampled, which has been illustrated in tropical and subtropical regions (Tavares *et al.* 2008) and in hot and arid regions (Briese & Macauley 1980; Cros *et al.* 1997). Similarly, individual taxa considered as rare could also be nocturnal in behaviour, such as the rare arboreal myrmicine genus *Peronomyrmex* (Shattuck 2006) or the once elusive *Nothomyrmecia macrops* Clark which evaded collection for 46 years and was finally rediscovered when researchers did a night time survey and discovered that *N. macrops* is an exclusively nocturnal scavenger (Taylor 1978). Thus, in order to have a complete species inventory, we recommend including nocturnal sampling to maximize the collection of potential nocturnal specialist species, especially within tropical and subtropical regions that possess rich and ecologically complex ant communities.

Proposed explanations for why some ant genera are so rarely collected include small population size, habitat specificity, sampling difficulties and inconspicuous nature (Espadaler & Lopez-Soria 1991, Brandão *et al.* 2008). However, the discovery of *Paratopula* and *Rotastruma* in such a disturbed habitat suggests that habitat-specificity may not be an issue and due to the relatively large size of *Paratopula* it cannot be considered inconspicuous. Therefore small colony size, cryptic behaviour and the underutilisation of arboreal collection techniques may be the reasons for the rarity of collection events for *Paratopula*. Brandão *et al.* (2008) highlighted that very little of the life history of rarely collected ants is known, so it is difficult to determine which collection method is the most effective to use.

The discovery of *Paratopula* and *Rotastruma* in Hong Kong was not unexpected; other species of *Paratopula* have been recorded in the region, in Shanghai and Taiwan (antmaps.org). This emphasizes the possibility of discovering

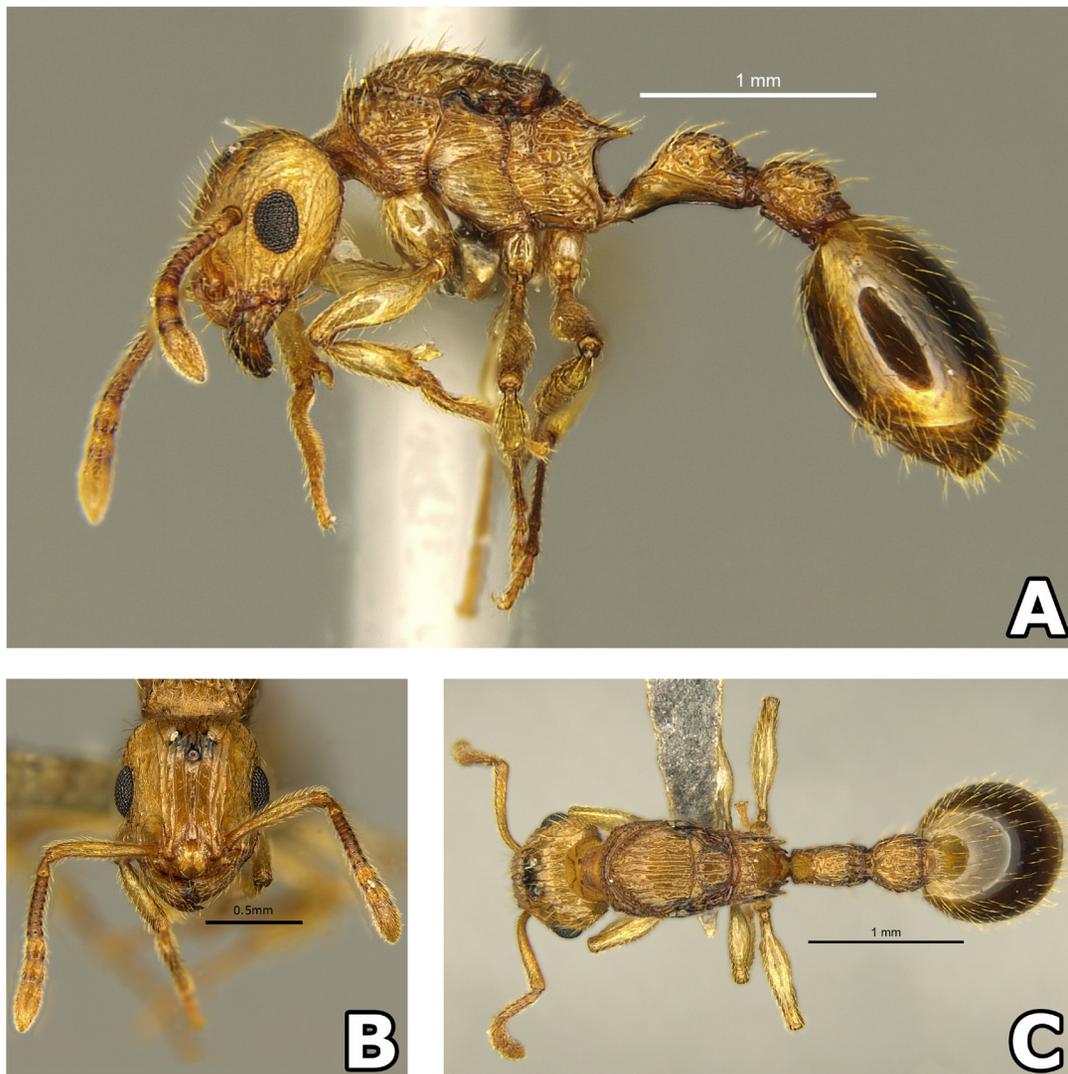


Fig. 10. Specimen of *R. stenoceps* Bolton examined in A) profile view. B) dorsal view. C) full face view.

new records of *Paratopula* and *Rotastruma* in other provinces in China, especially since China is regarded as an under sampled region for ant biodiversity (Guénard & Dunn 2012). The description of this new species from Hong Kong raises the possibility that previous identifications of *P. ceylonica* from South East China could be erroneous and re-examination of previously collected specimens could confirm this.

The discovery of a new species of the rarely collected ant genus *Paratopula* in Hong Kong is further evidence that our knowledge of the ant community in the region is still

incomplete. Collection using underutilised arboreal techniques and nocturnal sampling could yield additional ant species records for the region.

ACKNOWLEDGEMENTS

The authors would like to thank Dr. Zheng Hui XU for providing us with new images of the *P. zhengi* holotype and allowing us to use the images, Gordon Yong for collecting and sharing his specimen, Laura Wong for identifying the trees near the site where the type specimens were

found and Lily Ng for helping in imaging the specimens. We are also very grateful to the two reviewers, Sandor Csósz and Georg Fischer, for their very valuable comments on the manuscript. Additionally we would like to thank Roger Lee, Toby Tsang, Briony Mamo and Brian Worthington for their input on the manuscript. This work was supported by the Seed Funding Programme for Basic Research for New Staff from the University of Hong Kong.

REFERENCES

- antmaps.org, 2016. Available from <https://antmaps.org/>. Accessed on January 31st 2016
- Antcat.org, 2016. Available from <https://antcat.org/>. Accessed on January 31st 2016
- Bolton B., 1988. A review of *Paratopula* Wheeler, a forgotten genus of Myrmicine ants (Hym., Formicidae). *Entomologist's Monthly Magazine*, 125 – 143.
- Bolton B., 1991. New myrmicine ant genera from the Oriental Region (Hymenoptera: Formicidae). *Systematic Entomology*, 16, 1 – 13.
- Bolton B., 2004. Identification guide to the ant genera of the world. Cambridge, Mass.: Harvard University Press, 222 pp.
- Brandão C.R., Feitosa R.M., Schmidt F.A. & Solar R.R.A., 2008. Rediscovery of the putatively extinct ant species *Simopelta minima* (Brandão) (Hymenoptera, Formicidae), with a discussion on rarity and conservation status of ant species. *Revista Brasileira de Entomologia*, 52, 480–483.
- Briese D.T., & Macauley B.J., 1980. Temporal structure of an ant community in semi-arid Australia. *Australian Journal of Ecology* 5(2): 121 – 134.
- Cros S., Cerdá X., & Retana J., 1997. Spatial and temporal variations in the activity patterns of Mediterranean ant communities. *Ecoscience* 4(3): 269 – 278.
- Eguchi K., Bui T. V., & Yamane S., 2011. Generic synopsis of the Formicidae of Vietnam (Insecta: Hymenoptera), part I — Myrmicinae and Pseudomyrmecinae. *Zootaxa* 2878: 1 – 61.
- Emery, C., 1901. Ameisen gesammelt in Ceylon con Dr. W. Horn, 1899, *Dt. Ent. Z.*, 113 – 122.
- Espadaler X., & Lopez-Soria L., 1991. Rariness of certain Mediterranean ant species: fact or artifact? *Ins. Soc.* 38:365 – 377.
- Fischer G., Azorsa F., Fisher B., 2014. The ant genus *Carebara* Westwood (Hymenoptera, Formicidae): synonymisation of *Pheidologeton* Mayr under *Carebara*, establishment and revision of the *C. polita* species group. *Zookeys* 438: 57 – 112.
- Guénard B., & Dunn R., 2012. A checklist of the ants of China. *Zootaxa* 3558: 1 – 77.
- Janicki, J. H., Narula, N. Ziegler, M. Guénard B. & Economo. E. P. Visualizing and interacting with large-volume biodiversity data using client-server web mapping applications: The design and implementation of antmaps.org. *Ecological Informatics* 32: 185 – 193.
- Longino, J. T., 2003. The *Crematogaster* (Hymenoptera, Formicidae, Myrmicinae) of Costa Rica. *Zootaxa* 151: 1 – 150
- Serna, F., & Mackay, W., 2010. A descriptive morphology of the ant genus *Procryptocerus* (Hymenoptera: Formicidae). *Journal of Insect Science*, 10: 111.
- Shattuck S.O., 2006. A third species in the rare Australian ant genus *Peronomyrmex* Viehmeyer (Hymenoptera: Formicidae). *Zootaxa* 1194: 49 – 55.
- Sheela S., & Narendran T. C., 1998. A new species of the genus *Paratopula* Wheeler from India, *Geobias new Reports*, 17 (1): 23 – 26.
- Tavares A.A., Bispo P.C., & Zanzini, A.C., 2008. Effect of collect time on communities of epigeic ants (Hymenoptera: Formicidae) in areas of *Eucalyptus cloeziana* and Cerrado. *Neotropical Entomology* 37(2): 126 – 130.
- Taylor R.W., 1978. *Nothomyrmecia macrops*: A Living Fossil Ant rediscovered. *Science* 201: 979 – 985.
- 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(1): 61 – 81.
- Wheeler W. M., 1919. The ants of Borneo Bull. *Mus. comp. Zool. Harv.* 63: 43 – 147.
- Xu Z.H., & Xu G. L., 2011. A new species of the genus *Paratopula* Wheeler (Hymenoptera, Formicidae). *Acta Zootaxonomica*, 36 (3): 595 – 597.

ASIAN MYRMECOLOGY

A Journal of the International Network for the Study of Asian Ants

Communicating Editor: Francisco Hita Garcia