

ORIGINAL ARTICLE

Subterranean species of the ant genus *Crematogaster* in Asia
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Abstract

Three *Crematogaster* ant species, *C. (Orthocrema) javanica* Menozzi, *C. (O.) myops* Forel and *C. (O.) masukoi* sp. nov., share reduced compound eyes which characterizes them among Asian species of the subgenus *Orthocrema*. The new species is described based on material from Borneo. It can be distinguished from *C. javanica* and *C. myops* by its smooth surface of clypeus and acutely produced subpetiolar process. Reduced compound eyes and yellowish body suggest that these three species are subterranean.

Key words: Indonesia, *javanica*, Malaysia, *myops*, new species, *Orthocrema*.

INTRODUCTION

Several new myrmicine genera and species have recently been discovered from soil core samples (Bolton 1988; Belshaw & Bolton 1994; Eguchi *et al.* 2006; Eguchi & Bui 2007). Subterranean taxa are infrequently collected and often have distinctive morphological features. They have reduced compound eyes and depigmented yellowish body. Subterranean species are poorly known in the genus *Crematogaster*.

The genus *Crematogaster* is mostly arboreal, but some species belonging to the subgenus *Orthocrema* are ground-dwelling ants. These ground-dwelling ants are mainly collected from soil and leaf litter samples. The latest checklist (Bolton *et al.* 2006) counted 153 names (species and subspecies) in the subgenus, comprising 117 valid names and 36 junior synonyms. In Asia, 14 species and 4 subspecies are known. The subgenus can be easily distinguished by the following character combinations: (i) 2-segmented antennal club;

(ii) petiole with parallel sides; and (iii) postpetiole without median sulcus (Emery 1922; Santschi 1918); but it is difficult to identify specimens to species, and there are many undescribed species. In this paper, we follow the subgeneric classification (Bolton 1995, 2003; Bolton *et al.* 2006) temporarily for the purpose of taxonomic convenience and avoiding new synonyms.

Menozi (1935) provided a key to the *Orthocrema* species of Malesia and New Guinea. His key included only two small-eyed species, *C. (O.) javanica* Menozzi, 1935 and *C. (O.) myops* Forel 1911. These two species are unique among the Asian fauna in having compound eyes consisting of approximately six ommatidia, and can be easily distinguished from other *Orthocrema* species by this character. In the course of our recent examination of specimens collected from soil samples, we found a third small-eyed *Orthocrema* species similar to *C. (O.) javanica* and *C. (O.) myops*. We here describe the species and discuss morphological specializations and affinities of small-eyed *Orthocrema* species.

MATERIALS AND METHODS

Specimens examined or referred to are deposited in the collections below. Codes for public institutions mainly follow those in Brandão (2000).

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Table 1 Characteristics of three small-eyed *Orthocrema* species in Asia

Characters	<i>Crematogaster</i> (<i>O.</i>) <i>javanica</i> (original description)	<i>Crematogaster</i> (<i>O.</i>) <i>masukoi</i>	<i>Crematogaster</i> (<i>O.</i>) <i>myops</i>
Median portion of head	<i>No description.</i>	Smooth.	Smooth.
Clypeus	Striated with rugulae.	Smooth.	Striated with rugulae.
Scape	Reaching occipital margin.	Reaching posterior corner of head.	Exceeding posterior corner of head.
Propodeal dorsum	<i>No description.</i>	Sculptured.	Smooth.
Subpetiolar process	Weakly developed.	Developed.	Weakly developed.
Subpostpetiolar portion	Convex.	Developed acutely.	Convex.

BMNH: The Natural History Museum, London, U. K.
IEGG: Istituto di Entomologia “Guido Grandi”,
Bologna, Italy.

ITBC: Institute for Tropical Biology and Conservation, Universiti Malaysia Sabah, Kota Kinabalu, Malaysia.

KUM: Institute of Tropical Agriculture and Entomological Laboratory, Kyushu University, Fukuoka, Japan.

MCZC: Museum of Comparative Zoology, Harvard University, Cambridge, MA, USA.

MHNG: Musée d’Histoire Naturelle, Geneva, Switzerland.

MZB: Museum Zoologicum Bogoriense, Cibinong, Bogor, Indonesia.

SKYC: SKY Collection at Kagoshima University, Kagoshima, Japan.

Abbreviations and definitions of measurements and indices are as follows. Measurement conventions for the petiole and postpetiole follow those described in Longino (2003).

Head Width (HW): Maximum width of head in full face view, excluding the eyes.

Head Length (HL): Perpendicular distance from vertex margin to line tangent to the anterior-most projections of clypeus in full face view.

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

Scape Length (SL): Length of the first antennal segment, excluding the neck and basal condyle.

Scape Index (SI): $SL/HW \times 100$.

Eye Length (EL): Maximum width of the compound eye.

Pronotal Width (PW): Maximum width of the pronotum in dorsal view.

Weber’s Length of mesosoma (WL): Diagonal length, measured in lateral view from the anterior margin of the pronotum (excluding the collar) to the posterior extremity of the propodeal lobe.

Propodeal Spine Length (PSL): Measured from tip of propodeal spine to closest point on outer rim of propodeal spiracle.

Petiole Length (PtL): Length of the petiole in lateral view (see Longino 2003, Fig. 2).

Petiole Width (PtW): Maximum width of petiole in dorsal view.

Petiole Height (PtH): Height of the petiole in lateral view (see Longino 2003, Fig. 2).

Postpetiole Length (PpL): Length of the postpetiole in dorsal view (see Longino 2003, Fig. 2).

Postpetiole Width (PpW): Maximum width of postpetiole in dorsal view, excluding the helcium.

Petiole Height Index (PtHI): $PtH/PtL \times 100$.

Petiole Width Index (PtWI): $PtW/PtL \times 100$.

Postpetiole Width Index (PpWI): $PpW/PpL \times 100$.

Waist Index (WI): $PpW/PtW \times 100$.

TAXONOMY

Crematogaster (*Orthocrema*) *javanica* Menozzi

Crematogaster (*Orthocrema*) *javanica* Menozzi 1935, p. 108, Figure 4, worker from INDONESIA: Buitenzorg (Bogor), Java (*W. Karawajew*) (2365) (probably in IEGG). (not seen).

Remarks

We were unable to examine the type-material of *C. (O.) javanica* Menozzi. In his key, Menozzi (1935) distinguished *C. (O.) javanica* from *C. (O.) myops* by the following characters: (i) median portion of clypeus impressed; (ii) longitudinal rugulae on clypeus, reaching the anterior margin. However, our examination of the type-material of *C. (O.) myops* revealed that the species had some rugulae on the clypeus (Table 1). For this reason, *C. (O.) javanica* may be a close relative of *C. (O.) myops*. The taxonomic status of *C. (O.) javanica* will remain uncertain until the type-material is examined.

***Crematogaster (Orthocrema) masukoi* sp. nov.**
(Figs 1, 3 and 5)

HOLOTYPE worker from MALAYSIA: Sepilok, Sandakan, Borneo, 17. viii. 1981 (*K. Masuko*) (ITBC).

Paratypes. 2 workers, same data as holotype (KUM, MHNG). 5 workers, INDONESIA: Sangkimah, Kutai N. P., E. Kalimantan, 13. ix. 1993 (P-2 soil-2) (*Sk. Yamane*) (BMNH, MCZC, MZB, KUM, SKYC).

Etymology

This species is dedicated to Prof Dr Keiichi Masuko, Senshu University, who collected the type material.

Measurements and indices

HW 0.46–0.5 mm; HL 0.46–0.48 mm; CI 100–106 mm; SL 0.36–0.37 mm; SI 74–78 mm; EL 0.04–0.05 mm; PW 0.28–0.31 mm; WL 0.53–0.57 mm; PSL 0.08–0.09 mm; PtL 0.17–0.18 mm; PtW 0.16–0.17 mm; PtH 0.12–0.13 mm; PpL 0.12 mm; PpW 0.16 mm; PtHI 67–76 mm; PtWI 94–100 mm; PpWI 133 mm; WI 94–100 mm (Three workers measured).

Description of worker

Workers monomorphic in size.

Head subquadrate but, slightly broader than long, with weakly concave posterior margin, rounded posterior corners and convex sides. Mandibles smooth and shining, with four teeth, apical and subapical teeth large, basal two teeth smaller. Basal tooth arranged away from the third apical one. Anterior margin of clypeus convex. Anterolateral margins of clypeus not protruded anteriorly, forming convex anterior margin. Frontal triangle undeveloped. Frontal carinae developed, but not reaching the line between the bottom of eyes. Occipital carinae clear. Antennae 11-segmented; scape reaching posterior corner of head, with standing setae; antennal club 2-segmented. Compound eyes reduced and composed of approximately six ommatidia.

Dorsal outline of mesosoma almost convex in lateral view; metanotal groove obscure. Pronotum and mesonotum completely fused. Promesonotum steeply raised in profile. Anterior margin of pronotal collar not concave in dorsal view. Mesonotal dorsum without distinct rugulae laterally. The ridge separating lateral portion from ventral portion of mesopleuron distinct. Metanotal groove straight in dorsal view, wider than half of pronotal width. Metapleural gland opening slit-shaped, situated close to hind coxal base. Dorsal outline of propodeum to propodeal spines concave in lateral view. Transverse rugulae present behind metanotal groove; the rugulae connecting to the tips of propodeal spines. Propodeal spines developed, subparallel, and directed posteriorly in dorsal view.

Petiole, in dorsal view subrectangular with parallel sides, longer than broad, with node-like process posteriorly; subpetiolar process strongly developed; spiracle situated anteriorly and middle part between dorsal and ventral margin of petiole in lateral view. Postpetiole with more or less distinct node, in dorsal view wider than long, weakly bilobed behind, but without longitudinal median sulcus; anterior face more gently curved than posterior face in lateral view; spiracle distinct situated anteriorly on the lateral surface; subpostpetiolar process developed acutely.

Dorsal surface of head smooth and shining. Clypeus smooth without longitudinal rugulae. Propleuron smooth. Mesopleuron smooth except for marginal portion. Propodeal dorsum weakly sculptured.

Standing pilosity present. Dorsal face of head, clypeus and mesosoma with standing setae. Fourth abdominal tergite with standing setae sparsely.

Body colour yellow.

Distribution

This species is known from Borneo (Malaysia: Sabah; Indonesia: Kalimantan).

Remarks

This species is similar to *C. (O.) javanica* and *C. (O.) myops*, but can be distinguished from the two species by smooth surface of clypeus, relatively wide metanotal groove in dorsal view (more than half of pronotal width), developed subpetiolar process and acute subpostpetiolar process (Table 1).

***Crematogaster (Orthocrema) myops* Forel**

(Figs 2, 4 and 6)

Crematogaster myops Forel 1911, p. 31. LECTOTYPE worker (MHNG worker) (by present designation) and paralectotype workers from MALAYSIA: Sarawak, Borneo (*Haviland*) (MHNG) (examined). (Combination in *C. (Orthocrema)* by Santschi 1918, p. 182).

Measurements and indices

HW 0.46–0.48 mm; HL 0.5–0.52 mm; CI 92 mm; SL 0.42–0.44 mm; SI 91–94 mm; EL 0.05–0.06 mm; PW 0.27–0.29 mm; WL 0.56–0.58 mm; PSL 0.07 mm; PtL 0.19–0.21 mm; PtW 0.15–0.16 mm; PtH 0.11–0.12 mm; PpL 0.12–0.13 mm; PpW 0.15–0.16 mm; PtHI 55–63 mm; PtWI 75–79 mm; PpWI 115–133 mm; WI 100 mm (Three syntype workers measured).

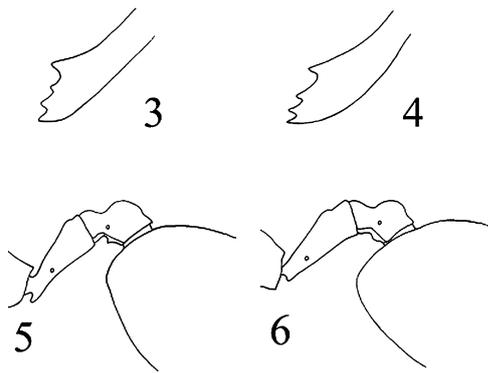
Description of worker

Workers monomorphic in size.

Head subquadrate, slightly longer than broad, with weakly concave posterior margin, rounded posterior



Figures 1,2 1 *Crematogaster (Orthocrema) masukoi*, worker. 1 a Lateral view; 1 b Head in full face view; 1 c Mesosoma in dorsal view. 2 *C. (O.) myops*, worker. 2 a Lateral view; 2 b Head in full face view; 2 c Mesosoma in dorsal view. Scale bars are all 0.5 mm.



Figures 3–6 3,4 Left mandible. 3 *Crematogaster* (*Orthocrema*) *masukoi*, worker. 4 *C. (O.) myops*, worker. 5,6 Petiole and postpetiole in lateral view. 5 *C. (O.) masukoi*, worker. 6 *C. (O.) myops*, worker.

corners and convex sides. Mandibles smooth and shining, with four teeth, apical and subapical teeth large, basal two teeth smaller. Basal tooth arranged away from the third apical one. Anterior margin of clypeus convex. Anterolateral margins of clypeus not protruded anteriorly, forming convex anterior margin. Frontal triangle undeveloped. Frontal carinae developed, but not reaching the line between the bottoms of eyes. Occipital carinae clear. Antennae 11-segmented; scape exceeding posterior corner of head, with standing setae; antennal club 2-segmented. Compound eyes reduced and composed of approximately six ommatidia.

Dorsal outline of mesosoma concave in lateral view because of distinct metanotal groove. Pronotum and mesonotum completely fused. Promesonotum steeply raised in profile. Anterior margin of pronotal collar not concave in dorsal view. Mesonotal dorsum with distinct rugulae laterally in posterior portion. The ridge separating lateral portion from ventral portion in mesopleuron distinct. Metanotal groove straight in dorsal view, not wider than half of pronotal width. Metapleural gland opening slit-shaped, situated close to hind coxal base. Dorsal outline of propodeum to propodeal spines not so concave in lateral view. Propodeal spines developed and directed posteriorly in dorsal view.

Petiole with node-like process posteriorly; subpetiolar process weakly developed; spiracle situated anteriorly and middle part between dorsal and ventral margin of petiole in lateral view; in dorsal view, the shape subrectangular with parallel sides, longer than broad. Postpetiole with more or less distinct node, in dorsal view wider than long, not bilobed, anterior face more gently curved than posterior face; spiracle distinct, situated anteriorly on the lateral surface; subpostpetiolar portion convex.

Dorsal surface of head weakly sculptured. Clypeus striated with rugulae. Propleuron smooth. Mesopleuron sculptured. Petiole and postpetiole smooth.

Standing pilosity present. Dorsal face of head, clypeus and mesosoma with standing setae. Fourth abdominal tergite with standing setae sparsely.

Body colour yellow.

Distribution

This species is known from Singapore, Malaysia (Peninsula, Borneo) and Indonesia (Sumatra).

Remarks

This species is distinct in having reduced compound eyes. The compound eyes consist of approximately six ommatidia.

Four worker specimens from leaf litter in Old Tower Region are somewhat different from the rest in having sculptured dorsal median portion of head and striated propodeal dorsum. Similar infraspecific variations on the body sculpture were also reported in other subterranean ants. For example, Eguchi *et al.* (2006) reported the two forms on the body sculpture of *Pheidole schoedli*. They suggested that future examination of nest series samples from various localities would reveal the taxonomic relationship of the two forms.

Specimens examined

SINGAPORE: 1 worker, 4. xii. 1995 (*Sk. Yamane*); MALAYSIA: 1 worker, Tower Region, Lambir N. P., Miri, Sarawak, 15. i. 1993 (*Sk. Yamane*) (Canopy Ecol.); 1 worker, Bako Nat. Park, Sarawak, Borneo, 21–22. iv. 1993 (*Sk. Yamane*); 1 worker, Danum Balley, Sabah, Borneo, E. Malaysia, 3–4. iii. 1999 (*Sk. Yamane*); 4 workers, Old Tower R., Lambir N. P., Sarawak, E. Malaysia, 30. versus 2004 (leaf litter) (*Sk. Yamane*); INDONESIA: 3 workers, Bt. Lawang Lowland, G. Leuser N. P., N. Sumatra, 17. viii. 2002 (primary forest) (*Sk. Yamane*).

DISCUSSION

Subterranean *Crematogaster* ants

Like subterranean ants of other groups, *C. (O.) masukoi* has reduced eyes and depigmented yellowish body. Those morphological features suggest that the species is also subterranean (cf. Eguchi *et al.* 2006). Most *Crematogaster* species are arboreal, but the species belonging to the subgenus *Orthocrema* are generally known as ground dwelling ants in Asia. Although some subterranean ants were described as the new taxa by the specialized morphological features

(*Secostruma*: Bolton 1988; *Parvimyrma*: Eguchi & Bui 2007), three species recognized in this study are members of the subgenus *Orthocrema*. This subgenus is distributed worldwide, but approximately half of the described species are known from the Neotropical region. Longino (2003) described a small-eyed species, *Crematogaster flavomicrops* from Costa Rica. This species has also yellow coloured body and small eyes. Similarly in Asian subterranean *Crematogaster* species, the species is mainly collected from leaf litter by the Berlese funnel or the Winkler bag. The Asian species have smaller eyes than the Neotropical species in the total number of ommatidia. The former have five to six ommatidia (eye length: 0.04–0.05 mm in *C. masukoi*; 0.05–0.06 mm in *C. myops*), whereas the latter have more than ten ommatidia (eye length: 0.095–0.123 mm in *C. flavomicrops*).

The arrangement of teeth on the mandible of *C. masukoi* and *C. myops* is unique among Asian *Orthocrema* species. Total number of teeth on masticatory margin of the mandible is four or five in the genus *Crematogaster* (Bolton 2003). The number of teeth is four in the subgenus *Orthocrema*. In the species recognized here, the basal tooth is arranged away from the third apical one (Figs 3–4), although the mandibular teeth are generally arranged at an equal distance, respectively, on the masticatory margin in other *Orthocrema* species. It is uncertain what it implies, because little is known about the biology of these species.

Affinities of the small-eyed *Orthocrema* species

As mentioned in the above descriptions, *C. (O.) masukoi* and *C. (O.) myops* are similar in having reduced compound eyes, but the two species are quite different from each other in other morphological characters (Table 1). *Crematogaster myops* is similar to *C. (O.) bironi quadriruga* Forel in having a relatively long scape, undeveloped subpetiolar and subpostpetiolar processes (Fig. 5), whereas *C. masukoi* is similar to *C. (O.) fritzi* Emery in having relatively short scape, and developed subpetiolar and subpostpetiolar processes (Fig. 6). Reduction of the eyes in these two species is therefore probably convergence as a consequence of their subterranean mode of life. Another example of the reduction of eyes in soil dwelling *Crematogaster* ants was known for *C. flavomicrops* in Costa Rica, which is thought to be closely related to Neotropical species with larger eyes (Longino 2003).

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