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Revision of the *Crematogaster brevis* complex in Asia (Hymenoptera: Formicidae)

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Abstract

The *Crematogaster brevis* complex is revised and seven species and one subspecies, including one new species, are recognized. Two species groups are established based on the worker caste. The *C. brevis* group contains two species: *brevis* Emery, 1887; and *overbecki* Viehmeyer, 1916. The *C. treubi* group contains five species and one subspecies: *bouvardi* Santschi, 1920. **stat. nov.**; *kojimai* **sp. nov.**; *treubi* Emery, 1896; *treubi apilis* Forel, 1913; *walshi* Forel, 1902; and *yappi* Forel, 1901. The following new synonymies are proposed: *C. treubi* Emery, 1896 = *C. millardi* Forel, 1902 = *C. treubi vastatrix* Forel, 1911. A key to the species based on the worker caste is given. *Crematogaster jacobsoni* Forel, 1911 is transferred to the subgenus *Crematogaster.*

Key words: Formicidae, *Crematogaster*, *C. brevis*, *C. treubi*, *Mesocrema*, taxonomy, Asia, new species

Introduction

The genus *Crematogaster* is one of the most species-rich ant genera in the family Formicidae and is abundant in the tropics (Hölldobler and Wilson, 1990). The genus includes more than 900 available species-level names and is divided into 16 subgenera (Bolton, 1995, 2003; Bolton et al. 2006). The taxonomy of *Crematogater* species has been improved in recent years (Blaimer, 2010; Hosoishi & Ogata, 2009; Longino, 2003). Taxonomic works at the subgeneric levels are sometimes useful in a large group, but some subgenera are out of date because diagnostic features are not clearly indicated.

In the course of classifying Asian *Crematogaster* species to subgenus using a traditional subgeneric classification (Santschi, 1918; Emery, 1922; Wheeler, 1922), we found that the species complex treated in this paper could not be clearly assigned to subgenus. The *Crematogaster brevis* complex can be distinguished from other Asian *Crematogaster* species by the following characters: (1) anterolateral margin of clypeus produced anteriorly; (2) antenna 11-segmented; (3) antennal club 2-segmented (exceptionally seems 3-segmented in the larger workers within a species); and (4) postpetiole weakly bilobed. Workers of the subgenus *Orthocrema* share features (2) and (3), but they do not share feature (1) for Asian fauna.

The species complex mostly falls in the old subgenus *Mesocrema*, but the taxonomy of the subgenus is quite confusing because of the vague subgeneric diagnosis established by Santschi (1928). Santschi (1928) referred to the species *C. rasoherinae brunneola* Emery (known from Madagascar), *C. queenslandica* Forel (Australia), *C. scita* Forel (Australia), *C. brevis* Emery (Indonesia), *C. millardi* Forel (Myanmar), *C. overbecki* Viehmeyer (Singapore), and *C. walshi* Forel (India) as "*Neocrema*-like" since they have a developed median sulcus on the postpetiole. In contrast to *Neocrema*, which have small queens with enlarged postpetiole, these species had normal-sized queens with small postpetiole ("*La ♀ de ce groupe a la grande taille des reines normales du s. g. Orthocrema avec le postpétiole pas notablement élargi*") and Santschi placed them in a new subgenus *Mesocrema*. In the same paper Santschi (1928) also suggested that *C. jacobsoni* Forel and *C. treubi vastatrix* should be placed in the subgenus *Acrocoelia* because of a three-segmented antennal club and an anteriorly elongated petiole. However he later transferred *C. jacobsoni* Forel, *C. flavicornis* Emery and *C. treubi* Emery to the subgenus *Mesocrema* without any comments (Santschi, 1937). We therefore consider the diagnoses presented by Santschi (1928) as problematic.

We divide the *C. brevis* complex into two species groups: the *C. brevis* group has a developed occipital carina and the petiole is rectangular in dorsal view; the *C. treubi* group has an undeveloped occipital carina and the petiole is broader anteriorly than posteriorly in dorsal view.

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Materials and methods

"Asia" in the present paper refers to the Manchurian subregion of the Palaearctic Region, Oriental Region, and Indo-Australian Region excluding New Guinea, Solomons, Vanuatu, Fiji and other islands of the Pacific Ocean.

Sources of material. Type specimens were examined and/or deposited in the collections listed below. Codes for public institutions mainly follow those in Brandão (2000). Nest series samples are represented as colony codes, e. g. "SH09-Mal-105".

BMNH	The Natural History Museum, London, U. K.
FRIM	Forest Research Institute Malaysia, Kepong, 52109 Kuala Lumpur, Malaysia.
KUM	Kyushu University, Fukuoka, Japan.
MCSN	Museo Civico di Storia Naturale "Giacomo Doria", Genoa, Italy.
MCZC	Museum of Comparative Zoology, Harvard University, Cambridge, MA, USA.
MHNG	Musee d'Histoire Naturelle, Geneva, Switzerland.
MZB	Museum Zoologicum Bogoriense, Cibinong, Java, Indonesia.
NHMB	Naturhistorisches Museum, Basel, Switzerland.
THNHM	Thailand Natural History Museum, Technopolis, Khlong Luang, Pathum Thani, Thailand.

Observations. Most observations were made on an Olympus SZX12 stereomicroscope. Images were processed using Helicon Focus 4.47.1 Pro.

Measurements and indices. Measurements were made under an Olympus SZX12 stereomicroscope using micrometers. All measurements are expressed in millimeters, recorded to the second decimal place. The measurements for petiole and postpetiole follow 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 anteriormost projections of clypeus in full-face view.

Cephalic Index (CI): HW/HL x 100.

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

Scape Index (SI): SL/HW x 100.

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

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

Weber's Length of the 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 lateral 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 x 100.

Petiole Width Index (PtWI): PtW/PtL x 100.

Postpetiole Width Index (PpWI): PpW/PpL x 100.

Waist Index (WI): PpW/PtW x 100.

The species groups of the *Crematogater brevis* complex in Asia

Crematogaster brevis group

Polymorphism unknown (*C. treubi* group is monomorphic). The occipital carina developed as distinct ridge (Fig. 2a). Pronotal shoulders developed as ridges (Fig. 4). The petiole in dorsal view rectangular, with angular anterolateral corners (Fig. 3a). Postpetiole bilobed behind. Mesosoma with standing hairs sparse.

This species group seems to be most similar to the Malagasy *Mesocrema* species, *C. rasoherinae*.

Crematogaster treubi group

Workers monomorphic. The occipital carina undeveloped, not forming a distinct ridge (Fig. 2b). Pronotal shoulders not developed as distinct ridges. The petiole in dorsal view broader anteriorly than posteriorly, with rounded, not angular, anterolateral margins (Fig. 3b). The postpetiole weakly bilobed, but without distinct longitudinal median sulcus. Mesosoma with abundant standing hairs.

This species group is easily defined by the undeveloped occipital carina and generally 2-segmented antennal club, not only from *C. brevis* group, but also from other Asian *Crematogaster* species.

Synonymic list of the *Crematogater brevis* complex in Asia

brevis group
brevis Emery, 1887.
overbecki Viehmeyer, 1916.

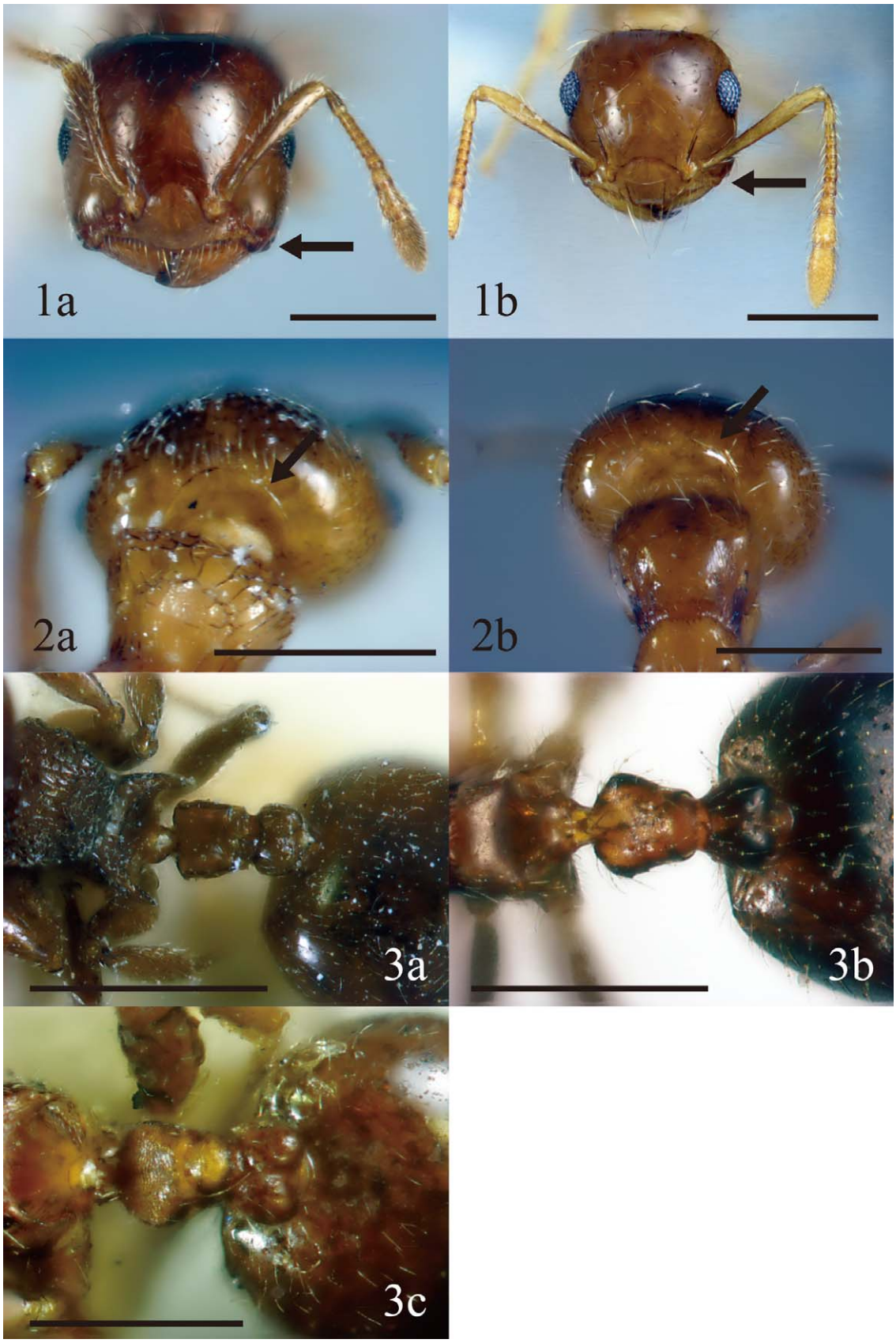
treubi group
bouvardi Santschi, 1920. **stat. nov.**
kojimai **sp. nov.**
treubi Emery, 1896.
= *millardi* Forel, 1902. **syn. nov.**
= *treubi vastatrix* Forel, 1911a. **syn. nov.**
treubi apilis Forel, 1913.
walshi Forel, 1902.
yappi Forel, 1901.

Species excluded from the subgenus *Mesocrema* in Asia

jacobsoni Forel, 1911b. Transferred to the subgenus *Crematogaster.*

Key to species based on the worker caste (except for *C. treubi apilis* Forel, which was not examined)

1	Clypeus with distinct rugulae. Petiole rectangular, with angular corners in dorsal view (Fig. 3a). Occipital carina developed as distinct ridge (Fig. 2a)	2
-	Clypeus relatively smooth and shining without distinct rugulae. Petiole broader anteriorly than posteriroly, but without angular corners (Fig. 3b). Occipital carina undeveloped, without distinct ridge (Fig. 2b)	3
2	Clypeus with one longitudinal rugula on the median portion and two distinct pairs of longitudinal rugulae laterally. Dorsal promesonotum with dense reticulate sculpture (Fig. 4a)	*brevis*
-	Clypeus with two distinct pairs of longitudinal rugulae, but lacking median rugula. Dorsal promesonotum with more open reticulate sculpture with shiny interspaces (Fig. 4b).	*overbecki*
3	Propodeal spines undeveloped (Fig. 12)	*yappi*
-	Propodeal spines developed (Fig. 6)	4
4	Postpetiole strongly bilobed behind (Fig. 3c)	*walshi*
-	Postpetiole weakly bilobed (Fig. 3b).	5
5	Metanotal groove distinct and deep (Fig. 5a)	*bouvardi*
-	Metanotal groove less distinct and deep (Fig. 5b)	6
6	Propodeal spines short and stout, their length shorter than the diameter of propodeal spiracles (Fig. 5b).	*kojimai*
-	Propodeal spines long and slender, their length longer than the diameter of propodeal spiracles (Fig. 5c)	*treubi*



FIGURES 1–3. 1. Full face view of head. 1a, *Crematogaster treubi*; 1b, *C.* (*Orthocrema*) *longipilosa*. Arrow indicates antero-lateral margin of clypeus. Scale bars are all 0.5mm. **2.** Occipital carina in posterior view. 2a, *Crematogaster overbecki*; 2b, *C. bouvardi*. Arrow indicates occipital carina. Scale bars are all 0.5mm. **3.** Petiole and postpetiole in dorsal view. 3a, *Crematogaster brevis*; 3b, *C. treubi*; 3c, *C. walshi*. Scale bars are all 0.5mm.

Species accounts

Crematogaster bouvardi Santschi stat. nov.

(Figs 2b, 5a, 6)

Crematogaster walshi st. *bouvardi* Santschi, 1920: 160. LECTOTYPE worker (bottom and tip specimen of six on one pin) (by present designation) and five paralectotype workers from VIETNAM: Lang Bian, Cochinchine [South Vietnam] (*Bouvard*) (NHMB) [examined]. Also described as new by Santschi, 1924: 98.

Measurements and indices. HW 0.76-0.85; HL 0.76-0.8; CI 99-106; SL 0.51-0.57; SI 65-75; EL 0.14; PW 0.43-0.45; WL 0.79-0.86; PSL 0.07-0.08; PtL 0.21-0.26; PtW 0.23; PtH 0.13-0.14; PpL 0.13-0.14; PpW 0.19-0.21; PtHI 50-62; PtWI 88-110; PpWI 143-169; WI 83-96 (Lectotype and two paralectotype workers and one non-type worker measured).

General description of worker. Compound eyes not projecting from lateral margin of head, the outer margin of eye almost flush with head capsule in full face view. Scape not reaching posterior corner of head, the scape with standing setae.

Anterior margin of pronotal collar almost straight in dorsal view. Metanotal groove deep and distinct with longitudinal rugulae. Propodeal spines as long as the diameter of propodeal spiracles. Anterior margin of metapleural gland bulla not reaching anterior margin of propodeal spiracle.

Petiole in dorsal view broader anteriorly than posteriorly. Postpetiole weakly bilobed, but without distinct longitudinal median sulcus. Subpetiolar and subpostpetiolar processes undeveloped.

Malar region near clypeal margin of head with rugulae. Clypeus relatively smooth and shining, but with feeble rugulae. Dorsal face of mesosoma almost smooth and shining. Dorsolateral face of pronotum with feeble rugulae in dorsal view. Lateral surface of pronotum smooth and shining. Higher and lower portions of mesopleuron weakly sculptured.

Standing setae abundant. Dorsal face of head, clypeus and mesosoma with standing setae. Fourth abdominal tergite with sparse standing setae.

Distribution. This species is known from South Vietnam and North Thailand.

Remarks. This species can be easily distinguished from other *C. treubi* group species by the distinct deep metanotal groove.

Specimens examined. THAILAND: 1 worker, Doi Suthep, nr Chiang Mai, N. Thailand, 21. xii. 1997 (*Sk. Yamane*).

Crematogaster brevis Emery

(Figs 3a, 4a, 7)

Crematogaster brevis Emery, 1887: 467 (footnote), pl. 2, fig. 19. LECTOTYPE worker (top specimen of two on one pin) (by present designation) and one paralectotype worker, one paralectotype queen, four paralectotype males from INDONESIA: Buitenzorg [Bogor, Java] (*Conte Solms Laubach*) (MCSN) [examined]. Combination in *C.* (*Orthocrema*) by Emery, 1922: 132; in *C.* (*Mesocrema*) by Santschi, 1928: 33.

Measurements and indices. HW 0.7-0.71; HL 0.68-0.72; CI 99-103; SL 0.49-0.53; SI 70-75; EL 0.14; PW 0.4-0.44; WL 0.62-0.63; PSL 0.1-0.11; PtL 0.23; PtW 0.19-0.21; PtH 0.15; PpL 0.12-0.13; PpW 0.19-0.2; PtHI 65; PtWI 91; PpWI 154-158; WI 95-100 (Lectotype and one paralectotype workers measured).

General description of worker. Compound eyes slightly projecting from lateral margin of head. Scape reaching posterior corner of head, the scape with standing and appressed setae.

Pronotal shoulders developed as ridges. Mesonotal dorsum convex in lateral view. Metanotal groove concave. Propodeal spines longer than the diameter of propodeal spiracles, curved upward. Anterior margin of metapleural gland bulla not reaching anterior margin of propodeal spiracle.

Petiole in dorsal view rectangular with angular corners. Subpetiolar process not visible in the specimens examined. Postpetiole bilobed behind, but without distinct longitudinal median sulcus.

Dorsal surface of head generally smooth, but the malar region with longitudinal rugulae. Clypeus with one

median and two distinct pairs of lateral rugulae. The rugulae connecting the anterior and posteror clypeal margins. Dorsal face of promesonotum with dense reticulate sculpture. Lateral surface of pronotum generally smooth and shining, but some longitudinal rugulae extending from the anterior portion of the pronotum. Mesopleuron smooth, but lower portion of mesopleuron weakly sculptured. Longitudinal rugulae developed on the front and behind the metanotal groove in lateral view.

Fourth abdominal tergite with abundant appressed setae and sparse standing setae.

Distribution. This species is known only from the type locality in Indonesia (Java).

Remarks. This species is similar to *C. overbecki*. It differs in having a single median rugula in addition to two pairs of lateral rugulae on the clypeus, and in the pronounced sculpture on the dorsum of the mesonotum.

The type specimens were collected from the vine *Dischidia major* (Vahl) (= *Dischidia rafflesiana* Wallich) with *Dolichoderus bituberculatus* Mayr (Emery, 1887).

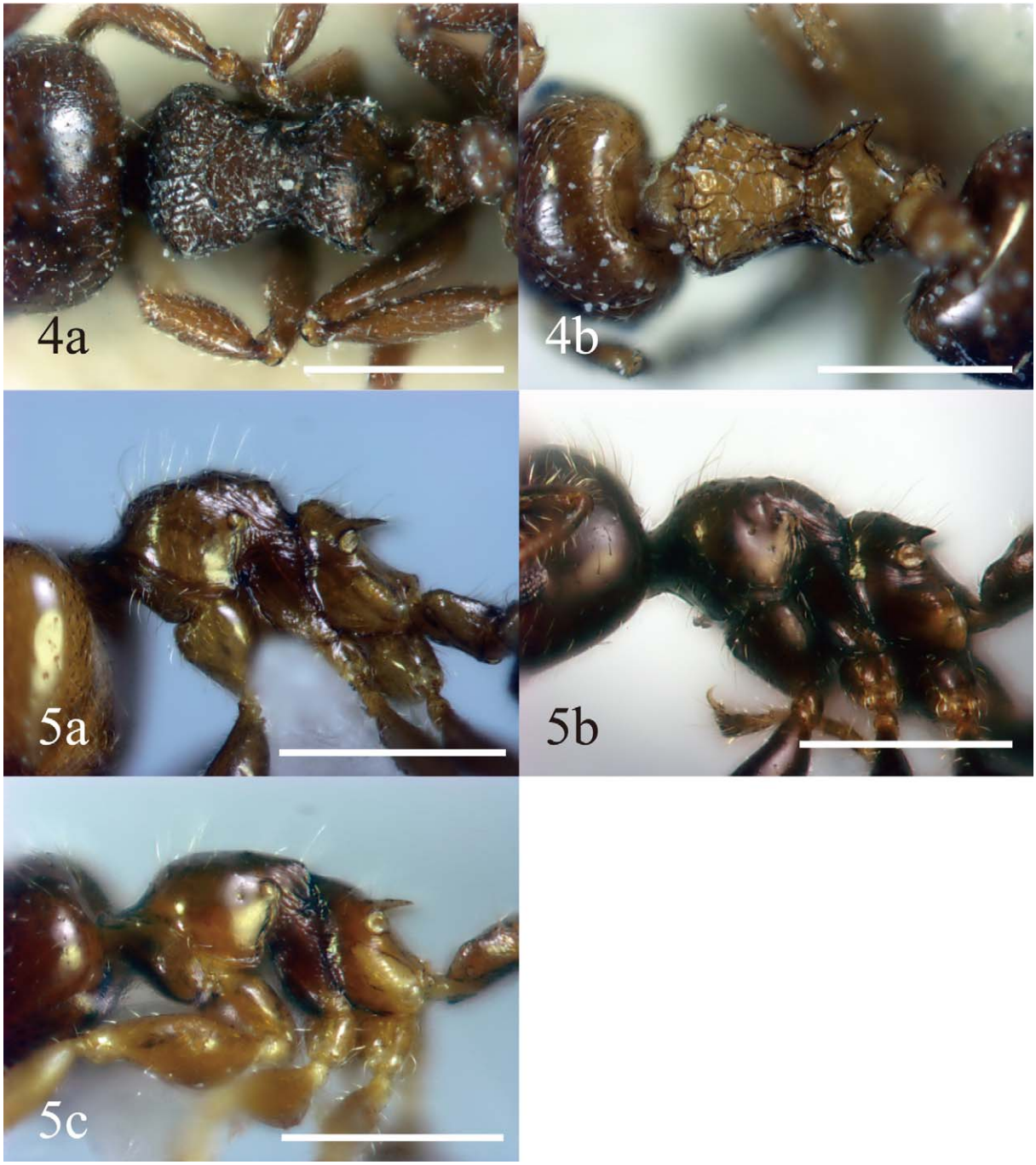


FIGURE 4. Mesosoma in dorsal view. 4a, *Crematogaster brevis*; 4b, *C. overbecki*. Scale bars are all 0.5mm.
FIGURE 5. Mesosoma in lateral view. 5a, *Crematogaster bouvardi*; 5b, *C. kojimai*; 5c, *C. treubi*. Scale bars are all 0.5mm.

***Crematogaster kojimai* sp. nov.**
(Figs 5b, 8)

HOLOTYPE worker from MALAYSIA: path 3, Cameron Highlands, 13. iii. 2010 (SH10-Mal-53) (*S. Hosoishi*) (FRIM). Eight paratype workers, same data as holotype (BMNH, KUM, MCZC, MHNG, NHMB, MCSN, MZB, THNHM).

Measurements and indices. HW 0.6-0.71; HL 0.61-0.69; CI 95-104; SL 0.45-0.51; SI 69-77; EL 0.1-0.13; PW 0.34-0.4; WL 0.66-0.77; PSL 0.05-0.09; PtL 0.16-0.2; PtW 0.18-0.22; PtH 0.11-0.14; PpL 0.1-0.14; PpW 0.14-0.19; PtHI 60-82; PtWI 100-129; PpWI 114-158; WI 78-94 (Twelve workers measured).

General description of worker. Workers monomorphic.

Compound eyes slightly projecting from lateral margin of head. Scape usually just reaching posterior corner of head in smaller workers, not reaching it in larger workers, the scape with standing setae.

Anterior margin of pronotal collar almost straight in dorsal view. Metanotal groove concave in lateral view. Propodeal spines short and stout, their length shorter than the diameter of propodeal spiracles. Anterior margin of metapleural gland bulla exceeding anterior margin of propodeal spiracle.

Petiole in dorsal view broader anteriorly than posteriorly. Postpetiole weakly bilobed, without distinct longitudinal median sulcus. Subpetiolar and subpostpetiolar processes undeveloped.

Clypeus relatively smooth and shining, but with feeble rugulae. Dorsal face of mesosoma almost smooth and shining. Dorsolateral face of pronotum smooth in dorsal view. Lateral surface of pronotum smooth and shining. Lateral surface of mesonotum with rugulae. Mesopleuron relatively smooth and shining, but the anterodorsal and lower portions weakly sculptured.

Standing setae abundant. Dorsal face of head, clypeus and mesosoma with standing setae. Fourth abdominal tergite with sparse standing setae.

Distribution. This species is known from Malaysia (Peninsula).

Remarks. This species is similar to *C. treubi*, but can be distinguished by the short and stout propodeal spines.

The nest series in Cameron Highlands (e. g. SH10-Mal-83) was collected from *Dischidia astephana* (c.f. Rintz, 1980).

Specimens examined. MALAYSIA: 2 workers, path 3, Cameron Highlands, 11. iii. 2005 (2005c9) (*S. Hosoishi*); 3 workers, path 3, Cameron Highlands, 11. iii. 2005 (2005c14) (*S. Hosoishi*); 5 workers, path 3, Cameron Highlands, 13. iii. 2010 (SH10-Mal-83) (*S. Hosoishi*); 13 workers, St. 8, Gunung Berembun, Cameron Highlands, 15. vii. 2003 (Fogging) (*H. Kojima et al*).

***Crematogaster overbecki* Viehmeyer**
(Figs 2a, 4b, 9)

Crematogaster overbecki Viehmeyer, 1916: 123, fig. 3. Syntype worker from SINGAPORE (*H. Overbeck*). (NHMB) [examined]. Combination in *C.* (*Orthocrema*) by Emery, 1922: 132; in *C.* (*Mesocrema*) by Santschi, 1928: 33.

Measurements and indices. HW 0.63; HL 0.63; CI 100; SL 0.44; SI 70; EL 0.12; PW 0.4; WL 0.64; PSL 0.11; PtL 0.18; PtW 0.19; PtH 0.13; PpL 0.12; PpW 0.18; PtHI 72; PtWI 106; PpWI 150; WI 95 (One syntype worker measured).

General description of worker. Compound eyes slightly projecting from lateral margin of head. Scape reaching posterior corner of head, the scape with standing and appressed setae.

Pronotal shoulders developed as ridges. Mesonotal dorsum highly convex in lateral view. Metanotal groove concave. Propodeal spines longer than the diameter of propodeal spiracles, curved upward. Anterior margin of metapleural gland bulla not reaching anterior margin of propodeal spiracle.

Petiole in dorsal view rectangular with angular corners. Subpetiolar process weakly developed, angulate. Postpetiole bilobed behind, but without distinct longitudinal median sulcus.

Dorsal surface of head generally smooth, but the malar region with longitudinal rugulae. Clypeus with two distinct pairs of rugulae laterally. The rugulae connecting the anterior and posteror clypeal margins. Dorsal face of promesonotum with relatively open, reticulate sculpture with shiny interspaces. Lateral surface of pronotum generally smooth and shining, but some longitudinal rugulae extending from the anterior portion of pronotum.

Mesopleuron smooth, but lower portion of mesopleuron weakly sculptured. Longitudinal rugulae developed on the front and behind the metanotal groove in lateral view. Some rugulae on the mesonotum extending to the anterior portion of propodeal dorsum.

Fourth abdominal tergite with abundant appressed setae, and sparse standing setae.

Distribution. This species is known only from the type locality in Singapore.

Remarks. This species is similar to *C. brevis*, but can be distinguished by lacking median rugula on the clypeus, and by the distinctive sculpture of the mesonotal dorsum.

Crematogaster treubi Emery

(Figs 1a, 3b, 5c, 10)

Crematogaster treubi Emery, 1896: 246. LECTOTYPE worker (MCSN worker) (by present designation) and two paralectotype workers from INDONESIA: Java (*M. Massart*) (MHNG) [examined]. Combination in *C.* (*Orthocrema*) by Emery, 1922: 132; in *C.* (*Mesocrema*) by Santschi, 1937: 310. Senior synonym of *sic* by Emery, 1922: 132.

Crematogaster millardi Forel, 1902: 205. LECTOTYPE worker (by present designation) and one paralectotype worker from MYANMAR: Moulmain (*Hodgson*) (MHNG) [examined]. Description of queen by Viehmeyer, 1916: 125. Combination in *C.* (*Orthocrema*) by Emery, 1922: 132; in *C.* (*Mesocrema*) by Santschi, 1928: 33. **Syn. nov.**

Crematogaster treubi var. *vastatrix* Forel, 1911a: 24. LECTOTYPE worker (top specimen of three on one pin, MHNG worker) (by present designation) and seven paralectotype workers from INDONESIA: Java (*Roepke*) (MHNG, NHMB) [examined]. Combination in *C.* (*Orthocrema*) by Emery, 1922: 132; in *C.* (*Acrocoelia*) by Santschi, 1928: 34. **Syn. nov.**

Measurements and indices. HW 0.51-0.74; HL 0.52-0.71; CI 94-104; SL 0.34-0.51; SI 65-74; EL 0.1-0.15; PW 0.28-0.44; WL 0.57-0.81; PSL 0.04-0.1; PtL 0.15-0.22; PtW 0.16-0.22; PtH 0.1-0.14; PpL 0.1-0.15; PpW 0.15-0.19; PtHI 55-78; PtWI 91-111; PpWI 113-150; WI 81-100 (Seventeen workers measured).

General description of worker. Workers monomorphic.

Compound eyes not projecting from lateral margin of head, the outer margin of eye almost flush with head capsule in full face view. Scape not reaching posterior corner of head, the scape with standing setae.

Anterior margin of pronotal collar almost straight or slightly concave in dorsal view. Metanotal groove shallow. Propodeal spines long and slender, their length longer than the diameter of propodeal spiracles. Anterior margin of metapleural gland bulla reaching or exceeding anterior margin of propodeal spiracle.

Petiole in dorsal view broader anteriorly than posteriorly. Postpetiole weakly bilobed, without distinct longitudinal median sulcus. Subpetiolar and subpostpetiolar processes undeveloped.

Clypeus relatively smooth and shining, but with feeble rugulae. Dorsal face of mesosoma almost smooth and shining. Dorsolateral face of pronotum smooth in dorsal view. Lateral surface of pronotum smooth and shining. Lateral surface of mesonotum with rugulae. Mesopleuron relatively smooth and shining, but the anterodorsal and lower portions weakly sculptured. Longitudinal rugulae developed anteriorly and posteriorly of the metanotal groove in lateral view.

Dorsal face of head, clypeus and mesosoma with abundant standing setae. Fourth abdominal tergite with sparse standing setae.

Distribution. This species is widely distributed, occurring in Cambodia, Thailand, Myanmar, Malaysia (Peninsula and Borneo), Brunei, and Indonesia (Kalimantan, Java, Bali, Sunda Strait, Sulawesi).

Remarks. This species is similar to *C. kojimai*, but can be distinguished by the long and slender propodeal spines.

Slight morphological variations are found not only in the specimens collected from different localities, but also within nest series collections. Some specimens collected in Bali have shorter propodeal spines in contrast to the usual long and slender spines. The mesopleuron is relatively smooth and shining in most specimens, but especially shining in Sepilok specimens or somewhat shagreened in Pulau Sebeku specimens. These variants are treated as intraspecific variation within *C. treubi* until molecular data are available.

Specimens examined. CAMBODIA: 5 workers, Rubber Plantation, Kampong Cham, 2. v. 2010 (SH10-Cam-118) (*S. Hosoishi*); 5 workers, Community Forest, Kampong Chnang, 21. iv. 2010 (SH10-Cam-85) (*S. Hosoishi*); 3 workers, Natural Forest (Permanental sample plots), Kampong Thom, 20. xi. 2010 (SH10-Cam-42) (*S. Hosoishi*); 2 workers, Natural Forest, Kampong Thom, 20. xi. 2010 (SH10-Cam-152) (*S. Hosoishi*); THAILAND: 6 workers, Maegar, Phayao, 22. iii. 1990 (no collector's name); 6 workers, Ngao, Lampang, 17. ii. 1991 (no collector's name);

11 workers, Maegar Seed Orch., Phayao, Lampang Province, 16. iii. 1991 (*T. Goto*); 6 workers, Maeklong Watershed, Research Station, Kanchanaburi Prov., W. Thailand, 29. xi. 2003 (TH03-SKY-146) (*Sk. Yamane*); 4 workers, Khao Soi Dao W. S., Chanthaburi Prov., E. Thailand, 19. vii. 1997 (*Sk. Yamane*); MALAYSIA: 12 workers, 7 miles, Cameron Highlands, 9. iii. 2005 (2005c3) (*S. Hosoishi*); 3 workers, 7 miles, Cameron Highlands, 12. iii. 2005 (2005c24) (*S. Hosoishi*); 14 workers, Ulu Gombak, Selangor, 28. xi. 2005 (SH05-Mal-10) (*S. Hosoishi*); 8 workers, Ulu Gombak, Selangor, 7. iii. 2009 (SH05-Mal-29) (*S. Hosoishi*); 5 workers, 7 miles, Cameron Highlands, 9. iii. 2010 (SH10-Mal-15) (*S. Hosoishi*); 4 workers, 7 miles, Cameron Highlands, 9. iii. 2010 (SH10-Mal-01) (*S. Hosoishi*); 4 workers, 7 miles, Cameron Highlands, 9. iii. 2010 (SH10-Mal-02) (*S. Hosoishi*); 7 workers, Malaya Univ., Selangor, 4. iii. 2009 (SH09-Mal-08) (*S. Hosoishi*); 6 workers, Malaya Univ., Selangor, 4. iii. 2009 (SH09-Mal-05) (*S. Hosoishi*); 6 workers, Malaya Univ., Selangor, 4. iii. 2009 (SH09-Mal-06) (*S. Hosoishi*); 4 workers, Sepilok, Sandakan, Sabah, 17. viii. 1981 (*K. Masuko*); 1 worker, Kota Kinabalu, Sabah, Borneo, E. Malaysia, 22. vii. 1996 (*K. Eguchi*); 2 workers, Tower Region, Lambir N. P., Miri, Sarawak (T-1-9) 30. i. 1993 (Canopy Ecology) (*Sk. Yamane*); 6 workers, Poring HQ (ca 600m alt), Sabah, Borneo, E. Malaysia, 10. iii. 2008 (tree decayed part) (SB08-SKY-01) (*Sk. Yamane*); 1 worker, P. Manukan, T. Tunku Abd., Rahman, Sabah, Borneo, 21. iii. 1995 (*Sk. Yamane*); 1 worker, Poring, Kinabalu (nr HQ, 550m alt), Sabah, Borneo, E. Malaysia, 16. iii. 1995 (*Sk. Yamane*); 2 workers, Pulau Sapi, T. Tunku Abd., Rahman, Sabah, Borneo, 12. iii. 1995 (*Sk. Yamane*); SINGAPORE: 4 workers, 4. xii. 1995 (*Sk. Yamane*); BRUNEI: 2 workers, Tasek Merimbun, 11. ii. 1999 (Eg09-BOR-010) (*K. Eguchi*); INDONESIA: 2 workers, Teluk Kabah, Kutai N. P., E. Kalimantan, 17. ix. 1993 (*Sk. Yamane*); 1 worker, Kutai National Park (near Km9), E. Kalimantan, 7. viii. 1992 (*Sk. Yamane*); 1 worker, Sangkimah, Kutai National Park, E. Kalimantan, 11. ix. 1993 (Canopy Ecology) (*Sk. Yamane*); 1 worker, Samarinda, E. Kalimantan, 9-12. viii. 1992 (*Sk. Yamane*); 2 workers, Jasinga, nr Bogor, W. Java, 5. xi. 1985 (*Sk. Yamane*); 2 workers, Campus of Gajah Mada Univ. (100m alt), Yogyakarta, C. Java, 29. xii. 2002 (JV02/03-SKY-31) (*Sk. Yamane*); 7 workers, Pesanggaran (0 m), Bali, 5. x. 2000 (*K. Ogata*); 7 workers, Pesanggaran (0 m), Bali, 5. x. 2000 (*J. Abe*); 3 workers, Pesanggaran (0 m), Bali, 5. x. 2000 (*H. Simbolon*); 2 workers, Pulau Sebesi, Lampung Prov., Sunda Strait, 11. viii. 2005 (RK05-SKY-01) (*Sk. Yamane*); 4 workers, Pulau Sebesi, Lampung Prov., Sunda Strait, 14. viii. 2005 (RK05-SKY-56) (*Sk. Yamane*); 6 workers, Gn. Makaroewa (550m alt), Kab. Maros, S. Sulawesi, 24. i. 2010 (CE10-SKY-34) (*Sk. Yamane*); 2 workers, Benteng, Pulau Togian, Sulawesi, 25. viii. 2008 (*Sk. Yamane*).

Crematogaster treubi apilis Forel

Crematogaster treubi r. *apilis* Forel, 1913: 195. worker from TAIWAN: Pilam (*Stück*) (types not found in MHNG) [not seen]. Combination in *C.* (*Orthocrema*) by Emery, 1922: 132.

Remarks. We have not been able to examine type-material of *C. treubi apilis*. From the original description, this subspecies belongs to the *C. treubi* group. Forel (1913) described the following features: (1) scape exceeding posterior corner of head by two times of the width of the scape; (2) the metanotal groove deep. The first feature is not found in the other species of the *C. treubi* group. It is impossible to judge the depth of the metanotal groove from the original description. The taxonomic status of this subspecies will remain uncertain until the type-material can be examined.

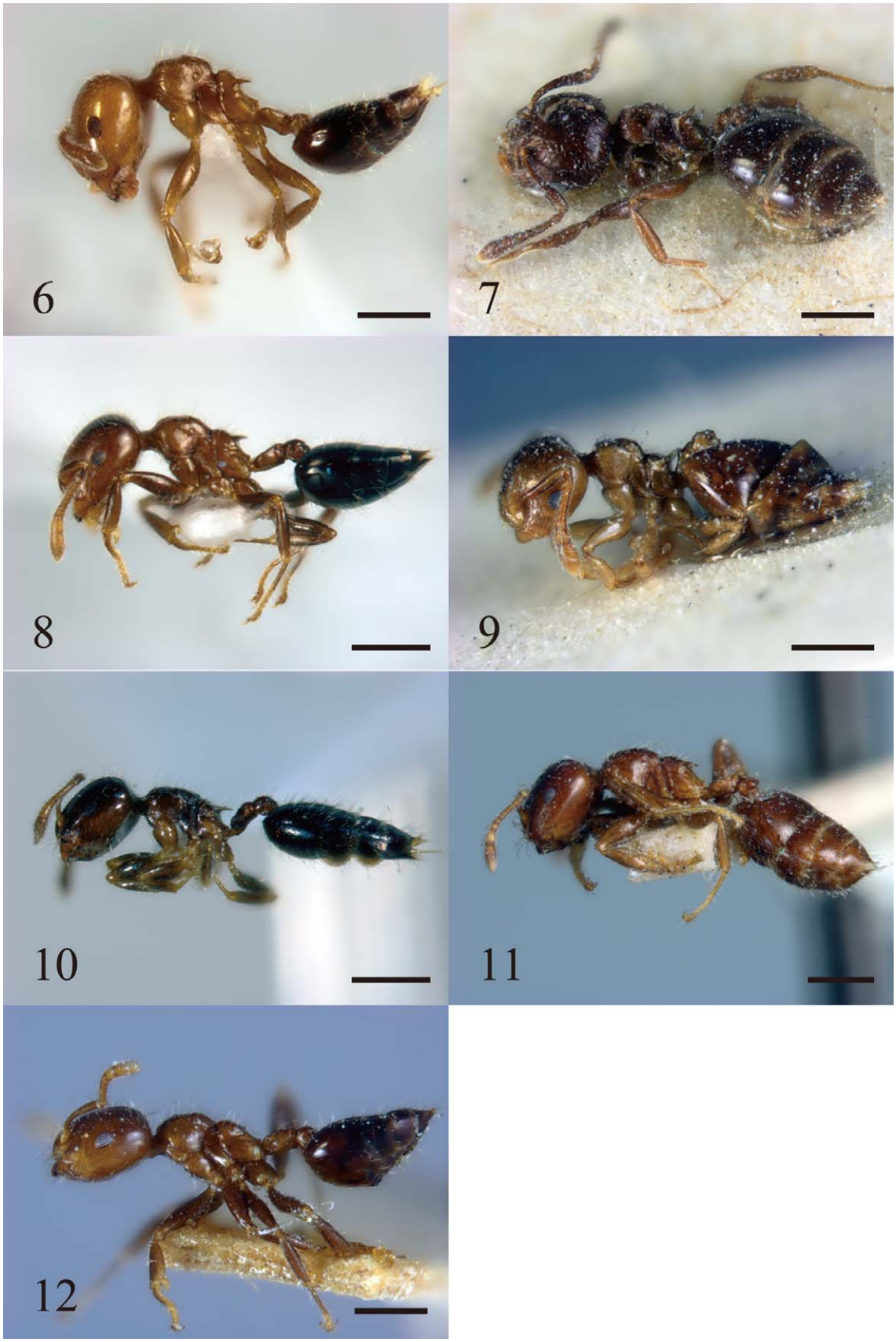
Crematogaster walshi Forel

(Figs 3c, 11)

Crematogaster walshi Forel, 1902: 205. LECTOTYPE worker (top specimen of three on one pin, MHNG worker) (by present designation) and five paralectotype workers from INDIA: Pooree, Bengale [Puri, Bengal] (*Walsh*) (MHNG, NHMB) [examined]. Combination in *C.* (*Orthocrema*) by Emery, 1922: 132; in *C.* (*Mesocrema*) by Santschi, 1928: 33.

Measurements and indices. HW 0.72-0.93; HL 0.76-0.92; CI 93-103; SL 0.49-0.58; SI 62-69; EL 0.13-0.17; PW 0.42-0.53; WL 0.83-1.03; PSL 0.04-0.08; PtL 0.21-0.27; PtW 0.21-0.27; PtH 0.13-0.17; PpL 0.13-0.18; PpW 0.2-0.26; PtHI 59-68; PtWI 93-105; PpWI 139-162; WI 87-100 (Lectotype and five paralectotype workers measured).

General description of worker. Workers monomorphic.



FIGURES 6–12. Asian species of the *Crematogater brevis* complex in lateral view. Scale bars are all 0.5mm. 6, *Crematogaster bouvardi* [Doi Suthep, Chiang Mai, North Thailand]; 7, *C. brevis* [Bogor, Java]; 8, *C. kojimai* [path 3, Cameron Highlands, Malay Peninsula]; 9, *C. overbecki* [Singapore]; 10, *C. treubi* [7 miles, Cameron Highlands, Malay Peninsula]; 11, *C. walshi* [Puri, Bengal]; 12, *C. yappi* [Gunung Inas, Kedah].

Compound eyes not projecting from lateral margin of head, the outer margin of eye almost flush with head capsule in full face view. Scape not reaching posterior corner of head, the scape with standing setae.

Anterior margin of pronotal collar almost straight or slightly convex in dorsal view. Metanotal groove concave in lateral view. Propodeal spines developed, but their length variable. Anterior margin of metapleural gland bulla exceeding anterior margin of propodeal spiracle.

Petiole in dorsal view broader anteriorly than posteriorly in smaller workers, broader at middle portion in larger workers. Postpetiole strongly bilobed behind without a distinct longitudinal median sulcus. Subpetiolar and subpostpetiolar processes undeveloped.

Clypeus relatively smooth, but with feeble rugulae. Dorsal face of mesosoma almost smooth and shining. Dorsolateral face of pronotum smooth in dorsal view. Lateral surface of pronotum smooth and shining. Mesopleuron weakly sculptured, but the higher portion with longitudinal rugulae in lateral view.

Dorsal face of head, clypeus and mesosoma with abundant standing setae. Fourth abdominal tergite with sparse standing setae.

Distribution. This species is known only from the type locality in India.

Remarks. This species is distinct in having the strongly bilobed postpetiole.

Crematogaster yappi Forel

(Fig 12)

Crematogaster yappi Forel, 1901: 374. LECTOTYPE worker (bottom specimen of three on one pin, MHNG worker) (by present designation) and five paralectotype workers from MALAYSIA: Gunung Inas, Kedah (*M. R. H. Yapp*) (MHNG, NHMB) [examined]. Combination in *C.* (*Acrocoelia*) by Emery, 1922: 152.

Measurements and indices. HW 0.65-0.74; HL 0.66-0.75; CI 94-105; SL 0.48-0.54; SI 70-77; EL 0.11-0.15; PW 0.34-0.4; WL 0.71-0.81; PSL 0; PtL 0.18-0.22; PtW 0.21-0.24; PtH 0.12-0.15; PpL 0.12-0.14; PpW 0.17-0.2; PtHI 67-74; PtWI 105-111; PpWI 129-167; WI 77-90 (Lectotype and five paralectotype workers measured).

General description of worker. Compound eyes slightly projecting from lateral margin of head. Scape reaching posterior corner of head, the scape with standing setae.

Anterior margin of pronotal collar almost straight in dorsal view. Metanotal groove concave in lateral view. Propodeal spines undeveloped. Anterior margin of metapleural gland bulla almost reaching anterior margin of propodeal spiracle.

Petiole in dorsal view broader anteriorly than posteriorly. Postpetiole weakly bilobed, but without a distinct longitudinal median sulcus. Subpetiolar and subpostpetiolar processes undeveloped.

Dorsal surface of head generally smooth and shining, but the lower portion near clypeal margin with longitudinal rugulae. Clypeus relatively smooth, but with feeble rugulae. Dorsal face of mesosoma almost smooth and shining. Dorsolateral face of pronotum smooth in dorsal view. Lateral surface of pronotum smooth and shining. Mesopleuron relatively smooth, but with feeble rugulae on the higher portion.

Fourth abdominal tergite with sparse standing setae.

Distribution. This species is known only from the type locality in Malaysia (Peninsula).

Remarks. This species can be easily distinguished from other species of the *C. brevis* complex found in Asia by its undeveloped propodeal spines.

Species excluded from the subgenus *Mesocrema* in Asia

Crematogaster (*Crematogaster*) *jacobsoni* Forel

Crematogaster jacobsoni Forel, 1911b: 201. Three syntype workers from INDONESIA: Semarang, Java (MHNG) and one syntype worker (NHMB) [examined]. Combination in *C.* (*Orthocrema*) by Emery, 1922: 132; in *C.* (*Acrocoelia*) by Santschi, 1928: 34; in *C.* (*Mesocrema*) by Santschi, 1937: 310.

Remarks. Examination of syntype workers in MHNG and NHMB reveals that *C. jacobsoni* is not similar to the *C. brevis* group or *C. treubi* group in Asia. Characteristic features include: occipital carinae developed; petiole weakly broader anteriorly, but without angular corners; postpetiole weakly bilobed with longitudinal median sulcus.

This species is similar to *C.* (*C.*) *semperi* Emery, 1893 or *C.* (*C.*) *simoni* Emery, 1893. We hereby transfer *C. jacobsoni* to the subgenus *Crematogaster*, to compare it with closely related species in this group in the future.

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