

An evaluation of infraspecific names in *Crematogaster* (*Paracrema*) *modiglianii* EMERY, 1900 based on nest series (Hymenoptera: Formicidae)

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Abstract

The infraspecific names in *Crematogaster* (*Paracrema*) *modiglianii* EMERY, 1900 are revised on the basis of nest series samples. Those forms are represented by a single species, *C. modiglianii*. *Crematogaster* (*Paracrema*) *modiglianii* var. *anamita* SANTSCHI, 1925, *C. (P.) modiglianii* var. *anoemica* SANTSCHI, 1925, *C. modiglianii* var. *clemensae* FOREL, 1910, *C. modiglianii* var. *sarawakana* FOREL, 1911 and *C. (P.) modiglianii* var. *surbeki* SANTSCHI, 1925 are synonymized under *Crematogaster modiglianii*. Nest series samples indicate that these infraspecific names represent morphological variation with weak geographical clines.

Key words: Formicidae, *Crematogaster modiglianii*, *Paracrema*, geographic variation, clines, nest series sample, new synonymy.

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Introduction

Crematogaster (*Paracrema*) *modiglianii* EMERY, 1900 is very common in lowland rainforests in tropical Asia (EGUCHI & YAMANE 2003, JAITRONG & NABHITABHATA 2005). The workers are easily distinguished from other Asian *Crematogaster* species by a combination of 4-segmented antennal club and strongly sculptured head and mesosoma. The ants are arboreal, and nest under the bark of trees or in relatively large tree hollows in a close association with *Camponotus* (*Myrmotarsus*) species (MENZEL & al. 2008).

Crematogaster modiglianii was described from Mentawai Islands, Indonesia, based on the worker caste. Five infraspecific taxa have been described under *C. (P.) modiglianii*, i.e., the nominotypical taxon, *C. modiglianii* var. *anamita* SANTSCHI, 1925 (type locality: Myanmar), *C. modiglianii* var. *anoemica* SANTSCHI, 1925 (Myanmar), *C. modiglianii* var. *clemensae* FOREL, 1910 (Philippines), *C. modiglianii* var. *surbeki* SANTSCHI, 1925 (Sumatra), and *C. modiglianii* var. *sarawakana* FOREL, 1911 (Borneo).

Those infraspecific forms are widely distributed from continental Southeast Asia, Malay Peninsula, Borneo, Sumatra, to the Philippines. They show great morphological variation geographically, causing considerable confusion in the taxonomy of this species. This variation is one of the most confusing ones among Asian *Crematogaster* species. Geographic variation has been studied in some ant species (e.g., *Tetraponera* spp. by WARD 2001), but analysis of clines involved in geographical variation has been made in limited cases (*Solenopsis saevissima* (F. SMITH, 1855) complex by WILSON 1952, *Pogonomyrmex occidentalis* (CRESSON, 1865) complex by SHATTUCK 1987). Here, we report a case of clines found in *Crematogaster modiglianii*.

Although recent studies have treated *Crematogaster modiglianii* as representing just a single species (EGUCHI & YAMANE 2003, JAITRONG & NABHITABHATA 2005, MENZEL & al. 2008, 2009), no revisional studies have been carried out. We follow the biological species concept (MAYR 1942) in delineating species boundaries. The present paper aims to revise the status of the infraspecific taxa of the *C. modiglianii* based on nest series samples. Such samples can reveal morphological continuities within conspecific taxa.

In this paper, we follow the traditional subgeneric classification temporarily for taxonomic practice avoiding excessive synonyms. The subgenus *Paracrema* is easily distinguished from other *Crematogaster* species, but its monophyly is currently dubious because no distinct synapomorphies are indicated.

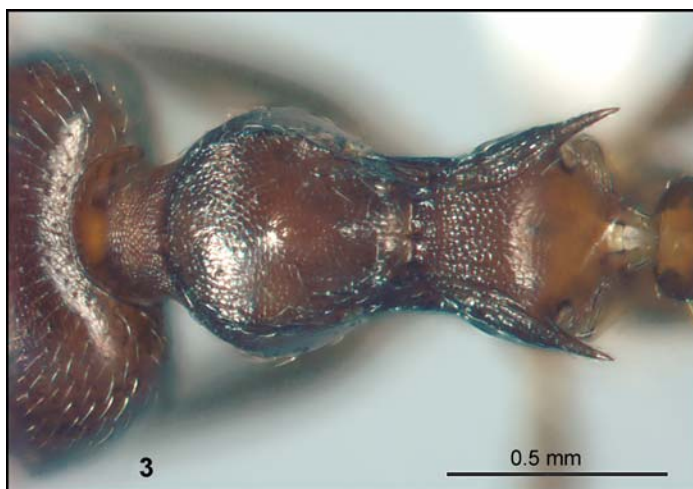
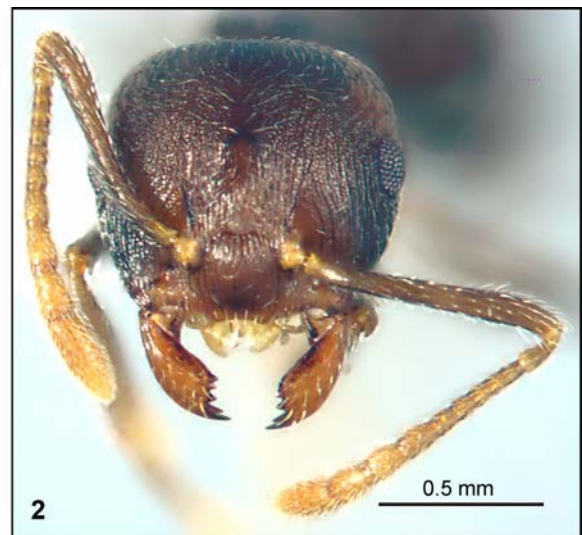
Materials and methods

Sources of material: Type specimens were examined in the collections listed below. Codes for public institutions follow those in BRANDÃO (2000). Nest series samples, most of which were recently collected, are represented as colony codes, e.g., "SH05-Mal-5."

MCSN Museo Civico di Storia Naturale "Giacomo Doria," Genoa, Italy

MHNG Muséum d'Histoire Naturelle, Geneva, Switzerland
NHMB Naturhistorisches Museum, Basel, Switzerland

Observation: Most observations were made on a Nikon SZX12 stereomicroscope. To avoid glare and light reflections, a sheet of tracing paper was used to disperse light. Images (Figs. 1-7) were taken using an Olympus DP25 digital camera and processed using Helicon Focus 4.47.1 Pro.



Figs. 1 - 3: *Crematogaster (Paracrema) modiglianii*. (1) Body in lateral view; (2) full face view of head; (3) dorsal view of mesosoma. [UKM Forest, Selangor, Malaysia].

Measurements and indices: Measurements were made under the stereomicroscope using micrometers. They are presented in millimeters, to the second decimal place. We normally measure three worker specimens (small, medium and large workers) in the taxonomic studies of *Crematogaster* ants, but in this study, we measured as many specimens from nest series samples as possible to discuss infraspecific variation. The measurements for petiole and postpetiole follow LONGINO (2003).

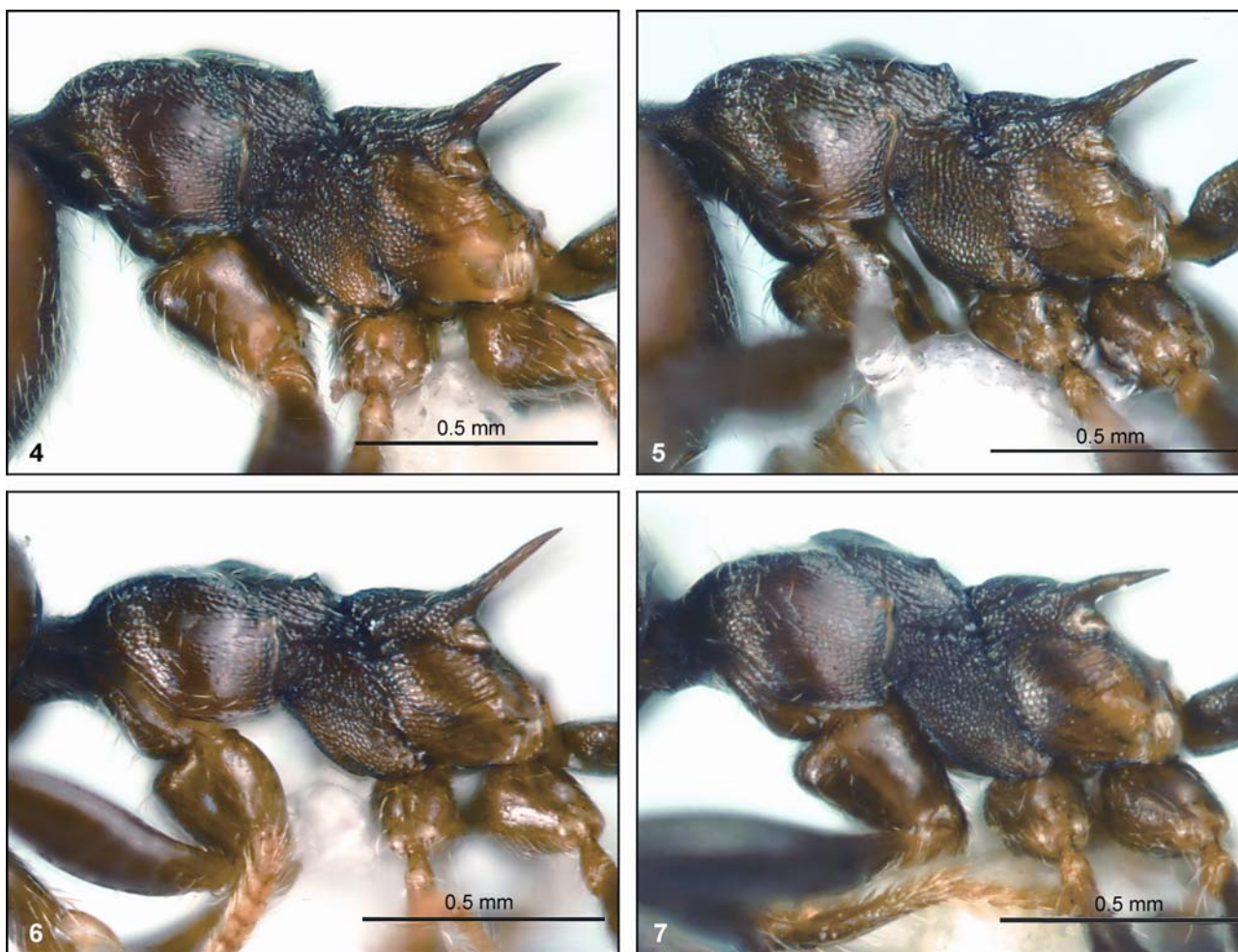
- CI Cephalic Index: $HW / HL \times 100$.
- EL Eye Length: Maximum length of compound eye.
- HL Head Length: Perpendicular distance from vertex margin to line tangent to anteriormost projection of clypeus in full-face view.
- HW Head Width: Maximum width of head in full-face view, excluding eyes.
- PpL Postpetiole Length: Length of postpetiole in lateral view (see LONGINO 2003: fig. 2).
- PpW Postpetiole Width: Maximum width of postpetiole in dorsal view, excluding helcium.
- PpWI Postpetiole Width Index: $PpW / PpL \times 100$.
- PSL Propodeal Spine Length: Measured from tip of propodeal spine to closest point on outer rim of propodeal spiracle.
- PtH Petiole Height: Height of petiole in lateral view (see LONGINO 2003: fig. 2).

- PtHI Petiole Height Index: $PtH / PtL \times 100$.
- PtL Petiole Length: Length of petiole in lateral view (see LONGINO 2003: fig. 2).
- PtW Petiole Width: Maximum width of petiole in dorsal view.
- PtWI Petiole Width Index: $PtW / PtL \times 100$.
- PW Pronotal Width: Maximum width of pronotum in dorsal view.
- SI Scape Index: $SL / HW \times 100$.
- SL Scape Length: Length of first antennal segment, excluding neck and basal condyle.
- WI Waist Index: $PpW / PtW \times 100$.
- WL Weber's Length of mesosoma: Diagonal length, measured in lateral view from anterior margin of pronotum (excluding collar) to posterior extremity of propodeal lobe.

Geographic variation

Our material comprises collections from several localities, almost covering the whole range of *Crematogaster modiglianii*. These collections revealed that intraspecific variation is found in the depth of the metanotal groove in lateral view, and in the shape and length of the propodeal spines (Figs. 4 - 7).

The depth of the metanotal groove in lateral view showed geographical variation. Specimens from the Indochinese



Figs. 4 - 7: Mesosoma of *Crematogaster (Paracrema) modiglianii* in lateral view. (4) Specimen from Middle Vietnam (Na Xan, Que Phong Distr., Nghe An Prov.); (5) specimen from Southern Thailand (Khao Nam Kang National Park, Songkhla Prov.); (6) specimen from Borneo (Lambir N. P., Miri, Sarawak); (7) specimen from Sumatra (Pinang-pinang, Ulu Gadut, Padang).

Peninsula and Sumatra had distinctly concave grooves (Figs. 4, 7), while those from the Malay Peninsula had shallow ones (Fig. 5). However, specimens from Borneo had both distinctly concave grooves and shallow ones (Fig. 6). In specimens with the shallow groove, a ridge connecting the mesonotum and propodeum in dorso-lateral portion was found.

The shape and length of the propodeal spines were difficult to quantify. A weak geographic cline was found among the following specimens. Specimens from Vietnam and Laos had thick and down-curved propodeal spines (Fig. 4). Specimens from the Malay Peninsula had thick and straight ones (Fig. 5). Specimens from Borneo had slender and straight ones (Fig. 6). On the other hand, specimens from Sumatra had two types of spines, i.e., thick and straight ones and down-curved ones (Fig. 7). The nest series samples revealed a north-south clinal variation in the shape of the propodeal spines (Fig. 8).

Those geographic races are treated as conspecific with *Crematogaster (Paracrema) modiglianii* until molecular data are available (cf. MOREAU 2009, SEIFERT 2009, BERNASCONI & al. 2010).

Taxonomy

Crematogaster (Paracrema) modiglianii EMERY, 1900 (Figs. 1 - 7)

Crematogaster modiglianii EMERY, 1900: 68. [Combination in *C. (Paracrema)*: EMERY 1922: 156; SANTSCHI 1925: 90]. [Misspelled as *modigliani* by BINGHAM 1903]. *Crematogaster (Paracrema) modiglianii* var. *anamita* SANTSCHI, 1925: 90. [attributed to FOREL]. [*Crematogaster modiglianii* var. *annamita* FOREL, 1903: 680. Nomen nudum, attributed to EMERY]; **syn.n.**

Crematogaster (Paracrema) modiglianii var. *anoemica* SANTSCHI, 1925: 91; **syn.n.**

Crematogaster modiglianii var. *clemensae* FOREL, 1910: 125. [Combination in *C. (Paracrema)*: EMERY 1922: 156]; **syn.n.**

Crematogaster modiglianii var. *sarawakana* FOREL, 1911: 25. [Combination in *C. (Paracrema)*: EMERY 1922: 156]; **syn.n.**

Crematogaster (Paracrema) modiglianii var. *surbeki* SANTSCHI, 1925: 90; **syn.n.**

Type material examined: *Crematogaster modiglianii* EMERY, 1900: 688, 2 syntype workers from Indonesia: Mentawai Islands, Sipora Island, Sioban [2° 10' N, 99° 41' E], leg. Modigliani (MCSN).

Crematogaster (Paracrema) modiglianii var. *anamita* SANTSCHI, 1925: 90, 1 syntype worker from Myanmar: Mawlamyine [16° 29' N, 97° 37' E], leg. Hodges (NHMB).

Crematogaster (Paracrema) modiglianii var. *anoemica* SANTSCHI, 1925: 91, 1 syntype worker from Myanmar, leg. Bingham (NHMB).

Crematogaster modiglianii var. *clemensae* FOREL, 1910: 125, 4 syntype workers from Philippines: Mindanao, Camp Keithley [Lanao Del Sur Province, Marawi, 8° 0' N, 124° 17' E], leg. M.S. Clemens (NHMB, MHNG).

Crematogaster modiglianii var. *sarawakana* FOREL, 1911: 25, 5 syntype workers from Malaysia: Borneo, Sarawak, leg. Haviland (NHMB, MHNG).

Crematogaster (Paracrema) modiglianii var. *surbeki* SANTSCHI, 1925: 90, 6 syntype workers from Indonesia: Sumatra, Labouan Bilik, leg. V. Surbek (NHMB).

Additional specimens examined: **Vietnam:** 2 workers, Middle Vietnam, Nghe An Prov., Que Phong Distr., Na Xan, 500 m a.s.l. [19° 36' N, 104° 55' E], 14.IV.1999, leg. T.V. Bui; **Laos:** 2 workers, Viang Chan Prov., Vang Vieang [18° 54' N, 102° 22' E], no date, no collector's name. **Cambodia:** 5 workers, Kampong Thom, Permanent Sample Plots [12° 45' N, 105° 01' E], 8.I.2010 (SH10-Cam-01), leg. S. Hosoiishi. **Thailand:** 4 workers, South Thailand, Songkhla Prov., Khao Nam Kang National Park [6° 34' N, 100° 34' E], 25.VII.1997, leg. Sk. Yamane. **Malaysia:** 1 worker, Malay Pen., Ulu Gombak [3° 20' N, 101° 40' E], 12.XII.1992 (leg. K. Tomiyama); 2 workers, Malay Pen., Selangor Prov., Ulu Gombak, ca. 250 m a.s.l. [3° 20' N, 101° 40' E], 5.VII.1999 (MA99-SKY-02), leg. Sk. Yamane; 2 workers, Selangor, Ulu Gombak [3° 20' N, 101° 40' E], 7.VI.2006 (SH06-Mal-5), leg. S. Hosoiishi; 8 workers, Cameron Highland, 7 miles [4° 32' N, 101° 14' E], 9.III.2005 (2005c1), leg. S. Hosoiishi; 5 workers, Cameron Highland, 7 miles [4° 32' N, 101° 14' E], 12.III.2005 (2005c21), leg. S. Hosoiishi; 5 workers, Cameron Highland, 7 miles [4° 32' N, 101° 14' E], 12.III.2005 (2005c23), leg. S. Hosoiishi; 3 workers, Selangor, Bangi, UKM Forest [2° 55' N, 101° 46' E], 16.III.2005 (2005c42), leg. S. Hosoiishi; 4 workers, Sarawak, Miri, Lambir N. P., Head Quarter R. [4° 12' N, 114° 2' E], 15-17.VIII.1995, leg. Sk. Yamane; 3 workers, Borneo, Sarawak, Miri, Lambir N. P., Bt. Pantu [4° 12' N, 114° 2' E], 2.I.1998, leg. F. Yamane; 3 workers, Borneo, Sarawak, Miri, Lambir N. P. [4° 12' N, 114° 2' E], 31.XII.1997 (SR97-MA-02), leg. Sk. Yamane; 6 workers, East Malaysia, Sarawak, Lambir N. P., 8 ha Plot [4° 12' N, 114° 2' E], 30.VI.2004, leg. Sk. Yamane; 2 workers, Borneo, Sarawak, Kuching, Kubah N. P. [1° 41' N, 110° 14' E], 28.XII.1997, leg. F. Yamane; 4 workers, East Malaysia, Borneo, Sabah, Tawau Hills N. P., HQ [4° 28' N, 117° 55' E], 9.VII.1996 (SB96-SKY-20), leg. Sk. Yamane; 1 worker, Sarawak, Bako Nat. Park [1° 43' N, 110° 28' E], 12.VI.1985, leg. Imai & al.; 3 workers, Sabah, Sandakan, Sepilok, Forest Res. Cen. [5° 51' N, 117° 58' E], 13.VIII.1981, leg. K. Masuko. **Brunei:** 2 workers, Tasek Merimbun [4° 35' N, 114° 40' E], 14.II.1999 (Eg99-BOR-097), leg. K. Eguchi. **Indonesia:** 1 worker, West Sumatra, Ulu Gadut nr Padang [0° 57' S, 100° 21' E], 27. - 30.VIII.1985 (Sumatra Nature Study – SNS Col.), leg. Sk. Yamane;

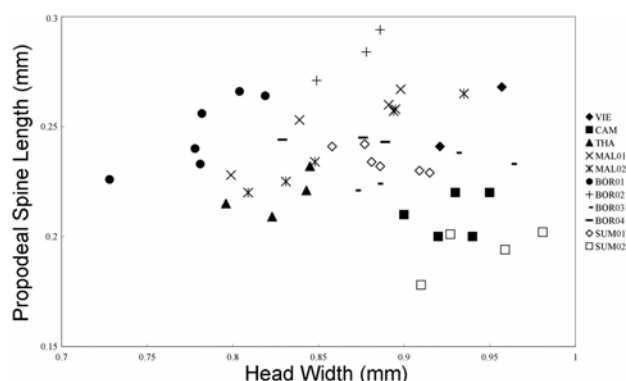


Fig. 8: Relationship of worker head width and propodeal spine length for *Crematogaster (Paracrema) modiglianii*. VIE, 2 specimens from Middle Vietnam; CAM, 5 nest series samples (SH10-Cam-01) from Cambodia; THA, 4 specimens from South Thailand; MAL01-02, 4 and 6 nest series samples (2005c1; SH09-Mal-41) from Malay Peninsula; BOR01-04, 6 specimens, 3 nest series samples (SR97-MA-02), 4 nest series samples (SB96-SKY-20) and 3 specimens from Borneo; SUM01-02, 6 and 4 nest series samples (SU02-SKY-138; SU04-SKY-37) from Sumatra.

4 workers, West Sumatra, Padang, Ulu Gadut, Pinangpinang, ca. 500 m a.s.l. [0° 57' S, 100° 21' E], 11.II.2004 (SU04-SKY-37), leg. Sk. Yamane; 7 workers, North Sumatra, Pulau Nias (Lotu), lowland [1° 4' N, 97° 31' E], 22.VIII.2002 (SU02-SKY-129), leg. Sk. Yamane; 6 workers, North Sumatra, Pulau Nias (Lotu), lowland [1° 4' N, 97° 31' E], 22.VIII.2002 (SU02-SKY-138), leg. Sk. Yamane.

Measurements and indices: HW 0.73 - 0.98; HL 0.70 - 0.93; CI 103 - 109; SL 0.70 - 0.88; SI 80 - 94; EL 0.15 - 0.20; PW 0.43 - 0.54; WL 0.85 - 1.11; PSL 0.18 - 0.29; PtL 0.24 - 0.30; PtW 0.21 - 0.27; PtH 0.11 - 0.16; PpL 0.13 - 0.17; PpW 0.19 - 0.23; PtHI 40 - 57; PtWI 77 - 98; PpWI 133 - 163; WI 79 - 96 (47 workers measured).

Diagnosis: Workers distinguished from other Asian *Crematogaster* ants by 4-segmented antennal club, a distinct median longitudinal carina on the dorsal mesonotum, and sculptured head and mesosoma.

General description of worker: Weakly polymorphic in body size. Head slightly broader than long, with straight to weakly concave posterior margin, roundly angular posterior corner and weakly convex lateral sides. Occipital carina developed but confined to posterior portion of head. Mandible striate, with five teeth; apical and subapical teeth large. Anterior margin of clypeus convex broadly produced and slightly impressed medially; anterolateral margins of clypeus processed anteriorly; posterior margin roundly produced between frontal lobes. Frontal carinae almost parallel. Antenna 11-segmented, with 4-segmented club; scape exceeding beyond posterolateral corner of head. Eye slightly projecting beyond lateral margin of head in full face view.

Pronotum and mesonotum almost fused without defined suture. Pronotal dorsum laterally margined with developed carinae. Mesothoracic spiracle reduced to form small pit dorsoventrally. Mesonotum in dorsal view with distinct median longitudinal carina, posterolaterally with small triangular process. Metanotal groove straight in dorsal view, deep, forming a concave region between mesonotum and

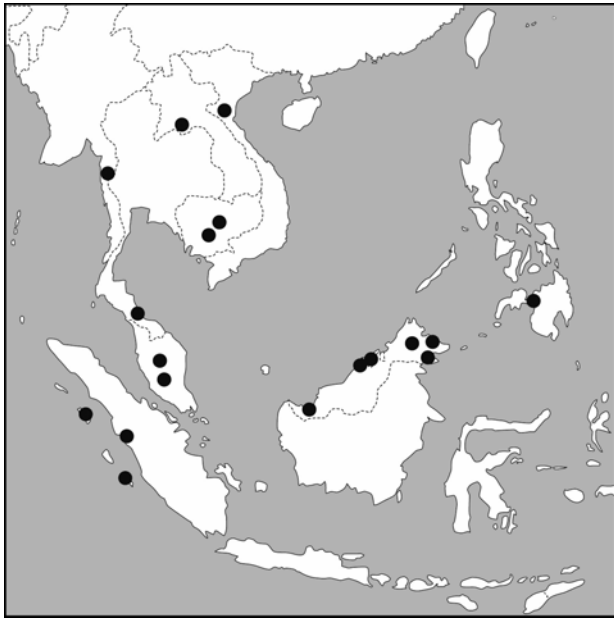


Fig. 9: Distribution map of *Crematogaster (Paracrema) modiglianii* specimens examined during this study.

propodeum. In dorsal view, lateral longitudinal ridges sometimes connecting mesonotum and propodeum. Metapleural gland opening slit-shaped. Propodeal spiracles facing posterolaterally. Propodeal spines developed, diverging apicad.

Petiole as long as broad or slightly longer than broad, flattened without node nor subpetiolar process; spiracle situated anteriorly, in profile low in position. Postpetiole higher and shorter than petiole without distinct longitudinal median sulcus, weakly incised medially on posterior margin; spiracles located near anterior margin of lateral face.

Head almost entirely microsculptured, with mainly longitudinal carinae (sculpturation in smaller workers tend to be weaker). Clypeus densely with longitudinal striae. Promesonotum entirely covered with small punctures. Lateral face of pronotum rather weakly to moderately punctuated, often smooth and shining in central portion. Propleuron moderately punctuated. Mesopleuron and propodeal dorsum densely punctuated with longitudinal rugulae. Posterior face of propodeum much superficially punctate and shining. Petiole and postpetiole also extensively punctate, but punctation on dorsum of petiole very weak.

Standing pilosity sparse. Dorsal face of head with some pairs of long erect setae, in addition shorter and densely decumbent hairs; venter of head often with standing hairs. Clypeus with some standing setae. Erect setae sometimes present on pronotal dorsum. Fourth abdominal tergite with appressed short hairs.

Body brown to dark reddish brown, with gaster often darker.

Distribution: This is a wide-ranging species found from Myanmar, Thailand, Laos, Cambodia, Vietnam, Malaysia (Peninsula and Borneo), Brunei and Indonesia (Sumatra) to the Philippines (Fig. 9).

Remarks: This species is similar to *Crematogaster (Paracrema) coriaria* MAYR, 1872, but can be distinguished by the strongly sculptured head and mesosoma, and distinct median longitudinal carina on the mesonotum in dorsal view.

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Zusammenfassung

Die infraspezifischen Namen von *Crematogaster (Paracrema) modiglianii* EMERY, 1900 werden anhand von Nestserien revidiert. Diese Formen gehören zu einer Art, *C. modiglianii*. *Crematogaster (Paracrema) modiglianii* var. *anamita* SANTSCHI, 1925, *C. (P.) modiglianii* var. *anoemica* SANTSCHI, 1925, *C. modiglianii* var. *clemensae* FOREL, 1910, *C. modiglianii* var. *sarawakana* FOREL, 1911 und *C. (P.) modiglianii* var. *surbeki* SANTSCHI, 1925 werden unter *Crematogaster modiglianii* synonymisiert. Die Nestserien deuten an, dass diese infraspezifischen Namen morphologische Variationen mit schwachen geographischen Klinien repräsentieren.

References

- BERNASCONI, C., CHERIX, D., SEIFERT, B. & PAMILO, P. 2010: Molecular taxonomy of the *Formica rufa* group (red wood ants) (Hymenoptera: Formicidae): a new cryptic species in the Swiss Alps? – *Myrmecological News* 14: 37-47.
- BINGHAM, C.T. 1903: The fauna of British India, including Ceylon and Burma. Hymenoptera 2. Ants and Cuckoo-Wasps. – Taylor and Francis, London, 506 pp.
- BRANDÃO, C.R.F. 2000: Major regional and type collections of ants (Formicidae) of the World and sources for the identification of ant species. In: AGOSTI, D., MAJER, J.D., ALONSO, L.E. & SCHULTZ, T.R. (Eds.): *Ants: standard methods for measuring and monitoring biodiversity*. – Smithsonian Institution Press, Washington & London, pp. 172-185.
- EGUCHI, K. & YAMANE, Sk. 2003: Species diversity of ants (Hymenoptera, Formicidae) in a lowland rainforest, Northwestern Borneo. – *New Entomologist* 52 (1, 2): 49-59.
- EMERY, C. 1900: Formiche raccolte da Elio Modigliani in Sumatra, Engano e Mentawai. – *Annali del Museo Civico di Storia Naturale di Genova* (2) 20 [40]: 661-722.
- EMERY, C. 1922: Hymenoptera, Fam. Formicidae, subfam. Myrmicinae. – *Genera Insectorum Fasc.* 174B: 95-206.
- FOREL, A. 1903: Les formicides de l'Empire des Indes et de Ceylan. Part 10. – *Journal of the Bombay Natural History Society* 14: 679-715.
- FOREL, A. 1910: Fourmis des Philippines. – *Philippine Journal of Science* 5 (section D): 121-130.
- FOREL, A. 1911: Fourmis de Bornéo, Singapore, Ceylan, etc. récoltées par MM. Haviland, Green, Winkler, Will, Hose, Roepke et Waldo. – *Revue Suisse de Zoologie* 19: 23-62.
- JAITRONG, W. & NABHITABHATA, J. 2005: A list of known ant species of Thailand (Formicidae: Hymenoptera). – *The Thailand Natural History Museum Journal* 1(1): 9-54.

- LONGINO, J. 2003: The *Crematogaster* (Hymenoptera, Formicidae, Myrmicinae) of Costa Rica. – *Zootaxa* 151: 1-150.
- MAYR, E. 1942: Systematics and the origin of species. – Columbia University Press, New York, 334 pp.
- MENZEL, F., LINSSENMAIR, K.E. & BLÜTHGEN, N. 2008: Selective interspecific tolerance in tropical *Crematogaster-Camponotus* associations. – *Animal Behaviour* 75: 837-846.
- MENZEL, F., SCHMITT, T. & BLÜTHGEN, N. 2009: Intraspecific nestmate recognition in two parabiotic ant species: acquired recognition cues and low inter-colony discrimination. – *Insectes Sociaux* 56: 251-260.
- MOREAU, C.S. 2009: Inferring ant evolution in the age of molecular data (Hymenoptera: Formicidae). – *Myrmecological News* 12: 201-210.
- SANTSCHI, F. 1925: Contribution à la faune myrmécologique de la Chine. – *Bulletin de la Société Vaudoise des Sciences Naturelles* 56: 81-96.
- SEIFERT, B. 2009: Cryptic species in ants (Hymenoptera: Formicidae) revisited: we need a change in the alpha-taxonomic approach. – *Myrmecological News* 12: 149-166.
- SHATTUCK, S.O. 1987: An analysis of geographic variation in the *Pogonomyrmex occidentalis* complex (Hymenoptera: Formicidae). – *Psyche* 94: 159-179.
- WARD, P.S. 2001: Taxonomy, phylogeny and biogeography of the ant genus *Tetraponera* (Hymenoptera: Formicidae) in the Oriental and Australian regions. – *Invertebrate Taxonomy* 15: 580-665.
- WILSON, E.O. 1952: The *Solenopsis saevissima* complex in South America (Hymenoptera: Formicidae). – *Memórias do Instituto Oswaldo Cruz* 50: 60-68.