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Source: Revue suisse de Zoologie, 125(2) : 221-229

Published By: Muséum d'histoire naturelle, Genève

URL: <https://doi.org/10.5281/zenodo.1414203>

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New combination and redescription of *Brachyponera mesoponeroides* Radchenko, 1993 (Hymenoptera: Formicidae: Ponerinae)

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Abstract: Two paratype workers of *Brachyponera mesoponeroides* Radchenko, 1993 were examined. As the result, this species disagreed with *Brachyponera* but well agreed with *Hypoconera* in some important diagnostic characters separating the two genera: the apicoventral part of metatibia without a small and simple spur in front of a large and pectinate spur; outer basal portion of mandible without the pit or groove; prora present; subpetiolar process as a rounded lobe, lacking a posterior shelf-like process. Therefore, *B. mesoponeroides* was transferred to the genus *Hypoconera* as a new combination *Hypoconera mesoponeroides*. Then the worker of this species was re-described, and the queen was described for the first time based on the paratype workers and nest series newly collected from Cuc Phuong National Park, Ninh Binh province (type locality), Van Lang district, Lang Son province and Na Hang Natural Reserve, Tuyen Quang province, Vietnam. COI-based DNA barcoding was also conducted for examining the species boundaries of *Hypoconera mesoponeroides*.

Keyword: Ant - *Hypoconera mesoponeroides* - queen - DNA barcoding.

INTRODUCTION

Brachyponera was established by Emery (1900) as a subgenus of the genus *Euponera* Forel, 1891, with the type species *E. (B.) croceicornis* (Emery, 1900), and raised to full genus level by Bingham (1903). Later, *Brachyponera* was synonymized under the genus *Pachycondyla* F. Smith, 1858 by Snelling (1981). This treatment was supported by Brown (in Bolton, 1994), and widely accepted until Schmidt (2013) and Schmidt & Shattuck (2014) in which *Brachyponera* was revived again as a genus based on molecular phylogenetic analysis and morphological examination.

Radchenko (1993) described a new species, *Brachyponera mesoponeroides*, based on workers collected from Cuc Phuong, Ninh Binh, Vietnam, and it was then transferred to *Pachycondyla* by Bolton (1995). Later, Schmidt & Shattuck (2014) revived *Brachyponera* as an independent genus and transferred the species back to *Brachyponera*. In the course of our long-term project revealing species diversity of ants in Indo-China, two paratype workers

of *Brachyponera mesoponeroides* were examined to confirm its generic position, and we have concluded that Radchenko's species disagrees with *Brachyponera* but well agrees with *Hypoconera* in some important diagnostic characters separating the two genera. Therefore, in the present paper, *B. mesoponeroides* is transferred to *Hypoconera* as a new combination. The worker of this species is re-described and the queen is described for the first time based on the paratype workers and nest series newly collected from Cuc Phuong National Park, Ninh Binh province (type locality), Van Lang district, Lang Son province and Na Hang Natural Reserve, Tuyen Quang province, Vietnam. COI-based DNA barcoding was also conducted for examining the species boundary of *Hypoconera mesoponeroides*.

MATERIALS AND METHODS

Abbreviations of the specimen depositories: Abbreviations of the specimen depositories are as follows:

IEBR, Institute of Ecology and Biological Resources, Hanoi, Vietnam; MHNG, Muséum d'histoire naturelle, Geneva, Switzerland; MIZ, Museum and Institute of Zoology, Polish Academy of Sciences, Warsaw, Poland; SKYC, Sk. Yamane collection, Japan.

Specimen Imaging: Images were produced by Helicon Focus Pro 6.7.1 from a series of source images taken using a Lumix DMC GX8 digital camera attached to a Nikon AZ100 (for details see Satria *et al.*, 2015).

Measurements and Indices: The following parts of the bodies were measured using ImageJ (<http://imagej.nih.gov/ij/>) based on the photographs taken using a Panasonic Lumix DMC-GX8 digital camera attached to the Nikon AZ100 microscope under suitable magnifications. The measurements and indices basically follow those in Bolton & Fisher (2011).

HL Head Length: length of head capsule excluding the mandibles, measured in full-face view in a straight line from the mid-point of anterior clypeal margin to the mid-point of the posterior margin of head.
 HW Head Width: maximum width of head including eyes, measured in full-face view.
 HS Head Size: HL + HW, divided by 2.

SL Scape Length: maximum straight-line length of scape, excluding the basal constriction or neck that occurs just distal of condylar bulb.
 ML Length of closed mandible in full-face view from apex to midpoint of clypeal margin.
 EL Eye length: maximum length of compound eye, measured along the maximum diameter.
 PrW Pronotal Width: maximum width of pronotum in dorsal view.
 WL Weber's Length of Mesosoma: diagonal length of mesosoma in lateral view, from the angle at which the pronotum meets cervix to the posterior basal angle of metapleuron.
 PeH Petiole Height: vertical height of petiole, measured in lateral view from the lowest point of subpetiolar process to a line that intersects the highest point of the dorsal outline.
 PeNL Petiole Node Length: in lateral view, the maximum length of petiole node, measured in a straight horizontal line from immediately above the dorsal base of the anterior petiolar tubercle to the posterior margin.
 PeNW Petiole Node Width: The maximum width of petiole node in dorsal view.
 PeS Petiole Size: PeH + PeNL + PeNW, divided by 3.

Table 1. List of specimens used for COI-based DNA barcoding, with DDBJ/Genbank accession number.

CP., Cuc Phuong National Park, Ninh Binh, Vietnam; VL., Van Lang, Lang Son, Vietnam; NH, Na Hang Nature Reserve, Tuyen Quang, Vietnam; CYS, Chu Yang Sin National Park, Dak Lak, Vietnam.

Species	Specimen code	Colony code	Locality	Accession Number
<i>Hypoponera mesoponeroides</i>	AD170511-01	AD17CP37	CP	LC349909
<i>Hypoponera mesoponeroides</i>	AD170511-02	AD17CP60	CP	LC349910
<i>Hypoponera mesoponeroides</i>	AD170511-03	AD17CP74	CP	LC349911
<i>Hypoponera mesoponeroides</i>	AD170511-04	AD17CP57	CP	LC349912
<i>Hypoponera mesoponeroides</i>	AD170511-05	AD17CP34	CP	LC349913
<i>Hypoponera mesoponeroides</i>	AD170511-06	AD17CP16	CP	LC349914
<i>Hypoponera mesoponeroides</i>	AD170511-07	AD17CP43	CP	LC349915
<i>Hypoponera mesoponeroides</i>	AD170511-08	ADLS0027	VL	LC349916
<i>Hypoponera mesoponeroides</i>	AD170511-09	AD17CP41	CP	LC349917
<i>Hypoponera mesoponeroides</i>	AD170511-10	AD17CP30	CP	LC349918
<i>Hypoponera mesoponeroides</i>	AD170511-11	AD17CP38	CP	LC349919
<i>Hypoponera mesoponeroides</i>	AD170511-12	AD17CP87	CP	LC349920
<i>Hypoponera mesoponeroides</i>	AD170511-13	AD17CP58	CP	LC349921
<i>Hypoponera mesoponeroides</i>	AD170511-14	AD17CP31	CP	LC349922
<i>Hypoponera mesoponeroides</i>	AD170525-17	Eg13iii15-25	NH	LC349923
<i>Hypoponera mesoponeroides</i>	AD170525-19	Eg13iii15-16	NH	LC349924
<i>Hypoponera</i> sp.1	AD171005-52	AD16-CYS-016	CYS	LC349925
<i>Hypoponera</i> sp.1	AD171005-54	AD16-CYS-119	CYS	LC349926

- CI Cephalic Index: HW divided by HL, $\times 100$.
 MI Mandibular Index: ML divided by HL, $\times 100$.
 SI Scape Index: SL divided by HW, $\times 100$.
 PeNI Petiole Node Index: PeNW divided by PrW, $\times 100$.
 LPeI Lateral Petiole Index: PeNL divided by PeH, $\times 100$.
 DPeI Dorsal Petiole Index: PeNW divided by PeNL, $\times 100$.

DNA barcoding: A single worker of each colony listed in the Table 1 was used for DNA barcoding; the colonies were morphologically determined as *B. mesoponeroides* by comparing them with the two paratype workers of *B. mesoponeroides*.

DNA extraction, PCR amplification of the 658bp of the standard DNA barcoding region (Folmer region) near the 5' terminus of the mitochondrial CO1 gene, sequencing using ABI PRISM 3100 (Applied Biosystems), and sequence assembly using ChromasPro 1.7.6 (Technelysium Pty Ltd., Australia) were conducted by following Satria *et al.* (2015). A total of 18 sequences were submitted to the DNA Data Bank

of Japan (accession numbers: LC349909-LC349926; Table 1). The 18 sequences together with the following five sequences of the three other *Brachyponera* species (*B. chinensis*: GQ264568; *B. luteipes*: GQ264582; *B. nakasujii*: GQ264594; *Cryptopone sauteri*: GQ264538; *Ectomomyrmex javanus* GQ264573) were aligned with using ClustalW (Thompson *et al.*, 1994) built in MEGA 7 (Kumar *et al.*, 2016). Then, based on a 438 bp dataset, pairwise divergences were calculated using p-distance (obtained by dividing the number of nucleotide differences by the total number of nucleotides compared) and the K2P distance model (Kimura, 1980). A neighbor-joining tree based on the K2P distance model was created using MEGA 7 (Fig. 1).

RESULTS AND DISCUSSIONS

Schmidt & Shattuck (2014, p. 77) distinguished the workers of the genera *Brachyponera* and *Hypoconera* by the following character states: outer basal portion of mandible usually with a basal pit (obsolete or vestigial in some species) in *Brachyponera*, but without the pit or

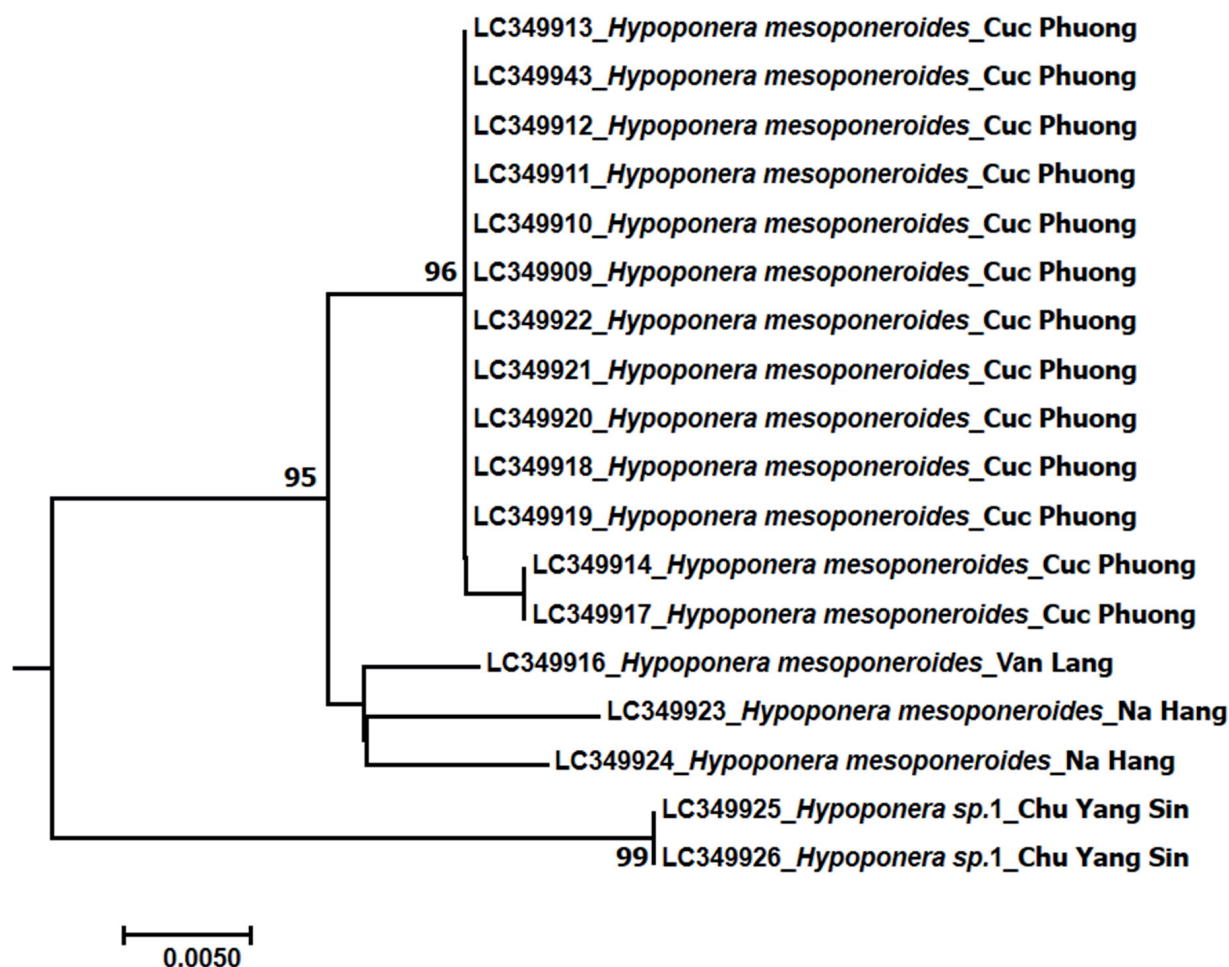


Fig. 1. Neighbor-joining tree generated under the K2P distance model, based on a dataset consisting of 438 bp sequences.

groove in *Hypoponera*; the apicoventral part of metatibia with a small and simple spur in front of a large and pectinate spur in *Brachyponera*, but with a pectinate large spur in *Hypoponera*; prora reduced and not externally visible in *Brachyponera* while present in *Hypoponera*; subpetiolar process well developed, posteroventrally with an acute angle or a pair of acute angles in *Brachyponera*, but as a rounded lobe, lacking a posterior shelf-like process in *Hypoponera*. In our examination, the two paratype workers of *B. mesoponeroides* Radchenko, 1993 agree with the concept of *Hypoponera* proposed by Schmidt & Shattuck (2014); *B. mesoponeroides* is, therefore, transferred to the genus *Hypoponera*.

Through COI-based DNA barcoding, two distinct clusters are recognized within the colonies morphologically determined as “*H. mesoponeroides*” (Fig. 1). The minimal divergences between them are 3.7% in p-distance and 0.038 in K2P. According to previous studies on various arthropoda taxa (Smith *et al.*, 2005 for Formicidae; Robinson *et al.*, 2009 for spiders; Renaud *et al.*, 2012 for Diptera) suggested that intraspecific divergence values of COI are usually less than 2-3%. And so, there is a certain possibility that the two clusters are different at the species level. Consequently, the cluster comprising the colonies from Cuc Phuong (type locality), Van Lang and Na Hang is herein determined as the real *H. mesoponeroides* (maximum intraspecific diversity: 0-1.8% in p-distance and 0-0.019 in K2P), and the queen is described for the first time based on the colonies from Cuc Phuong. The status of the other cluster, consisting of the colonies collected from Chu Yang Sin, will be solved after further intensive sampling in the whole of Vietnam and analyzing the samples.

TAXONOMIC TREATMENT AND REDESCRIPTION

Hypoponera mesoponeroides (Radchenko, 1993)

comb. nov.

Figs 2-5

Brachyponera mesoponeroides Radchenko, 1993: 81. – Schmidt & Shattuck, 2014: 80.

Pachycondyla mesoponeroides. – Bolton, 1995: 307.

Type materials examined: *Brachyponera mesoponeroides*; MIZ; 2 paratype workers; Vietnam, Ninh Binh, Cuc Phuong; 05.06.1966; R. Bielawski & B. Pisarski leg.

Nontype materials examined: IEHR; Vietnam, Ninh Binh, Cuc Phuong, 20.29472°N 105.64500°E - 20.30250°N 105.65611°E, ca. 231 m alt.; 1 worker (colony AD17CP16), 1 worker (AD17CP30), 1 worker, 1 dealate queen (AD17CP31), 1 worker (AD17CP34), 1 worker (AD17CP37), 1 worker (AD17CP38), 1 worker (AD17CP41), 1 worker (AD17CP43); 22.03.2017; Dang V.A. leg. – MHNG; Vietnam, Ninh Binh, Cuc Phuong, 20.29472°N 105.64500°E

- 20.30250°N 105.65611°E, ca. 231 m alt.; 1 worker (colony AD17CP16); 22.03.2017; Dang V.A. leg. – IEHR; Vietnam, Ninh Binh: Cuc Phuong, 20.35000°N 105.57805°E - 20.35861°N 105.59333°E, ca. 366 m alt.; 1 worker, 1 dealate queen (AD17CP57), 1 worker (AD17CP58), 1 worker (AD17CP60), 1 worker (AD17CP74); 23.03.2017; Dang V.A. leg. – MHNG; Vietnam, Ninh Binh: Cuc Phuong, 20.35000°N 105.57805°E - 20.35861°N 105.59333°E, ca. 366 m alt.; 1 worker (AD17CP74); 23.03.2017; Dang V.A. leg. – IEHR; Vietnam, Ninh Binh, Cuc Phuong, 20.35861°N 105.59333°E, 212 m alt.; 1 worker (AD17CP87); 24.03.2017; Dang V.A. leg. – MHNG; Vietnam, Ninh Binh, Cuc Phuong, 20.35861°N 105.59333°E, 212 m alt.; 1 worker (AD17CP87); 24.03.2017; Dang V.A. leg. – IEHR; Vietnam, Tuyen Quang, Na Hang Nature Reserve, Ban Chu; limestone forest; 22.49389°N 105.42111°E, 90-185 m alt.; 1 worker (Eg13iii15-16), 1 worker (Eg13iii15-25); 13.03.2015; Eguchi K. leg. – IEHR; Vietnam, Lang Son, Van Lang, 20.39055°N 105.86889°E, 967 m alt.; 1 worker (ADLS0027); 21.04.2016; Dang V.A. leg. – MHNG; Vietnam, Lang Son, Van Lang, 20.39055°N 105.86889°E, 967 m alt.; 1 worker (ADLS0027); 21.04.2016; Dang V.A. leg.

Worker measurements and indices (nontypes, n=10): HL 0.85-0.93 mm; HW 0.77-0.85 mm; HS 0.81-0.89 mm; SL 0.71-0.79 mm; ML 0.31-0.34 mm; EL 0.07-0.10 mm; PrW 0.56-0.62 mm; WL 1.18-1.36 mm; PeH 0.58-0.69 mm; PeNL 0.26-0.28 mm; PeNW 0.38-0.41 mm; PeS 0.41-0.46 mm; ML 0.37-0.43 mm; CI 89-91; MI 33-38; SI 91-98; PeNI 64-69; LpeI 41-47; DPeI 136-154.

Worker description (Figs 2-4): Head in full-face view subrectangular, distinctly longer than wide, with posterior margin very weakly concave or almost straight, with lateral margin weakly convex, in lateral view with dorsal margin straight and ventral margin slightly convex; mandible triangular; masticatory margin of mandible with large apical and two distinct preapical teeth followed by a series of smaller teeth; outer basal portion of mandible without a pit or groove; median portion of clypeus produced anteriad, with anteromedian margin weakly concave; compound eye located on the side of head close to the mandibular insertion, small (EL 0.07-0.10 mm), consisting of 12-16 ommatidia in total; antenna 12-merous; antennal scape when laid backward extending beyond posterolateral corner of head by length of antennal segment II; II almost as long as total length of III and IV; III-V almost identical in length; VI-XII gradually increasing in length towards apex, not forming a distinct club. Pronotum in lateral view with steep anterodorsal outline; mesonotum in lateral view slightly convex; promesonotal suture and mesonotal-mesopleural suture distinct; metanotal groove conspicuous across mesosomal dorsum, deeply incised; mesopleuron not divided by distinct transverse

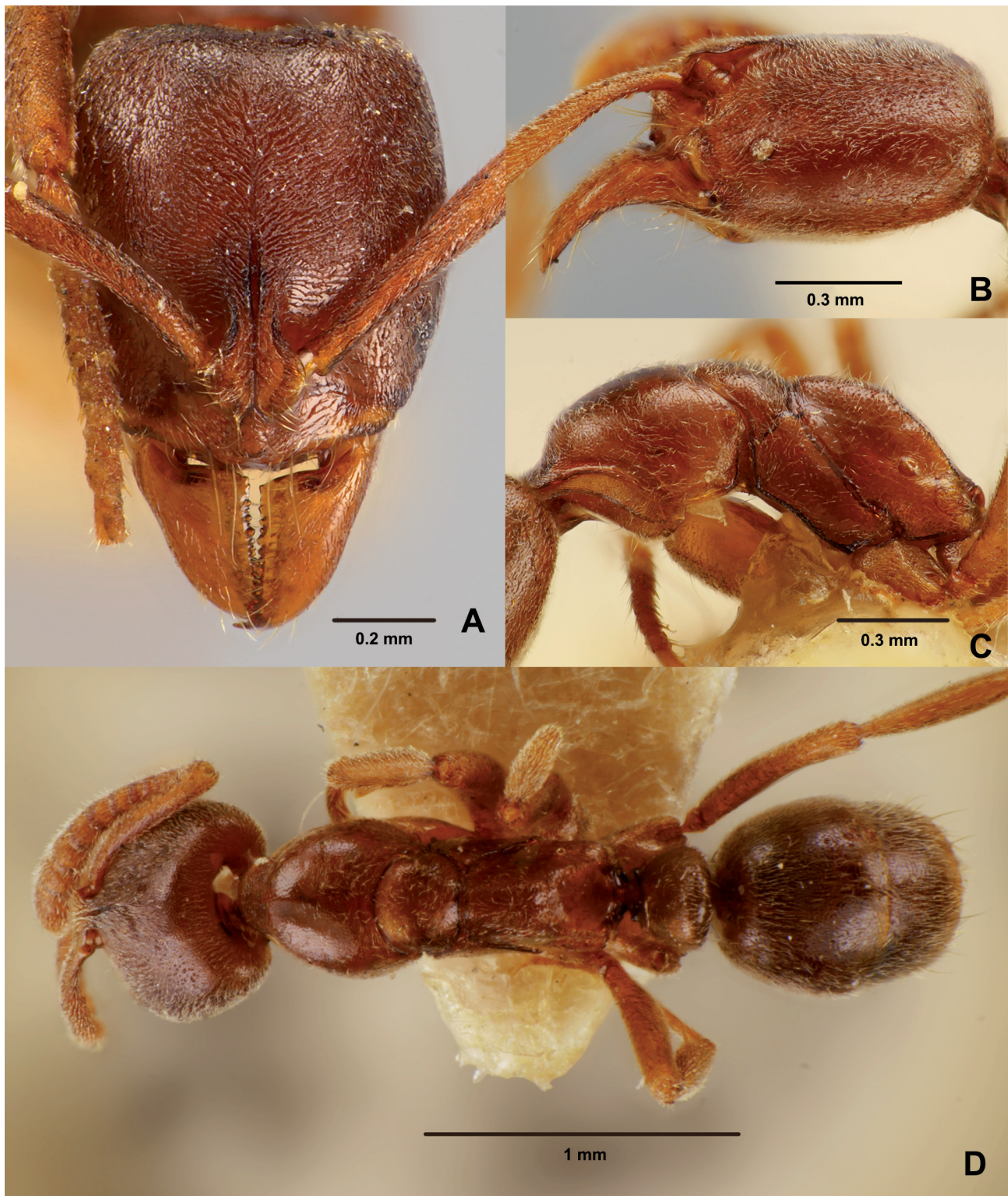


Fig. 2. *Hypoponera mesoponeroides* (Radchenko, 1993) comb. nov., paratype workers. (A) Head in full-face view. (B) Head in lateral view. (C) Mesosoma in lateral view. (D) Body in dorsal view. (B), (C), (D) specimen code: IMG20160605-01; (A) IMG20160605-02.

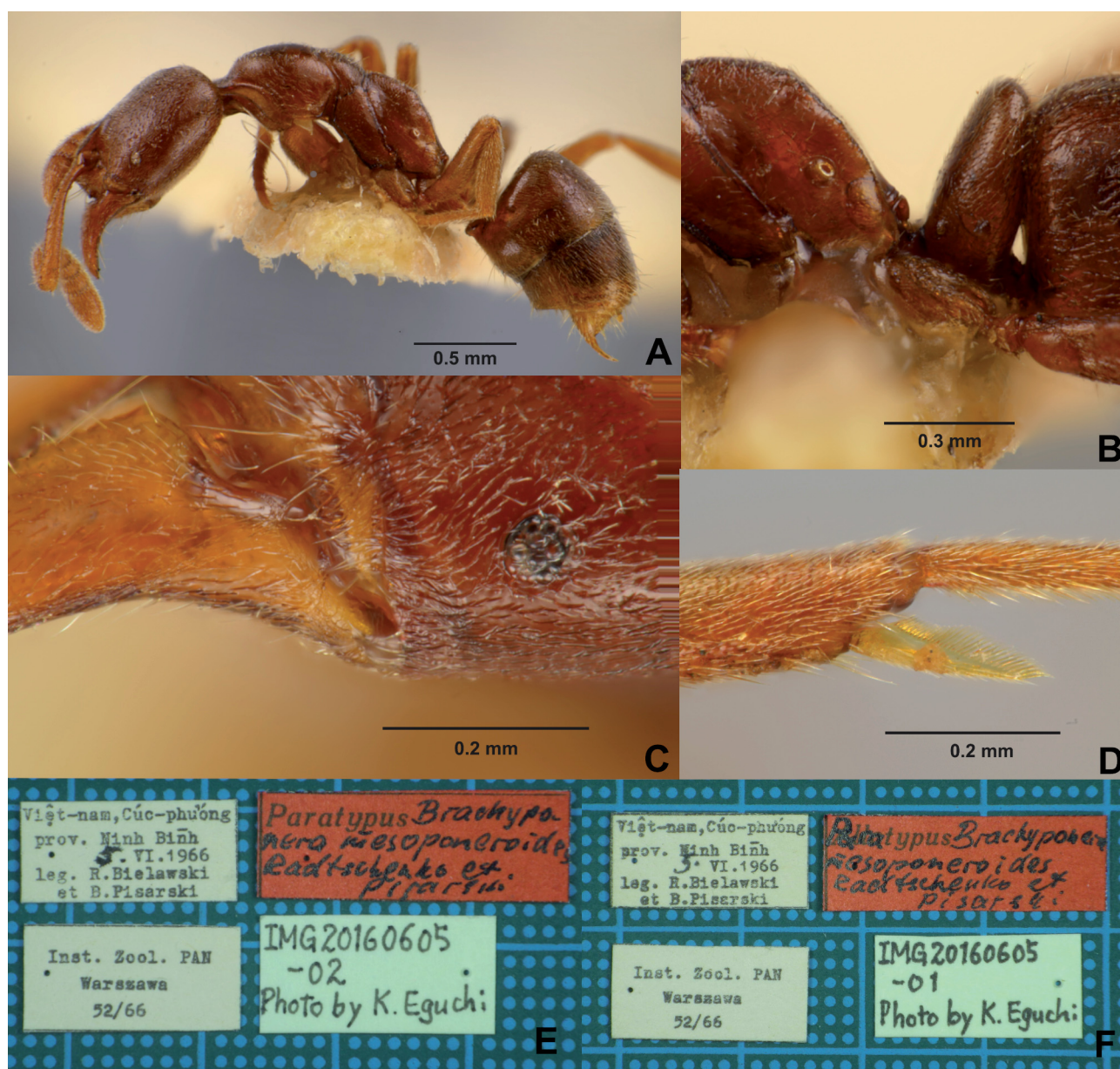


Fig. 3. *Hypoponera mesoponeroides* (Radchenko, 1993) comb. nov., paratype workers. (A) Body in lateral view. (B) Petiole in lateral view. (C) Mandible and gena in lateral view. (D) Metatibial spur. (E), (F) Labels of a paratype. (A), (F) specimen code: IMG20160605-01; (B), (C), (D), (E) IMG20160605-02.

sulcus; meso-metapleural suture distinct; propodeum in lateral view with dorsum short and faintly convex or almost straight, and posterior declivity almost straight; propodeal spiracle elliptical; propodeal lobe absent; apicoventral part of meso- and metatibia with a single pectinate spur. Petiolar node in lateral view squamiform and thin; subpetiolar process developed well as a lobe, without an anterior fenestra, in lateral view with a weak concavity on the ventral margin, without a posterior shelf-like process. Abdominal tergite III as long as or slightly longer than IV. Prora present as a distinct U-shaped ridge below helcium.

Head, pronotum, mesonotum and dorsum of propodeum

and petiole entirely covered with fine, hair-bearing punctures; mandible smooth; mesopleuron largely smooth and shiny; metapleuron largely smooth and shiny, with posteriormost part finely striate; pretergite IV almost smooth and shiny, with fuzzy transverse striations. Body covered with appressed to subdecumbent background pubescence which is sparser in mesopleuron and metapleuron than in the remainder of body; clypeus with several erect setae; compound eye with short hairs between ommatidia; antenna covered relatively desely with very short, appressed to suberect pubescence; abdominal segments III-VII with many erect to suberect setae among background pubescence.



Fig. 4. *Hypoponera mesoponeroides* (Radchenko, 1993) comb. nov., nontype worker. (A) Head in full-face view. (B) Body in lateral view. (C) Antenna. (D) Petiole. (E) Body in dorsal view. (A), (B), (C), (D) colony code: AD16CP60, specimen code: CAP20171220-01; (E) AD16CP58, CAP20170714-01.

Body dark-brown to reddish brown; mandibles, antenna and legs paler.

Queen measurements and indices (n=2): HL 0.98-0.99 mm; HW 0.88 mm; HS 0.93-0.94 mm; SL 0.84-0.87 mm; ML 0.38-0.4 mm; EL 0.20-0.22 mm; PrW 0.77-0.78 mm; WL 1.65-1.67 mm; PeH 0.79-0.80 mm; PeNL 0.36-0.37 mm; PeNW 0.46-0.48 mm; PeS 0.54-0.55 mm; ML 0.47-0.48 mm; CI 95; MI 48; SI 90-93; PeNI 60-62; LpeI 46; DPeI 128-130.

Queen description (Fig. 5): In general appearance queen similar to worker. Body larger than in the worker; gaster sometimes distinctly larger than in the worker. Compound eye large (EL 0.20-0.22 mm), with short hairs between ommatidia (Fig. 5C); ocelli present; distance between median and lateral ocelli as long as distance between lateral ocelli. Mesosoma with main sclerites associated with wing function (Fig. 5B); mesoscutum with conspicuous parapsidal lines, without notauli, in lateral view with slightly convex anterodorsal outline; dorsal outline of mesonotum in lateral view weakly depressed between mesoscutum

and mesoscutellum; mesopleuron with a well-developed transverse sulcus that divides it into upper and lower portions; propodeum in lateral view with dorsum short and gradually sloping posteriad, and posterior declivity almost straight. Apical part of petiolar node in lateral view tapering sharply more than in the worker.

Bionomics: This species inhabits in secondary and primary forests from the lowland to the highland (up to an approximately 1,000 m alt.), and nests in the leaf litters, soil, rotting logs and rotting wood fragments, and under rocks.

Distribution: Known from northern Vietnam.

ACKNOWLEDGEMENTS

We thank the director and staff of IEBR, Chu Yang Sin National Park (Dak Lak), Cuc Phuong National Park (Ninh Binh) and Na Hang Nature Reserve (Tuyen Quang). We are also thankful to Dr Phung Thi Hong Luong (IEBR), Dr Bui Tuan Viet (Vietnam National Museum of Nature)



Fig. 5. *Hypoponera mesoponeroides* (Radchenko, 1993) comb. nov., nontype queen, colony code: AD16CP57; specimen code: CAP20170716-01. (A) Head in full-face view. (B) Body in dorsal view. (C) Antenna. (D) Body in lateral view. (E) Compound eye. (F) Mesosoma in lateral view.

and Dr Rijal Satria (Andalas University, Indonesia) for their kind helps during our field surveys. This research is funded by the following foundations and societies: Asahi Glass Foundation (Leader: Katsuyuki Eguchi; FY2017-FY2020); the Japan Society for the Promotion of Science (JSPS), Grant-in-Aid for Scientific Research (B, no. 26304014 and 16H05769; C, no. 15K07193 and 15K07805); Tokyo Human Resources Fund for City Diplomacy. Our sincere thanks are extended to Dr Dariusz Iwan (MIZ) and Dr Alexander Radchenko (National Academy of Sciences of Ukraine) for the loan of the type material of *Brachyponera mesoponeroides*.

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