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Source: Revue suisse de Zoologie, 123(2) : 307-314

Published By: Muséum d'histoire naturelle, Genève

URL: <https://doi.org/10.5281/zenodo.155307>

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First discovery of subdichthadiigyne in *Yunodorylus* Xu, 2000 (Formicidae: Dorylinae)

Katsuyuki Eguchi^{1,*}, Riou Mizuno², Fuminori Ito², Rijal Satria¹, Dang Van An^{1,3}, Bui Tuan Viet⁴,
Phung Thi Hong Luong^{1,3}

¹ Systematic Zoology Laboratory, Department of Biological Sciences, Graduate School of Science and Engineering, Tokyo Metropolitan University, Hachioji 192-0397, Japan

² Faculty of Agriculture, Kagawa University, Ikenobe, 761-0795 Japan

³ Institute of Ecology and Biological Resources, Vietnam Academy of Science and Technology, 18 Hoang Quoc Viet Road, Cau Giay District, Hanoi, Vietnam

⁴ Vietnam National Museum of Nature, 18 Hoang Quoc Viet Road, Cau Giay District, Hanoi, Vietnam

* Corresponding author: antist2007@gmail.com / antist@tmu.ac.jp

Abstract

Yunodorylus comprises four named species and has so far been known exclusively from the Indo-Chinese and Indo-Malayan subregions. Recently, two queen-right colonies of *Yunodorylus eguchii* Borowiec, 2009 were found in a lowland evergreen forest in Lo Go Xa Mat National Park, southwestern Vietnam. The present paper is the first description of the queen caste of *Yunodorylus*. The queens were interestingly subdichthadiiform. This discovery has an important implication in our further understanding of the evolution of the “Army Ant Adaptive Syndrome” in the subfamily Dorylinae.

Key words: *Cerapachys sexspinus* group - Vietnam - queen - morphology - army ant adaptive syndrome.

INTRODUCTION

The ant genus *Yunodorylus* was established by Xu (2000) based on a single species *Y. sexspinus* from Yunnan province, China. He placed *Yunodorylus* under the subfamily Dorylinae based on its general habitus recalling the worker of *Dorylus*: waist consisting of a single-segment; worker polymorphic; and terrestrial habits (Xu, 2000). At the same time he considered it as “a possible inter-link between the subfamilies Dorylinae and Cerapachyinae in evolution”, because *Yunodorylus* also has features of Cerapachyinae: masticatory margin of mandible long and oblique, and armed with more than 3 teeth; promesonotal suture absent; propodeal spiracles low on side; pygidium not impressed medially, and posterolaterally armed with minute peg-like spines (Xu, 2000). However, Bolton (2003) synonymized *Yunodorylus* with *Cerapachys* under Cerapachyinae, because “the worker features used to define *Yunodorylus* included apomorphies and other morphological aspects that are characteristic of Cerapachyinae” (see also Bolton, 1990).

Borowiec (2009) basically followed the classification proposed by Bolton (2003) and redefined *Yunodorylus* as

the *Cerapachys sexspinus* group and provided diagnosis of the species group based on the worker. However, according to the most recent molecular phylogenetic analysis of the major dorylomorph lineages (Brady *et al.*, 2014), the six previous dorylomorph subfamilies, i.e., Aenictinae, Dorylinae, Ecitoninae, Aenictogitoninae, Leptanilloidinae, and Cerapachyinae, should be subsumed into a single subfamily, Dorylinae. Of these six families, “Cerapachyinae” is non-monophyletic and highly heterogeneous, while the others are monophyletic and *Yunodorylus* is an independent clade. Therefore, we hereafter refer to the *Cerapachys sexspinus* group *sensu* Borowiec (2009) as *Yunodorylus*.

Yunodorylus currently comprises four named species and has so far been known exclusively from the Indo-Chinese and Indo-Malayan subregions (Borowiec, 2009). Although the queen and male had been unknown for the genus, the present authors (K. Eguchi, R. Satria and V. A. Dang) found two queen-right colonies (no. Eg20ix15-01 and Eg19ix15-01) of *Yunodorylus eguchii* Borowiec, 2009 in a lowland evergreen forest in Lo Go Xa Mat National Park, southwestern Vietnam. The queens were interestingly subdichthadiiform. In the

present paper we describe the external morphology of the subdichthadiigyne. Results of laboratory observations on their foraging and reproduction will be presented in a separate paper.

MATERIALS AND METHODS

Species determination of the colonies Eg20ix15-01 and Eg19ix15-01 was done by referring to Borowiec (2009) and comparing the workers of the colonies with the paratypes of *Yunodorylus eguchi*.

Abbreviation of specimen depositories are as below.

- ACEG Ant Collection of Katsuyuki Eguchi (see contact address given under the title of this article).
 IEBR Institute of Ecology and Biological Resources, Vietnam Academy of Science and Technology, 18 Hoang Quoc Viet Road, Cau Giay District, Hanoi, Vietnam.
 MCZC Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts, USA.
 MHNG Muséum d'Histoire Naturelle, Geneva, Switzerland.
 VNMN Vietnam National Museum of Nature, Vietnam Academy of Science and Technology, 18 Hoang Quoc Viet Road, Cau Giay District, Hanoi, Vietnam.

Multi-focused, montage images were produced by Helicon Focus Pro 6.2.2 from a series of source images taken by an Olympus Pen Lite E-PL7 digital camera or Panasonic Lumix DMC-GX8 attached to a Nikon AZ100 microscope. Fine hairs and other features not recognized automatically were copied from the focused parts source from the source images on to the montage image using the retouching function of Helicon Focus. Artifacts (ghost images) and unnecessary parts (unfocused appendages, etc.) surrounding or covering target objects were erased and cleaned up using the retouching function of Helicon Focus. Finally, the background was cleaned up, and the color balance, contrast and sharpness were adjusted using Adobe Photoshop CS6.

Photographs for measuring were taken by an Olympus Pen Lite E-PL7 digital camera attached to a Nikon AZ100 microscope under suitable magnification. The following body parts were measured by ImageJ 1.49m (National Institute of Mental Health, USA, available at <http://imagej.nih.gov/ij/>) and then the indices were calculated: HL, maximum length of head measured from the level crossing the apexes of lateroclypeal teeth to the level crossing the posterolateral corners of head; HW, maximum width of head in full-face view; SL, maximum measurable length of scape, from the proximal point of scape shaft, not including the condyle, to the distal end of scape; ML, mesosomal length in dorsal view measured from the midpoint of anterior margin of promesonotal dome to the midpoint of a transverse line spanning the posterolateralmost points of mesosoma; MH, mesosoma height in lateral view measured from the lowermost point

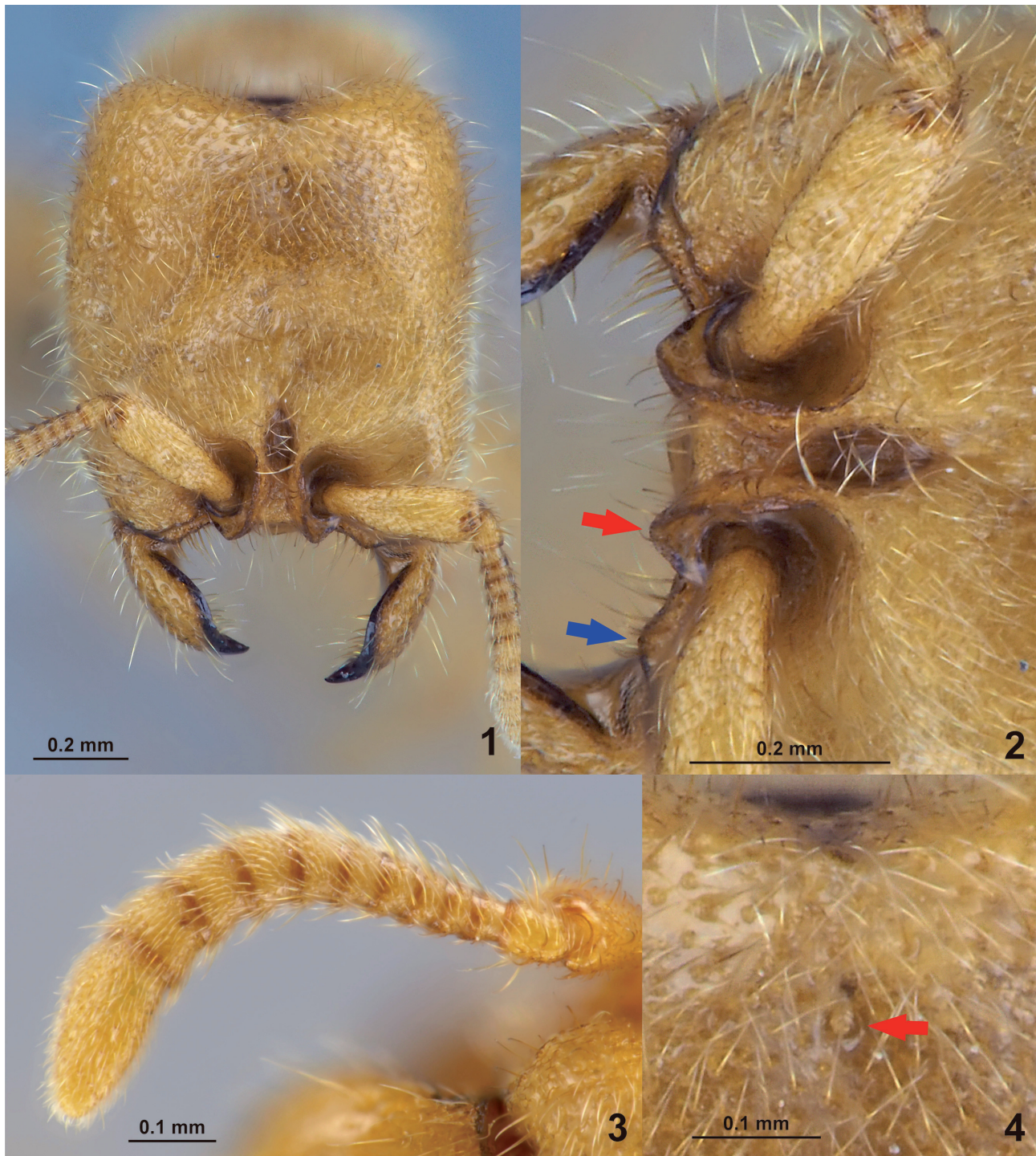
of mesopleuron (in front of middle coxa) to highest point of the dorsal outline of mesonotum; PNW, maximum width of pronotum; MFL, length of mid femur (because hind femora were deformed when dry-mounting the specimen); PL, maximum diagonal length of petiole (abdominal segment II) in lateral view measured from the anteriormost point of the base of subpetiolar process to the posterodorsal corner of petiole; PH, maximum height of petiole, measured from the posteroventral apex of subpetiolar process to the highest point of the dorsal outline of petiole; PW, maximum width of petiolar node; A3W, maximum width of abdominal segment III (gastral tergite I); A3L, maximum length of abdominal segment III (excluding helcium) in dorsal view; CI=HW/HLx100; MBI=MBL/HWx100; SI=SL/HWx100; MI=ML/PNWx100; MFI=FL/HWx100; A3I=A3W/PWx100.

DESCRIPTION OF THE SUBDICHTHADIIGYNE OF *YUNODORYLUS EGUCHII*

Description (Figs 1-12): Head in full-face view subrectangular, longer than broad, broadest slightly behind midlength of head, with lateral margins weakly convex and posterior margin broadly and strongly concave (Fig. 1), relatively low dorsoventrally (Fig. 4); preoccipital carina absent (Fig. 8); frontal lobes present as narrow erect to suberect walls narrowly separated from each other by a longitudinal strip of median portion of clypeus (Fig. 2); anteriormost portion of frontal lobe extending anteriorly far beyond the anterior margin of clypeus (red arrow in Fig. 2); parafrontal ridges completely absent; antennal socket in full-face view fully exposed, very close to anterior margin of head; clypeus narrow from front to back, with a weakly convex anteromedian margin; lateroclypeal teeth low and blunt (blue arrow in Fig. 2); mandible triangular, with a large apical tooth followed by two small teeth on the masticatory margin; antenna 12-segmented; segment II longer than broad; segment III to XI broader than long; apical segment bullet-shaped with blunt apex, much longer than broad; compound eye absent; median ocellus vestigial, recognized as a small impression (red arrow in Fig. 4), but lateral ocelli absent; palp formula unknown (not dissected); mesosoma almost box-shaped, stout, in lateral view with dorsal margin slightly convex, in dorsal view slightly constricted in front of propodeum lateral margins, without flight sclerites; promesonotal suture weakly recognized, convex anteriorly (red arrow in Fig. 8); metanotal groove relatively conspicuous dorsally and laterally, in dorsal view convex posteriorly (blue arrow in Fig. 8); anterior margin of mesopleuron forming a small lobe projecting over basal part of forecoxa (black arrow in Fig. 9); metapleural gland orifice concealed beneath a ventrolaterally directed cuticular flange (red arrow in Fig. 9); propodeum without any spines, carinae, etc. posteriorly, in lateral view with posterodorsal corner bluntly angulate, in posterodorsal view with a faint

median longitudinal depression; an endophragmal pit distinct on the lateral face of propodeum (blue arrow in Fig. 9); propodeal lobe very low; mesotibia and metatibia with a small simple spur in front of a large pectinate spurs; inner margin of pretarsal claws of all legs without teeth; metatibial gland absent; waist consisting of a single small segment (petiole); petiole without tergosternal

fusion, in dorsal view much broader than long, broadest around the posterior 1/3 length of the petiolar length, with anterior margin weakly concave and lateral margins weakly convex; subpetiolar process developed as a rectangular lobe, with an obtuse anteroventral and acute posteroventral angle (Fig. 7); abdominal segments III–VII without tergosternal fusion; abdominal segment III



Figs 1-4. Subdichthadiigyne (specimen no. IMG20160315-1; colony no. Eg20ix15-01). (1) Head in full-face view. (2) Clypeus in full-face view. (3) Left antenna. (4) Vertex in full-face view.

with anterodorsal face (above helcium) vertical, with anteroventral face (below helcium) weakly humped; the anteroventral face without any margin or carina; pygidium convex, but not flattened nor impressed dorsally (Fig. 10),

apically with relatively long, thick and truncate-tipped setae (red arrows in Fig. 12), but without any peg-like or spine-like setae on posterolateral margins; hypopygium flattened ventrally, with a U-shaped posterior margin,

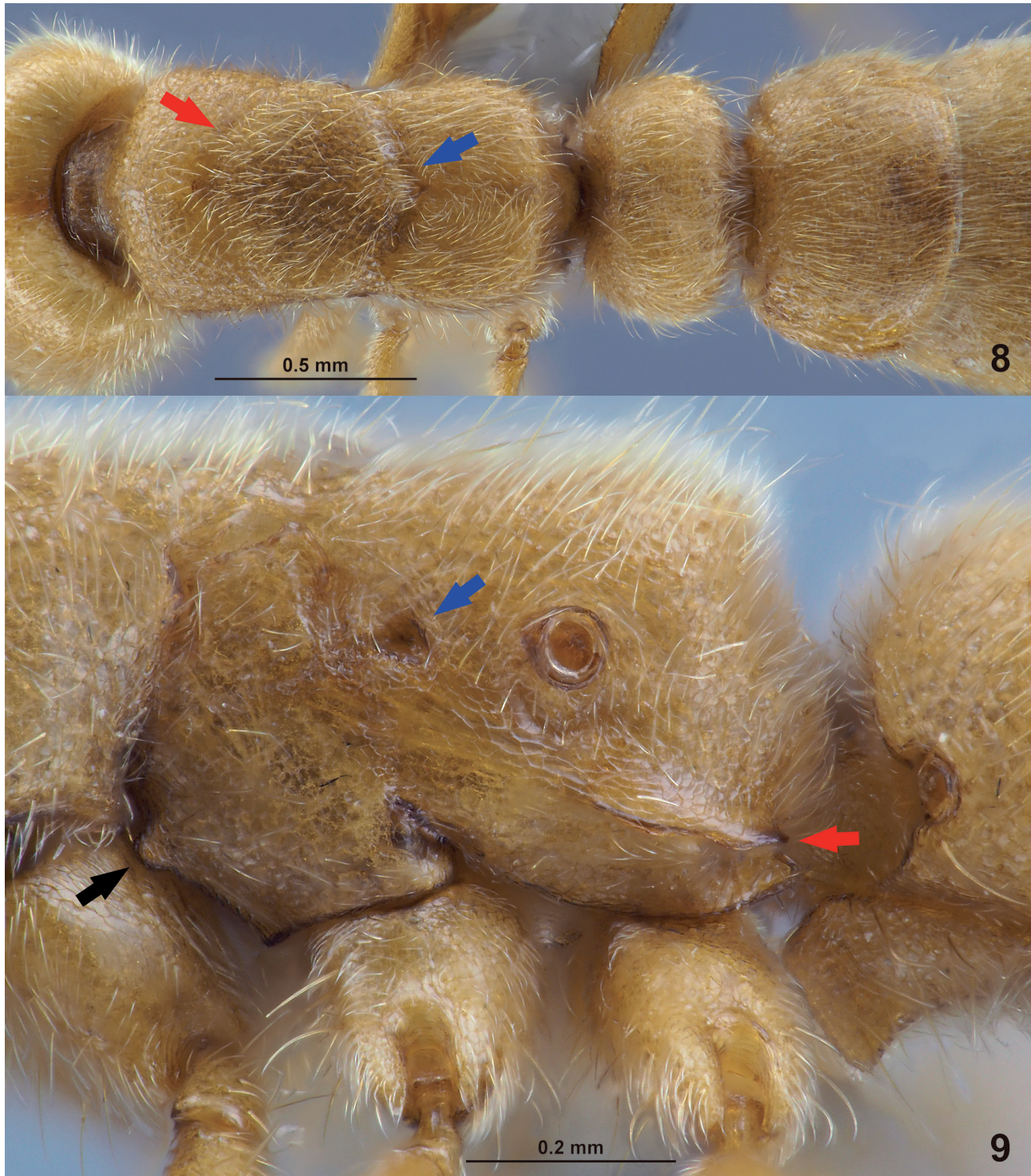


Figs 5-7. *Subdichthadiigyne* (specimen no. IMG20160315-1; colony no. Eg20ix15-01). (5) Body in lateral view. (6) Body in dorsal view. (7) Mesosoma and waist in lateral view.

without any peg-like or spine-like setae on posterolateral margins (Fig. 11); sting developed (Fig. 12).

Body densely covered with short standing hairs, less sculptured but densely with hair pits, yellowish-brown (see Figs 1, 5, 6); sclerotization of body relatively weak (head and some of legs deformed during dry-mounting).

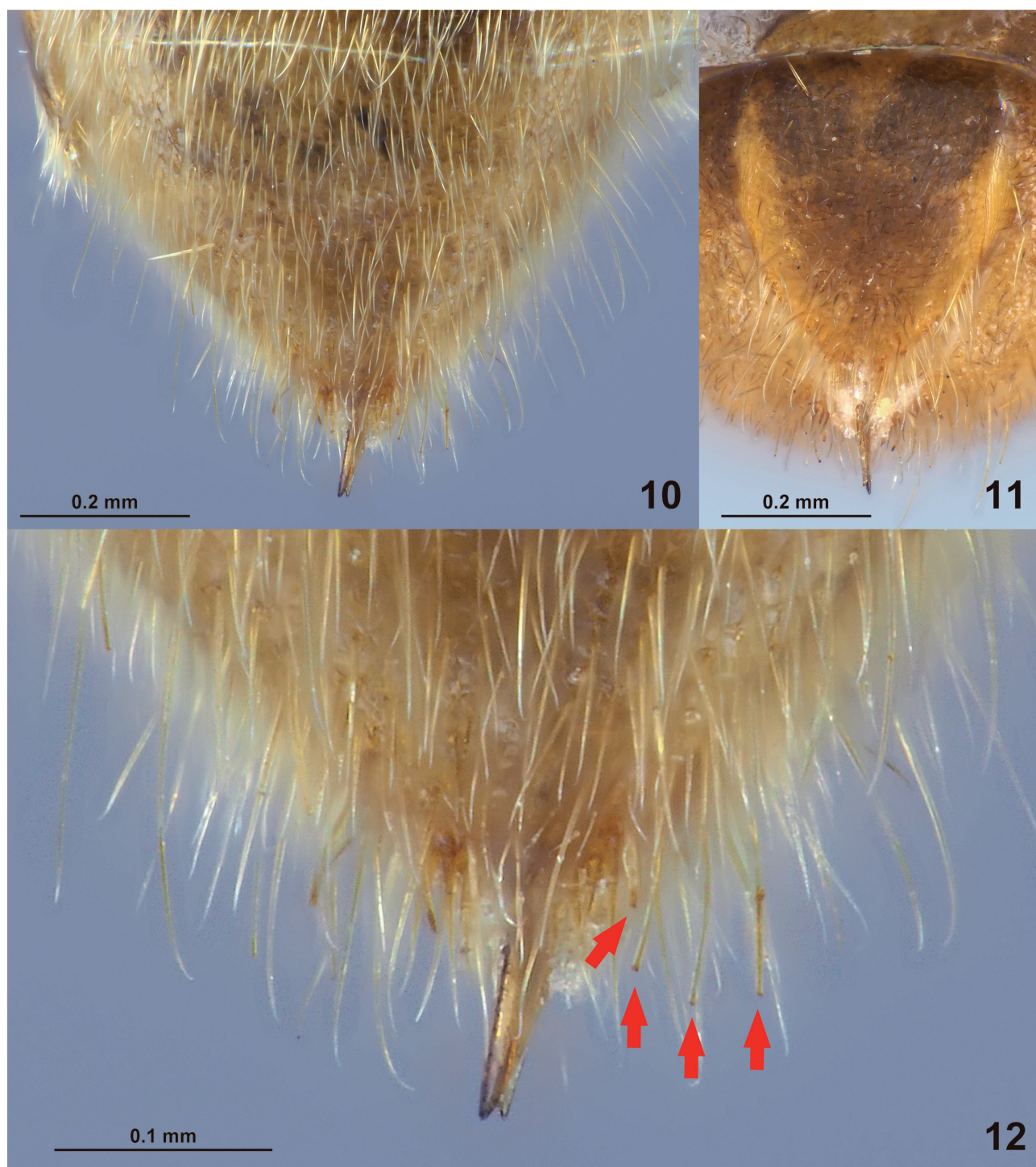
HL 1.013 mm; HW 0.865 mm; SL 0.351 mm; ML 1.266 mm; MH 0.520 mm; PNW 0.609 mm; MFL 0.499 mm; PL 0.452 mm; PH 0.569 mm; PW 0.613; A3W 0.750 mm; A3L 0.516 mm; CI 85; SI 35; MI 208; MFI 58; A3I 122.



Figs 8-9. Subdichthadiigyne (specimen no. IMG20160315-1; colony no. Eg20ix15-01). (8) Mesosoma and waist in dorsal view. (9) Propodeum in lateral view.

Specimen used for the description: MHNG; VIETNAM, Tay Ninh Province, Lo Go Xa Mat National Park, N11°35'17", E105°53'01-10", ca. 5-15 m alt.; K. Eguchi leg.; 20/IX/2015; subdichthadiigyne (specimen no. IMG20160315-1; colony no. Eg20ix15-01).

Specimens used for the species determination: ACEG; VIETNAM, Dong Nai Province, South Cat Tien National Park; K. Eguchi leg.; 21/X/2004; 2 paratype workers. – ACEG, IEBR, MCZC, MHNG, VNMN; for collection data see above; 20 workers (Eg20ix15-01). – ACEG, IEBR, MCZC, MHNG, VNMN; VIETNAM,



Figs 10-12. Subdichthadiigyne (specimen no. IMG20160315-1; colony no. Eg20ix15-01). (10) Pygidium in dorsal view. (11) Hypopygium in ventral view. (12) Apex of pygidium in dorsal view.

Tay Ninh Province, Lo Go Xa Mat National Park, N11°32'18-19", E105°53'03-11", ca. 0-20 m alt.; K. Eguchi leg.; 19/IX/2015; 20 workers (Eg19ix15-01).

Remarks: The “full-dichthadiigyne” in the dorylomorph lineages is usually defined by a combination of the following characteristics: compound eyes vestigial or absent; head swollen and subglobular, often with falcate mandibles; mesosoma without flight sclerites; petiole hypertrophied, commonly bilaterally cornulate; gaster distended (Bolton, 1990; Hölldobler & Wilson, 1990; Gotwald, 1995). Thus, it is safe to conclude that the queen of *Y. eguchii* is subdichthadiiform, based on the following exceptions: head less swollen and not subglobular; mandibles triangular (as seen in the worker); petiole less hypertrophied and simple in shape. In other words, the worker-queen dimorphism is weaker in *Yunodorylus* than in the dorylomorph lineages with a full dichthadiigyne. The remarkable differences between the worker and queen in *Yunodorylus* are the body proportion, presence (worker) or absence (queen) of metatibial gland, and presence (worker) or absence (queen) of pygidial peg-like or spine-like setae. Interestingly, the absence of pygidial peg-like or spine-like setae is also known in the normal and subdichthadiiform queens of the genus *Acanthostichus* (Brown, 1975; Mackay, 2004).

Bionomics: The colonies Eg20ix15-01 and Eg19ix15-01 were found in thick soil walls of termite mounds built on the ground of lowland evergreen forest fragments of Lo Go Xa Mat National Park (Fig. 13). The Eg20ix15-01 colony contained tiny larvae probably in earlier instar only, and the Eg19ix15-01 colony

contained many larger larvae probably in the final instar and a few pupae only. These field observations suggest the presence of synchronized brood development in *Yunodorylus*. Both colonies were brought back to our laboratory in Kagawa Univ., Japan, and their foraging and reproduction behaviors had been observed for several months (Fig. 14). During the observation the subdichthadiigyne of Eg19ix15-01 died or was killed, and then the body was destroyed or eaten by workers. Thus it was unusable for our morphological examination. The results of our laboratory observation will be presented in a separate paper.

ACKNOWLEDGEMENTS

We wish to thank Assoc. Prof. Dr Tran Huy Thai (Director of Institute of Ecology and Biological Resources, Vietnam), Assoc. Prof. Dr Nguyen Van Sinh (Vice director of Institute of Ecology and Biological Resources), Prof. Dr Nguyen Trung Minh (Director of Vietnam National Museum of Nature), Mr Chau Van Van (Director of Lo Go Xa Mat National Park, Tay Ninh Province, Vietnam), and Mr To Quang and other staff of the national park. This research is funded by the following foundations and societies: Vietnam National Foundation for Science and Technology Development (NAFOSTED, grant number 106.12-2012.16); 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); Advanced Research Program of Asian Human Resources Fund by Tokyo Metropolitan Government.



Fig 13. Termite mound in which the colony Eg19ix15-01 was found (photographed by Rijal Satria).

Fig 14. Subdichthadiigyne of the colony Eg19ix15-01 in the egg-laying phase (reared and photographed by Riou Mizuno in Kagawa University).

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