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Second discovery of the subdichthadiigyne in *Yunodorylus* (Borowiec, 2009) (Formicidae: Dorylinae)

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Abstract: The genus *Yunodorylus* comprises four named species known exclusively from the Indo-Chinese and Indo-Malayan subregions. The queen and male of the genus were unknown until recently. However, the subdichtadiigyne was firstly discovered from two colonies of *Y. eguchii* (Borowiec, 2009), and described by Eguchi *et al.* in 2016. Then, the present authors discovered a colony of *Yunodorylus doryloides* (Borowiec, 2009) with a subdichthadiigyne and herein describe the subdichthadiigyne. The subdichtadiigyne of *Y. doryloides* is morphologically similar to that of *Y. eguchii*, but it can be distinguished by the combination of the following morphological characters: mandible elongate and slender, with the edge behind the basalmost tooth of the masticatory margin almost straight; lateroclypeal teeth rounded; mesosoma in dorsal view slenderer in the former than in the latter; mesonotum in dorsal view distinctly longer than broad in the former, but almost as long as broad in the latter; anterior margin of mesopleuron without a small lobe; metanotal groove in dorsal view faintly recognized; ventral margin of metapleuron almost straight; petiole in dorsal view narrower and longer in the former than in the latter; pygidium apically without any specialized setae.

Keywords: Dorylinae - *Yunodorylus doryloides* - queen - Borneo - Indo-Malayan region.

INTRODUCTION

The ant genus *Yunodorylus* Xu, 2000 is the only non-army doryline ant with a single waist segment and no or very weak girdling constriction on abdominal segment IV (Borowiec, 2016). This genus was once synonymized with the genus *Cerapachys* F. Smith, 1857 by Bolton (2003), but very recently it was assigned to the subfamily Dorylinae, and revived as an independent genus (Brady *et al.*, 2014; Borowiec, 2016). The genus contains four named species and has so far been known exclusively from the Indo-Chinese and Indo-Malayan subregions (Borowiec, 2009). The queen and male of the genus were unknown until recently: Borowiec (2016) provided a diagnosis and full description of the male based on an undetermined species, and Eguchi *et al.* (2016) described the queen of *Y. eguchii* (Borowiec, 2009) which is interestingly subdichthadiiform. The morphological features as well as behavioral features of two queen-right colonies of *Y. eguchii* (Mizuno *et al.,* in prep.) suggest an independent evolution of the "Army Ant Adaptive Syndrome" in the *Yunodorylus* lineage.

At the almost same time as the publication of Eguchi *et al*. (2016), the first author of the present paper (R. Satria) collected a queen-right colony of *Yunodorylus doryloides* (Borowiec, 2009) in Lambir Hills National Park, Miri, Sarawak, Malaysia (colony no. RS-55-LMB16). The queen was also subdichthadiiform similar to that of *Y. eguchii*. Unfortunately, with regulations relating to the use of biological specimens obtained in Sarawak, Malaysia, the colony could not be kept alive. Therefore, herein we describe external morphology of the subdichthadiigyne and provide information on the habitat in which *Y. doryloides* was found.

MATERIALS AND METHODS

Abbreviations of specimen depositories are as follows: MHNG, Muséum d'histoire naturelle, Geneva, Switzer-

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land; SFDC, Sarawak Forest Department Collection, Kuching, Sarawak, Malaysia. Species determination of the colony RS-55-LMB16 was done by referring to the original description of *Yunodorylus doryloides* of which the holotype was also collected in Sarawak, Malaysia (Bako National Park, near Kuching, rainforest, soil core, IV 1978, N. M. Collins). The following specimens and images of the type material were examined in the present study.

Yunodorylus doryloides (Borowiec, 2009): SFDC; 1 subdichthadiigyne (colony no. RS-55-LMB16; individual no. SEMUT20170111B); MALAYSIA, Sarawak, Miri, Lambir Hills National Park, 04°11'43.7"N 114°02'22.7"E, ca. 61 m alt., nr. Small lake; R. Satria leg.; 11.IX.2016. – SFDC; 7 workers (colony no. RS-55-LMB16; individual no. SEMUT20170907A. – SEMUT20170907G); same data with the subdichthadiigyne. – MHNG; 3 workers (colony no. RS-55-LMB16; individual no. SEMUT20170907H. – SEMUT20170907J); same data with the subdichthadiigyne.

Yunodorylus eguchii (Borowiec, 2009): MHNG; 1 subdichthadiigyne (colony no. Eg20ix15-01; individual no. IMG20160315-1); VIETNAM, Tay Ninh Province, Lo Go Xa Mat National Park, 11°35'17"N 105°53'01-10"E, ca. 5-15 m alt.; K. Eguchi leg.; 20.IX.2015.

Acanthostichus quadratus Emery, 1895: Images of the paralectotype queen (CASENT0903813) provided in AntWeb v7.2.9 (https://www.antweb.org/).

Ooceraea crypta (Mann, 1921): Images of the type material (USNM ENT 00529135) provided in the website of Smithsonian National Museum of Natural History (https://www.si.edu/).

Multi-focused montage images were produced using Helicon Focus Pro. (Helicon Soft Ltd., http://www.heliconsoft.com/) from a series of source images taken by a Panasonic Lumix DMC-GX8 digital camera attached to a Nikon AZ100 stereomicroscope. Artifacts/ghosts and unnecessary parts (unfocused appendages, insect pin, etc.) surrounding or covering target objects were erased and cleaned up using the retouching function of Helicon Focus Pro, and the color balance, contrast and sharpness were adjusted using Adobe Photoshop CS6.

The following parts of the bodies were measured using ImageJ 1.49m (National Institute of mental Health, USA, available at http://imageJ.nih.gov/ij/) based on the photographs taken using a Panasonic Lumix DMC-GX8 digital camera attached to the Nikon AZ100 stereomicroscope. Measurements and indices are modified from Eguchi *et al*. (2016). HL, maximum length of head in full-face view, measured from the midpoint of a line drawn across the anteriormost points of clypeus to the midpoint of a line drawn across posteriormost points of vertexal lobes of head; HW, maximum width of head in full-face view; SL, maximum length of antennal scape excluding the basal condylar bulb; 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; HFL, length of hind femur; MFL, length of mid femur; PH, maximum height of petiole (abdominal segment II) measured from an imaginary line of ventralmost point of petiole to the apex as measured in lateral view; PL, maximum diagonal length of petiole measured from the anteriormost point of the base of subpetiolar process to the posterodorsal corner 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; SI=SL/HWx100; MI=WL/PNWx100; MFI=MFL/HWx100; A3I=A3W/PWx100; PTHI=PTH/PTLx100.

RESULTS AND DISCUSSION

Subdichthadiigyne of *Yunodorylus Doryloides*

Description (Figs 1-4): Head in full-face view subrectangular, longer than broad, with lateral outline straight parallel, with posterior margin broadly and strongly concave (Fig. 2A); head in lateral view with dorsal outline straight and ventral outline strongly convex; preoccipital carina absent; frontal lobes present as narrow erect to suberect walls, narrowly separated from each other by a longitudinal strip of median portion of clypeus (Fig. 2A); anteriormost portion of frontal lobe extending anteriad far beyond the anterior margin of clypeus (red arrow in Fig. 2A); 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 straight anteromedian margin; lateroclypeal teeth low and rounded (blue arrow in Fig. 2A); mandible elongate and slender, with a large apical tooth followed by two small teeth on the masticatory margin; the edge behind the basalmost tooth of the masticatory margin almost straight (blue arrow in Fig. 3B); 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 and left lateral ocelli vestigial, recognized as small swellings, and right lateral ocellus completely absent (Fig. 2A); palp formula unknown (not dissected); mesosoma almost box-shaped, slightly slender, in lateral view with dorsal margin slightly convex, in dorsal view slightly constricted in front of propodeum, without flight sclerites; promesonotal suture faintly recognized, convex anteriad; metanotal groove faintly recognized, accompanied with a median small

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Fig. 1. Subdichthadiigyne of *Yunodorylus doryloides* (colony no. RS-55-LMB16; individual no. SEMUT20170111B), body in lateral view.

depression (blue arrow in Fig. 2C); mesosoma in dorsal view distinctly longer than broad; anterior margin of mesopleuron weakly convex, but not forming a distinct lobe (red arrow in Fig. 2D); metapleural gland orifice concealed beneath a ventrolaterally directed cuticular flange; propodeum with a pair of faintly and bluntly produced posterodorsolateral corners, in posterodorsal view with a faint median longitudinal depression; an endophragmal pit distinct on the lateral face of propodeum (blue arrow in Fig. 2D); 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 a little behind midlength of petiole, with anterior margin weakly concave and lateral margins weakly convex; subpetiolar process developed as a rectangular lobe, with an obtuse anteroventral and posteroventral angle (Fig. 4A); abdominal segments III–VII without tergosternal fusion; abdominal segment III 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, apically without any specialized setae (such as thick and truncate-tipped setae), and without any peg-like or spine-like setae on posterolateral margins (Figs 4D, 4E); hypopygium flattened ventrally, with a U-shaped posterior margin, without any peg-like or spine-like setae on posterolateral margins (Fig. 4E); sting developed (Figs 4C, 4D, 4E).

Body densely covered with short standing hairs, less sculptured but densely with hair pits, yellowish-brown (see Fig. 1).

Measurements of the queen: HL 0.9 mm; HW 0.85 mm; SL 0.35 mm; ML 1.46 mm; MH 0.53 mm; PNW 0.61 mm;

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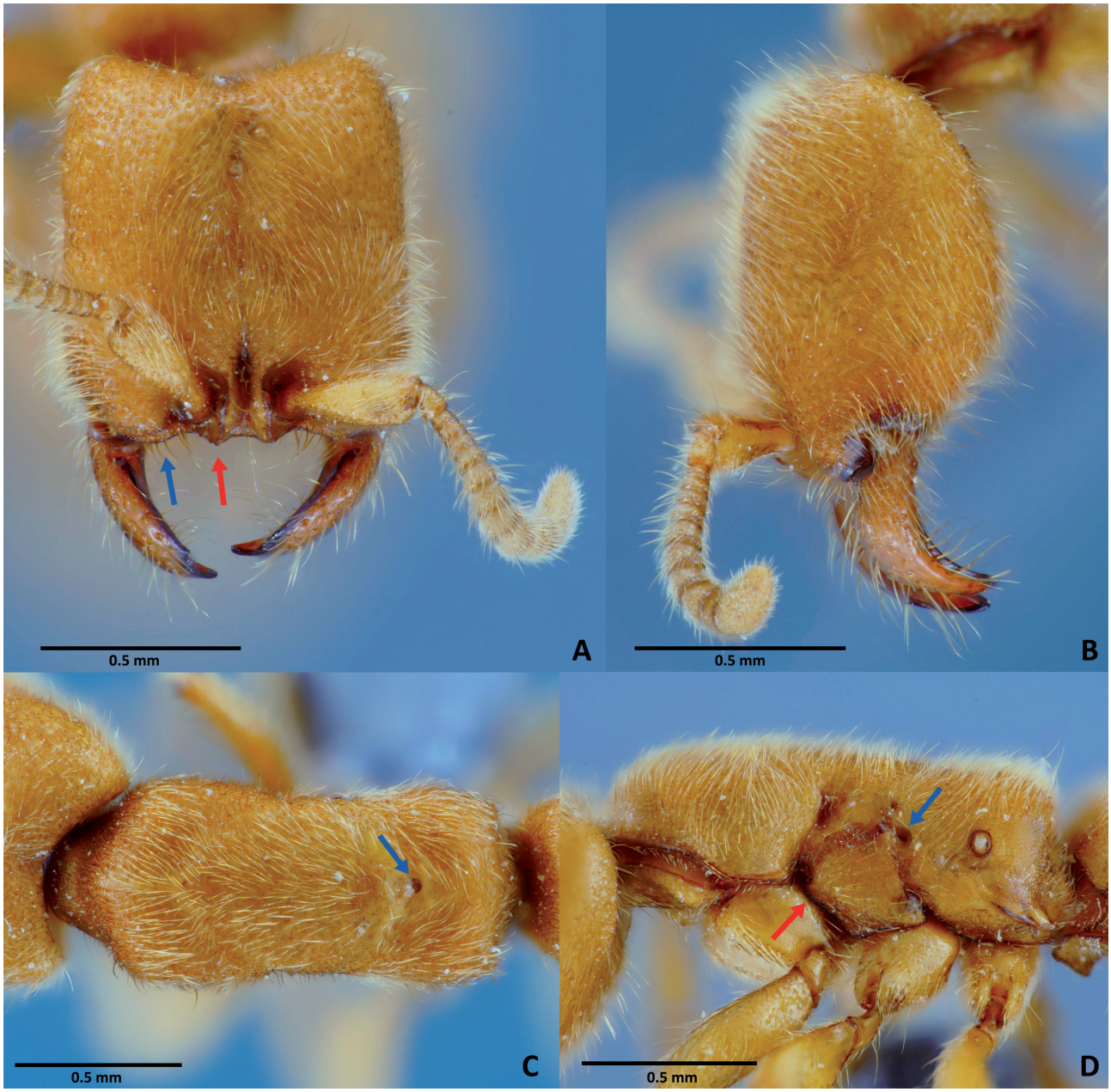


Fig. 2. Subdichthadiigyne of *Yunodorylus doryloides* (colony no. RS-55-LMB16; individual no. SEMUT20170111B). (A) Head in full-face view, with a blue arrow indicating lateroclypeal tooth, and a red arrow indicating the anteriormost portion of frontal lobe. (B) Head in lateral view. (C) Mesosoma in dorsal view, with a blue arrow indicating median small depression. (D) Mesosoma in lateral view, with a blue arrow indicating an endophragmal pit, and red arrow indicating the anterior margin of mesopleuron.

HFL 0.57 mm; MFL 0.51 mm; PH 0.59 mm; PL 0.61 mm; PW 0.54 mm; A3W 0.80 mm; A3L 0.51 mm; CI 94.44; SI 41.18; MI 239.34; MFI 60; A3I 148.15.

Taxonomic remarks: The subdichthadiigyne of *Yunodorylus doryloides* is very similar to that of *Y. eguchii*. However, the following morphological differences were observed externally: mandible elongate and slender, with the edge behind the basalmost tooth of the masticatory margin almost straight in the former (blue arrow in Fig. 3B), but triangular, with the edge behind the basalmost tooth distinctly convex in the latter (red arrow in Fig. 3A); lateroclypeal teeth rounded in the former, but weakly pointed in the latter; mesosoma in dorsal view slenderer in the former than in the latter; mesonotum in dorsal view distinctly longer than broad in the former, but almost as long as broad in the latter; anterior margin of mesopleuron without a small lobe (red arrow in Fig. 2D) in the former, but with a small distinct lobe projecting over basal part of forecoxa

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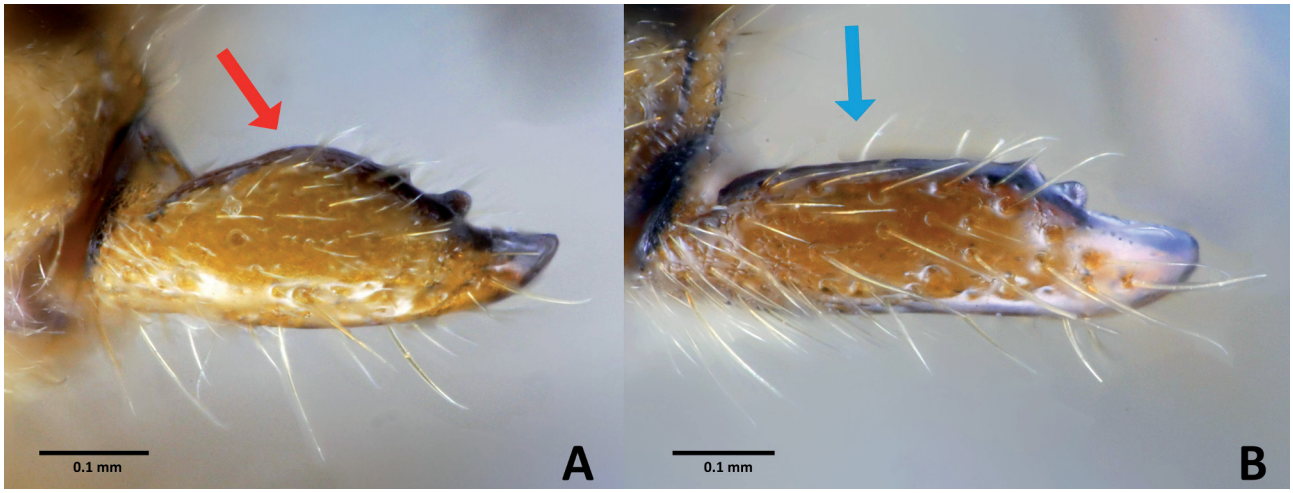


Fig. 3. Subdichthadiigyne of the genus *Yunodorylus,* mandible in full-face view with an arrow indicating edge of behind the basalmost tooth. (A) *Yunodorylus eguchii* (colony no. Eg20ix15-01; individual no. IMG20160315-1). (B) *Yunodorylus doryloides* (colony no. RS-55-LMB16; individual no. SEMUT20170111B).

in the latter; metanotal groove in dorsal view faintly recognized in the former, but relatively conspicuously recognized in the latter; ventral margin of metapleuron almost straight in the former, but weakly convex in the latter; petiole in dorsal view narrower and longer in the former than in the latter; pygidium apically without any specialized setae in the former, but with long, thick and truncate-tipped setae in the latter.

Eguchi *et al.* (2016) concluded that the queen of *Y. eguchii* is subdichthadiiform, because the worker-queen dimorphism is weaker in *Yunodorylus* than in the dorylomorph lineages with a full dichthadiigyne, i.e., 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. The present study on *Y. doryloides* also supported this view. The mode and degree of the morphological specialization in the subdichthadiigyne is similar among *Yunodorylus*, *Acanthostichus* (but a minority of the species has subdichthadiigynes), and *Ooceraea crypta*. However, interestingly, the "dichthadiigyne" of *O. crypta* has reduced compound eyes and three well-developed ocelli despite the worker lacking all of them (Borowiec, 2016). The visual function is presumably related to the mode of colony moving.

Biological remarks: The colony was found in soft and clayish soil under a rotting log on the floor of the forest edge near a natural pond. Although colonies of *Y. eguchii* were found in thick soil walls of termite mounds built on the ground of lowland evergreen forest (Eguchi *et al*., 2016), no relationship with termites was observed for *Y. doryloides*. The colony consisted of a single subdichthadiigyne, 393 workers, and 237 tiny larvae in earlier instar only. This suggests the presence of synchronized brood development in *Y. doryloides* as expected in *Y. eguchii* (Eguchi *et al.*, 2016).

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Fig. 4. Subdichthadiigyne of *Yunodorylus doryloides* (colony no. RS-55-LMB16; individual no. SEMUT20170111B). (A) Petiole in lateral view. (B) Petiole in dorsal view. (C) Apex of gaster in lateral view. (D) Hypopygium in ventral view. (E) Pygidium in dorsal view.

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