

New synonymy and redescription of *Anochetus mixtus* Radchenko, 1993, and distinction from the other members of the *Anochetus rugosus* group (Hymenoptera: Formicidae: Ponerinae)

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ABSTRACT. *Anochetus yunnanensis* Wang, 1993 is recognized as a junior synonym of *Anochetus mixtus* Radchenko, 1993, and the queen and male of *Anochetus mixtus* are described for the first time. In addition, male genitalia of *A. princeps*, *A. rugosus* and *A. mixtus* are described. The present study suggests the morphology of the male genitalia and associated sclerites may be useful for discriminating among *Anochetus* species in which the workers are largely indistinguishable.

Keywords: *Anochetus mixtus*, *Anochetus yunnanensis*, synonymy, queen, male

INTRODUCTION

The ant genus *Anochetus* Mayr, 1861 is assigned to the *Odontomachus* genus group of the tribe Ponerini, the subfamily Ponerinae (Schmidt & Shattuck, 2014; Bolton, 2016) based on the results of a recent molecular phylogenetic analysis (Schmidt, 2013). All members of the genus are distributed in tropical and subtropical zones, though a few species extend into the temperate zone. Brown (1978) revised the genus comprehensively, and proposed 22 species groups. His revision has been widely used as the basis for the taxonomy of the genus. A total of 112 extant and 8 fossil species have so far been described based on the worker caste (Bolton, 2016).

Radchenko (1993) described *Anochetus mixtus* based on the holotype worker from Cuc Phuong, Ninh Binh, Vietnam in his taxonomic paper on Vietnamese ants which was published in February, 1993. He assigned the species to the *A.*

rugosus species group sensu Brown (1978), and noted: “The species ... has mixed features of *A. rugosus* F. Smith (trunk, completely and boldly rugose, except mesopleura) and of *A. muzzioli* MENOZZI and *A. princeps* EMERY (head smooth, shining, only front and lower part of vertex with striae)”. That is to say that, according to Radchenko (1993) and Brown (1978), *A. mixtus* is differentiated from the other members of the species groups based on the worker morphology: a pronotal disc with coarse rugae in *A. mixtus*, but smooth and shiny in *A. muzzioli* Menozzi, 1932 and *A. princeps* Emery, 1884; vertex of head smooth and shiny in *A. mixtus*, but with fine longitudinal striation in *A. rugosus* (F. Smith, 1857). On the other hand, Wang (1993) described *Anochetus yunnanensis* based on the holotype from Yunnan Province, China in his paper published in April, 1993. Interestingly, Wang (1993) also presented a note almost identical to that of Radchenko (1993): “The new species is closely al-

lied to *A. princeps* and *A. muzziolii*. But, in the new species, there are coarse rugae on the disc of the pronotum; mandibles longer ($MI > 60$); head wider ($CI > 90$); antennal scapes just surpass posterior borders of the occipital lobes. In *A. princeps*, head narrower ($CI < 90$); antennal scapes surpass posterior borders of the occipital lobes by distinctly more than the length of the first funicular segment; pronotum smooth on the disc. In *A. muzziolii*, mandibles are shorter ($MI < 60$) and pronotum smooth on the disc”.

Furthermore, one of the paratypes of *A. mixtus* has the following data: “S China, Jugnnang, Dadugan, alt. 800 m, 3 May, 1957, leg. D. PANFILOV”. Jugnnang means Yunnan Province. While, the holotype of *A. yunnanensis* has the following data (according to English translation provided in the original description): “Yunnan Province (Xiaomengyuang 850 m), 1957.V.3, Панфилов”. Панфилов can be translated as Panfilov in English. That is to say that the locality, date and the collector name of the two specimens are identical. Thus, it is very probable that Wang (1993) described *A. yunnanensis* without referring to the original description of *A. mixtus* by Radchenko (1993).

After our careful examination of two paratype workers (both from Vietnam) of *A. mixtus* and the holotype (worker) of *A. yunnanensis*, we concluded that *A. mixtus* Radchenko, 1993 and *A. yunnanensis* Wang, 1993 are conspecific. In the present paper, therefore, we synonymize *A. yunnanensis* under *A. mixtus*, and provide the first description of the queen and male of *A. mixtus* based on colony-based samples collected from Vietnam.

In various lineages of ants, the reproductive, especially the male, should possess reliable species-diagnostic characters; previous studies, e.g., Schlick-Steiner *et al.*, (2006) and Satria *et al.* (2015), pointed out that morphology of male genitalia is often valuable in uncovering cryptic species. However, in the genus *Anochetus*, the combination of the worker, queen and male have not yet been known or described in 75 of the total 112 currently valid name species, and 3 of them only described based on the male. In the present paper, therefore, male genitalia of *A. princeps* and *A. rugosus* as well as *A. mixtus* are described and compared. We then discuss whether the morphology of the male genitalia and associated sclerites

is valuable in discriminating among *Anochetus* species in which the workers are very similar to each other.

MATERIALS AND METHODS

Abbreviations of the specimen depositories are as follows: ACEG, Ant Collection of Katsuyuki Eguchi (see the contact address of the present author); IEBR, Institute of Ecology and Biological Resources, Hanoi, Vietnam; IZCAS, Institute of Zoology, Chinese Academy of Sciences, Beijing, China; MHNG, Musée d'Histoire Naturelle, Geneva, Switzerland; MIZ, Museum and Institute of Zoology, Polish Academy of Sciences, Warsaw, Poland; RSC, collection managed by Rijal Satria (see the contact address of the present author); VNMN, Vietnam National Museum of Nature, Hanoi, Vietnam.

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, or by a Canon EOS 60D digital camera with a MPE Canon 65 mm lens. 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 microscope, or using a Canon EOS 60D digital camera with a MPE Canon 65 mm lens. Measurements and indices are modified from Satria *et al.* (2015). 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 in the worker and queen, or from the anteriormost point of clypeus to the midpoint of a line drawn across posteriormost points of lat-

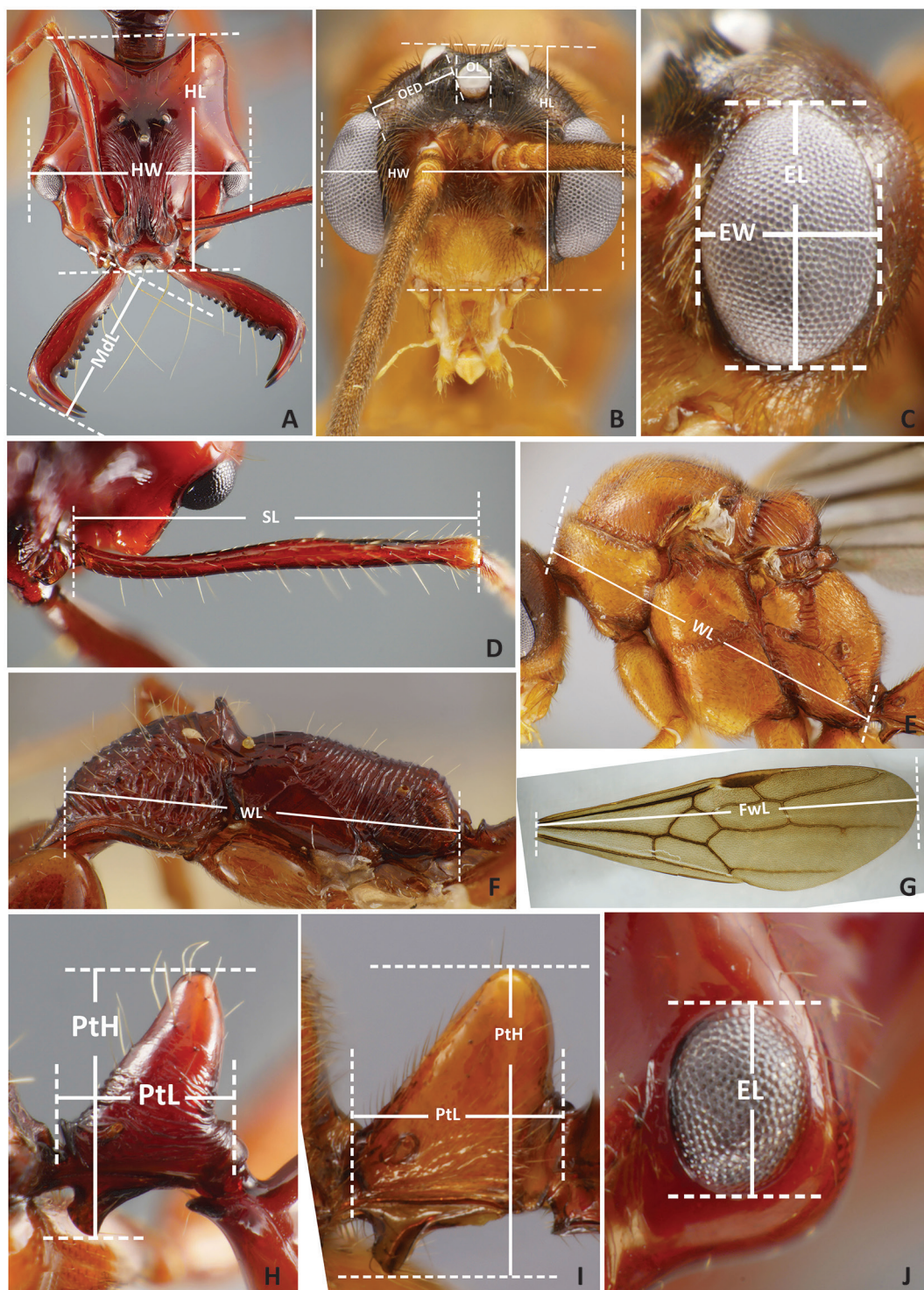


Fig. 1. Measurements for *Anochetus* species: A, D, G, J, queen; B, C, E, I, male; F, H, worker; A, B, head in full-face view; C, J, compound eye; D, antennal scape; E, F, mesosoma in lateral view; G, forewing; H, I, petiole in lateral view. Abbreviations are explained in Materials and methods section.

eral ocelli in the male. HW: maximum width of head in full-face view measured between the outer margins of ocular prominences in the worker and queen, or between the outer margins of compound eyes in the male. MDL: maximum length of mandible measured from mandibular insertion to apicalmost point of mandible (the worker and queen were measured). EL: diameter of major axis of compound eye measured in lateral view; EW, diameter of minor axis of compound eye in lateral view (male only); OL, diameter of major axis of median ocellus (queen and male). OED: maximum distance between lateral ocellus and compound eye (male only); SL, maximum length of antennal scape excluding the basal condylar bulb. WL: maximum diagonal distance of mesosoma in lateral view, measured from base of anterior slope of pronotum to posteriormost point of propodeal lobe. FWL: maximum length of forewing (the alate queen and male were measured). PTH: maximum height of petiole measured from ventralmost point of subpetiolar process to an imaginary line tangential to the apex as measured in lateral view. PTL: maximum length of petiole measured from anteriormost point of lateral flange of petiolar peduncle to the posterodorsal-most point of petiole in lateral view. $CI=HW/HL \times 100$; $MDI=MDL/HL \times 100$; $SI=SL/HW \times 100$; $PTHI=PTH/PTL \times 100$.

Male genitalia were cleaned by Chellex-TE method, then dehydrated and dissected in 99% ethanol and mounted on slide glasses with Euparal (Satria *et al.*, 2015). These slide-mounted specimens were examined with a Nikon SMZ1270, and imaged as mentioned above.

TAXONOMY

Species in the *Anochetus rugosus* species group sensu Brown (1978) can be morphologically well distinguished as below.

Key to species of *Anochetus rugosus* species group based on the worker caste

The following key is partly modified from Brown (1978).

1. Pronotal disc entirely coarsely rugose. ... 2
- Pronotal disc smooth and shiny. ... 3

2. Dorsum of head in full-face view largely smooth and shiny, but frons distinctly striate obliquely and longitudinally; mesopleuron smooth and shiny; petiolar node with its basal half weakly striate. ... *A. mixtus*
- Dorsum of head in full-face view largely striated (striation extending to nuchal carina); anterior third of mesopleuron finely sculptured; petiolar node largely coarsely rugose. ... *A. rugosus*
3. Mandibles longer ($MI > 60$); when head is seen in perfect full-face view, antennal scape surpassing posterior borders of occipital lobes by distinctly more than length of first funicular segment; head narrower ($CI < 90$). ... *A. princeps*
- Mandibles shorter ($MI < 60$); when head is seen in perfect full-face view, antennal scape surpassing posterior borders of occipital lobes at most by length of first funicular segment; head wider ($CI \geq 90$ or more). ... *A. muzziolii*

Anochetus mixtus Radchenko, 1993

(Fig. 2, 3, 4, 6A, 7A–C)

Anochetus mixtus Radchenko, 1993: 77, figs. 3–5, worker, type locality: Vietnam.

Anochetus mixtus: Guenard and Dunn, 2012: 58; Eguchi *et al.*, 2014: 27.

Anochetus yunnanensis Wang, 1993: 226, fig. 7, worker, type locality: China.

Syn. nov.

Type materials *Anochetus mixtus*: paratype (2 workers in MIZ), Vietnam: Ninh Binh: Cuc Phuong, 4.vi.1966, R. Bielawski and B. Pisarski leg.

Anochetus yunnanensis: holotype (worker in IZCAS), China: Yunnan: Xishuangbanna: Xiaomenyuang (850 m), 3.v.1957, D. Panfilov leg.

Non-type materials examined. VIETNAM – Hanoi: Ba Vi N.P., 21°03'32.3"N, 108°21'39.2"E, 1000 m alt., 25.ii.2016, Rijal S. leg., 8 workers, 13 queens (IEBR, IZCAS, MIZ, RSC, VNMM; colony: RS-09-BV16); Hanoi: Ba Vi N.P., 21°04'33"N, 105°22'02"E, ca. 710 m alt., 29.ii.2016, Rijal S. leg., 10 workers, 2 queens, 11 males (IEBR, IZCAS, MIZ, RSC, VNMM; RS-100-BV16); Ninh



Fig. 2. *Anochetus mixtus* Radchenko, paratype (worker): A, head in full-face view; B, body in lateral view; C, mesosoma in lateral view; D, mesosoma in dorsal view; E, apex of mandibles in frontal view, with an arrow indicating intercalary tooth; F, label.

Binh: Cuc Phuong N.P.: “Cay Da Co Thu” trail, 12.vi.2005, K. Eguchi leg., 1 worker (ACEG, RSC; colony: Eg12vi05-06); Lao Cai: Sa Pa: Cat Cat: along a trail to Fansipan, 3.v.2002, K. Eguchi leg., 1 worker (ACEG); Lao Cai: Van Ban: Liem Phu, ca. 300–650 m alt., 29.ix.2006, K. Eguchi leg., 1 worker (ACEG, RSC; colony: Eg29ix06-10); Bac Giang: W. Yen Tu, 21°10'38.3"N, 106°42'52.8"E, ca. 210 m alt., 27.iii.2003, K. Eguchi leg., 1 worker (ACEG, RSC; colony: Eg03-VN-049); Hai Phong: Cat Ba N.P., 20–22.vii.1999, B.T. Viet leg., 1 worker (ACEG).

Worker measurements and indices. Paratypes of *Anochetus mixtus* (n=2; PTH and PTL were unable to be measured because the measuring points were hidden by the other parts of body, and thus PTHI was not given): HL 1.96 mm, HW 1.73–1.74 mm, MDL 1.26–1.27 mm, EL 0.29 mm, SL 1.81–1.82 mm, WL 2.51–2.60 mm, CI 88.26–88.77, MDI 64.28–64.79, SI 92.35–92.86.

Holotype of *Anochetus yunnanensis*: HL 2.01 mm, HW 1.84 mm, MDL 1.31 mm, EL 0.26 mm, SL 1.83 mm, WL 2.68 mm, PTH 0.82 mm, PTL 0.53 mm, CI 91.54, MDI 65.17, SI 91.04, PTHI 154.71.

Non-types (n=10): HL 1.95–2.06 mm, HW 1.78–1.89 mm, MDL 1.30–1.39 mm, EL 0.29–0.31 mm, SL 1.81–1.90 mm, WL 2.58–2.68 mm, PTH 0.80–0.85 mm, PTL 0.52–0.56 mm, CI 89.50–93.53, MDI 66.00–68.66, SI 91.58–94.52, PTHI 148.14–154.72.

Worker description. Body relatively large (HL 1.95–2.06 mm, WL 2.58–2.68 mm). Head in full-face view slightly longer than broad (CI 88.26–88.77); ocular prominence strongly produced; posterior margin of head strongly concave. Compound eye large and oval. Mandible long (MDL 1.30–1.39 mm), slightly broadened from the base toward the midlength; masticatory margin with 11–14 distinct denticles which are arranged in a single row and gradually increase in size towards apex; intercalary tooth located at the midlength of apical tooth, well developed (indicated by an arrow in Fig. 2E). Palp formula 4, 4. Antenna 12-segmented; scape long, surpassing posterior margin of head when its laid backward, with weakly curved at distal third. Mesosoma in lateral view relatively slender. Pronotum in

lateral view forming a gentle and weakly convex slope from the posterior border to pronotal neck; mesopleural furrow conspicuous, obliquely running; upper part of mesopleuron (above the mesopleural furrow) distinctly carinate anteriorly and dorsally, forming a roundly produced anterodorsal lobe; mesonotum with an anterior transverse ridge which is usually concave medially in frontal view. Dorsal face of propodeum in lateral view long, almost straight, very gently sloping posteriad. Posterior margin of propodeum in lateral view short, gently sloping; the two faces meeting at an obtuse angle. Petiolar node in frontal and lateral views with a bluntly pointed apex, in lateral view with anterior slope almost straight and posterior slope weakly convex. Subpetiolar process in lateral view developed well as a rectangular lobe which is directed anteroventrally.

Dorsal, lateral and ventral faces of head largely smooth and shiny, but frons distinctly striate obliquely to longitudinally. Frontal lobe weakly striate. Pronotal disc coarsely rugose. Mesonotum with sparse longitudinal rugae. Mesopleuron smooth and shiny. Metapleuron and propodeum with dense transversal rugae. Petiolar node with its basal half weakly striate. First gastral tergum smooth and shiny.

Head, mesosoma, petiole and gaster with sparse, erect to suberect setae which vary in length. Head, mesosoma, petiole and gaster with sparse, decumbent to appressed pubescence which is very short on head and gaster.

For color pattern see Fig. 2; body reddish brown; mesosoma little darker than head and gaster; antennal scape reddish brown, with funiculus slightly paler; all legs brown with tibiae and tarsi slightly darker than coxae and femora.

Queen measurements and indices. Non-types (n=10): HL 2.08–2.15 mm, HW 1.97–2.04 mm, EL 0.39–0.40 mm, MDL 1.38–1.43 mm, OL 0.07–0.09 mm, SL 1.93–1.99 mm, WL 2.95–2.98 mm, PTH 1.00–1.04 mm, PTL 0.59–0.62 mm, CI 93.81–97.61, MDI 65.71–68.42, SI 89.77–94.76, PTHI 163.93–176.27.

Queen description. Body structure similar to that of the worker except in the following features: median and lateral ocelli present; distance between lateral ocelli longer than distance be-



Fig. 3. *Anochetus yunnanensis* Wang, holotype (worker): A, head in full-face view; B, body in lateral view; C, mesosoma in lateral view; D, mesosoma in dorsal view; E, label; F. *Anochetus mixtus* Radchenko, non-type worker, petiole in lateral view (colony: RS-09-BV16; Individual: SEMUT20160524F).

tween lateral and median ocelli. Mesosoma with main sclerites associated with wing function, in dorsal and lateral views relatively short and stout; pronotum in lateral view forming a gentle and almost straight slope from the posterior border to the pronotal neck; anterodorsal outline of mesoscutum in lateral view strongly and roundly raised; mesoscutum in dorsal view, with a weak posteromedian furrow, without notaular lines, with parapsidal lines of which each is recognized as a weak impression; dorsal face of propodeum in lateral view relatively short, almost straight, relatively steeply sloping posteriad; posterior face of propodeum in lateral view short, steeply sloping. Wing venation as in Figs. 4E and 4F. Petiolar node in lateral view short and high (Fig. 3F vs Fig. 4G); anterior and posterior faces meeting at an obtuse angle.

Sculpture of head similar to that of the worker: pronotum coarsely rugose; mesoscutum, mesoscutellum, and mesopleuron smooth and shiny; propodeum with dense transversal rugae; petiolar node largely striate with its apical half or one third smooth and shiny.

Pilosity similar to that of the worker. Color pattern similar to that of the worker (see Fig. 4).

Male measurements and indices. Non-types (n=10): HL 1.03–1.06 mm, HW 1.29–1.33 mm, EL 0.61–0.64 mm, OL 0.14–0.15 mm, OED 0.26–0.28 mm, SL 0.21–0.23 mm, WL 2.50–2.58 mm, FWL 5.01–5.04 mm, PTH 0.77–0.79 mm, PTL 0.49–0.51 mm, CI 121.70–128.15, SI 19.81–21.70, PTHI 154.90–157.14.

Male description. Body large (HL 1.03–1.06 mm, WL 2.50–2.58 mm). Antenna 13-segmented; scape short, 1/2 as long as segment III; segment II 1/2 as long as scape; segment III to XIII each extremely long. Palp formula 5, 4. Dorsal outline of clypeus in lateral view strongly convex. Anterior clypeal margin almost straight medially. Labrum rectangular, with distal margin triangularly emarginate. Mandible reduced to a triangular lobe. Mesosoma in dorsal and lateral views short and stout; pronotum forming a vertical and weakly convex slope from the posterior border to the pronotal neck; anterodorsal outline of mesoscutum strongly and roundly raised. Mesoscu-

tum in dorsal view with strong notauli of which posterior part forms a single longitudinal furrow (thus Y-shaped as a whole), and with very weak and slightly curved parapsidal lines. Mesopleural furrow relatively deep and wide, obliquely running. Dorsal margin of propodeum in lateral view relatively short, almost straight, steeply sloping posteriad; its posterior margin short, almost vertical; the two margins meeting at an obtuse angle; metapleuron distinctly separated from propodeum by a suture. Petiolar node in lateral view tapering to blunt apex, with anterior slope almost straight and posterior slope sinuate. Subpetiolar process in lateral view rectangular. Abdominal tergum VIII without a median spine.

Abdominal sternum IX (subgenital plate) longer than broad, triangular, tapering toward subrectangular apex, with obtuse but distinct posterolateral corners. Dorsal outline of paramere weakly convex. Distiventral part of valvaceps produced but shorter than broad, truncate distally. Ventral margin of valvaceps very weakly concave, with 23–24 denticles; its distal and dorsal margins straight, without denticles.

Wing venation similar to queen (see Figs. 4E and 4F for queen wings).

Head (excluding the venter), mesosoma (excluding mesoscutum, mesoscutellum and propodeum) and gaster largely smooth and shiny, but covered with dense hair pits. Venter of head faintly striate and shiny. Mesoscutum and mesoscutellum faintly striate; scuto-scutellar suture with sparse, strong, longitudinal rugae. Propodeum with faint texture, with weak rugae on its posterior slope. Petiole largely smooth and shiny, with basal area faintly striate.

Head, mesosoma, and gaster with fine dense subdecumbent to decumbent pubescence. Mandible, vertex near ocelli, petiole and gaster with several long setae.

For color pattern see Fig. 5; body, all legs, and antenna yellow, with posterior two third of head little darker than the remainder of body.

Biology. *Anochetus mixtus* inhabits secondary and primary forests in the lowlands to highlands, and nest in the rotting wood or beneath the bark of rotting wood.

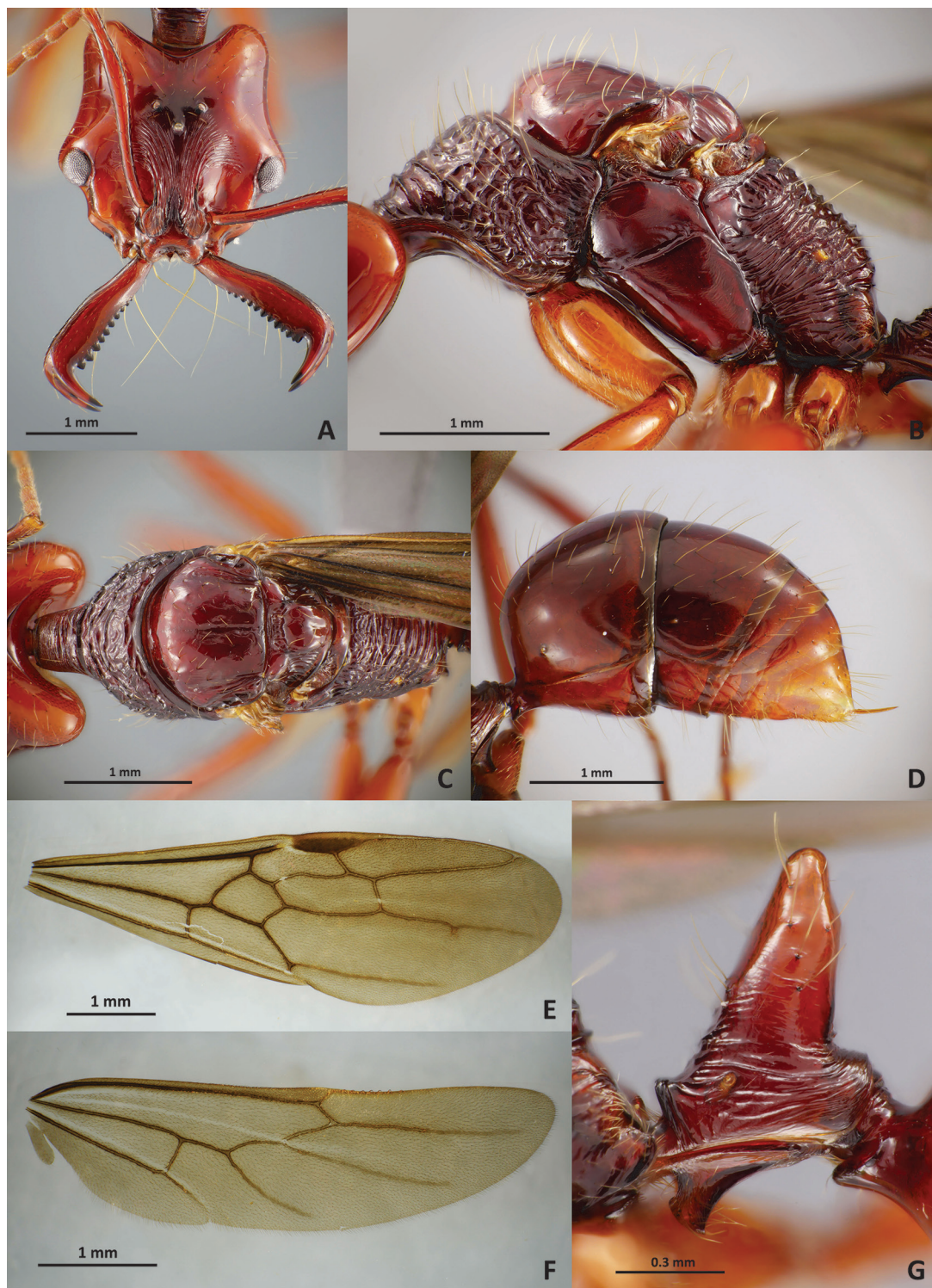


Fig. 4. *Anochetus mixtus* Radchenko, queen (colony: RS-09-BV16; individual: SEMUT20160520B): A, head in full-face view; B, mesosoma in lateral view; C, mesosoma in dorsal view; D, gaster in lateral view; E, forewing; F, hindwing; G, petiole in lateral view.

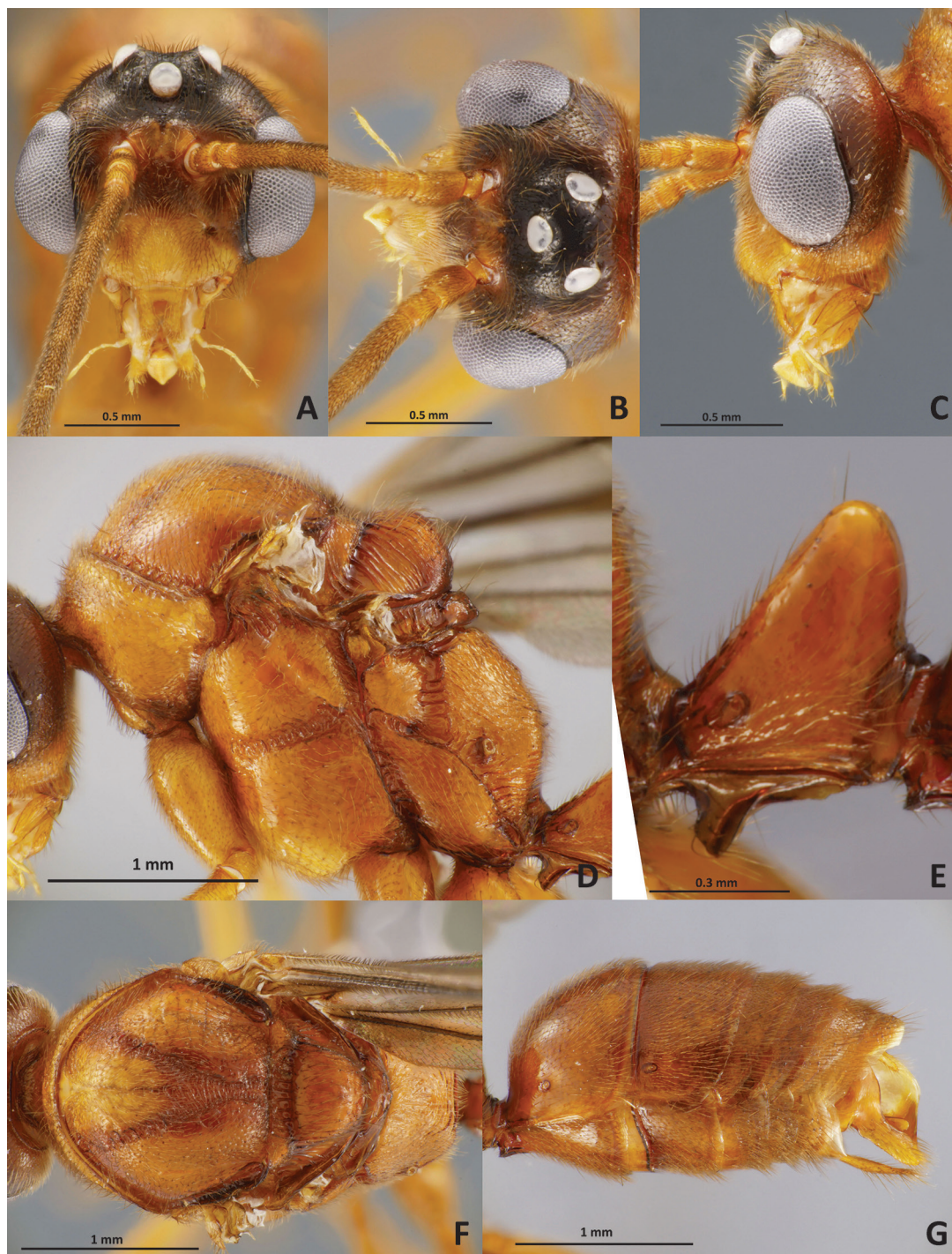


Fig. 5. *Anochetus mixtus* Radchenko, male (colony: RS-100-BV16; individual: SEMUT20160520A): A, head in full-face view; B, head in dorsal view; C, head in lateral view; D, mesosoma in lateral view; E, petiole in lateral view; F, mesosoma in dorsal view; G, gaster in lateral view.



Fig. 6. *Anochetus*, gastral apex of the male: A, *A. mixtus* Radchenko (colony: RS-100-BV16, individual: SEMUT20160520A); B, *A. princeps* Emery (colony: RS-10-CYS16, individual: SEMUT20160701A); C, *A. rugosus* (F. Smith) (colony: RS02-PAS-14, individual: SEMUT20160711B).

Distribution. Vietnam and southern part of China (Yunnan Province)

***Anochetus muzziolii* Menozzi, 1932**

Anochetus muzziolii Menozzi, 1932: 4, fig. 2, worker, type locality: Indonesia (Sumatra).

Anochetus muzziolii: Brown, 1978: 558, 576. Our recognition of *A. muzziolii* is based on the original description and Brown (1978).

Discrimination from *A. mixtus* based on the worker. Pronotal disc smooth and shiny; mandible short (Mdl < 60) (Brown, 1978).

***Anochetus princeps* Emery, 1884 (Fig. 6B, 7D–F)**

Anochetus princeps Emery, 1884: 379 (diagnosis in key), worker, type locality: Indonesia (Java).

Anochetus princeps: Brown, 1964: 213; Brown, 1978: 577, male; Wheeler & Wheeler, 1976: 61, larva; Zettel, 2012: 164; Eguchi *et al.*, 2014: 27.

Anochetus princeps var. *laeta* Forel, 1910: 27, worker, type locality: Indonesia (Sumatra). [in subspecies of *princeps* by Emery, 1911: 108; synonymy by Brown, 1964: 213.]

Anochetus jacobsoni Forel, 1911: 193, worker, type locality: Indonesia (Java). [synonymy by Brown, 1964: 213.]

Anochetus jacobsoni: Forel, 1913: 18 (q).

Anochetus jacobsoni var. *taipingensis* Forel, 1913: 18, worker, male, type locality: West Malaysia (Taiping). [synonymy by Brown, 1964: 213.]

Type material examined. *Anochetus jacobsoni*: holotype (worker in MHNG), Indonesia: Central Java: Goenoeng Oenggaran, 1.ix.1910, E. Jacobson leg.

Anochetus jacobsoni var. *taipingensis*: syntype (2 workers in MHNG), Malaysia: Malacca: Taiping: Maxwell's Hills, 1911–1912, H. v. Buttel-Reepen leg.

Anochetus princeps laeta: holotype (worker in MHNG), Indonesia: Sumatra, M. Seeldrayers leg. Images of the following material provided in AntWeb (<http://www.antweb.org>) are examined.

Anochetus princeps Emery, syntype worker (CASENT0903980); *A. serratus* Stitz, holotype (worker) (FOCOL1042).

Nontype material examined. VIETNAM – Dak Lak: Chu Yang Shin: Area 1359, N12°23'02.5", E108°20'41.7", ca. 1268 m alt., 04.iii.2016, Rijal S. leg., 6 workers, 2 queens, 2 males (IEBR, IZCAS, MIZ, RSC, VNMN; RS-10-CYS16); same loc., 04.iii.2016, Rijal S. leg., 4 workers, 3 queens (IEBR, IZCAS, MIZ, VNMN, RSC; RS-40-CYS16); same loc., 12°24'40.9"N, 108°21'07.2"E, 05.iii.2016, Rijal S. leg., 4 workers, 1 queens, 6 males (RSC; RS-21-CYS16); same loc., 12°24'42.9"N, 108°21'08"E, 05.iii.2016, Rijal S. leg., 10 workers, 2 males (IEBR, IZCAS, MIZ, RSC; RS-39-CYS16); same loc., 12°24'42.9"N, 108°21'08"E, 05.iii.2016, Rijal S. leg., 7 workers, 3 males (RSC; RS-41-CYS16); same loc.: Area 1342, 12°25'36.3–36.6"N, 108°19'17–25.8"E, 08.iii.2016, Rijal S. leg., 2 workers (RSC).

Discrimination from *A. mixtus* based on the worker. Pronotal disc smooth and shiny; mesosoma relatively slender; petiole in lateral view with a relatively long anterior peduncle.

Description of male genitalia and associated sclerites. Abdominal tergum VIII without a median spine. Abdominal sternum IX (subgenital plate) longer than broad, triangular, tapering toward subrectangular apex, without posterolateral corners. Dorsal outline of paramere in lateral view weakly convex. Distiventral part of valviceps forming an acute, pointed and slightly downcurved projection which is much longer than broad; ventral margin to the apex of projection weakly concave, with 13–14 denticles; dorsodistal margin to the apex very weakly sinuate, with ca. 10 denticles.

Anochetus rugosus (F. Smith, 1857)

(Fig. 6C, 7G–I)

Odontomachus rugosus F. Smith, 1857: 65, worker, type locality: Singapore.

Odontomachus rugosus: Wheeler & Wheeler, 1976: 61, larva.

Anochetus rugosus: Emery, 1911: 109; Brown, 1964: 214; Brown, 1978: 558, 575.

Anochetus beccarii Emery, 1884: 379 (diagnosis in key), worker, type locality: Indonesia (Sumatra). [synonymy by Brown, 1964: 214.]

Anochetus jacobsoni Menozzi, 1939:

178, fig. 3, worker, type locality: Indonesia (Sumatra). [junior primary homonym of *Anochetus jacobsoni* Forel, 1911; synonymy by Brown, 1964: 213.]

Anochetus menozzii Donisthorpe, 1941: 237, first replacement name for *Anochetus jacobsoni* Menozzi, 1939. [synonymy by Brown, 1978: 558.]

Anochetus ineditus Baroni Urbani, 1971: 360, second (unnecessary) replacement name for *Anochetus jacobsoni* Menozzi, 1939. [synonymy by Brown, 1978: 558.]

Type material examined. Images of the following material provided in AntWeb (<http://www.antweb.org>) are examined: *Anochetus beccarii* Emery, holotype (worker) (CASENT0905743).

Nontype material examined. INDONESIA – West Sumatra: Pasaman: Rimbo Panti, 6.iv.2014, Rijal, S. leg., 10 workers, 2 males (RSC; colony: RS02-PAS-14); Aceh: Putri Betung: Leuser Ecosystem, 19.ix.2012, Rijal, S. leg., 1 worker (RSC; colony: GK-17-12).

Our recognition of *A. rugosus* is based on the original description, Brown (1964, 1978), and our examination of the images of type material mentioned above.

Discrimination from *A. mixtus* based on the worker. Head in full-face view largely striated; lateral face of head partly striated; ventral face of head smooth and shiny; mesosoma relatively short and stout; petiolar node in lateral view with anterior face sinuate and posterior face weakly convex; anterior third of mesopleuron finely sculptured; propodeum coarsely rugose; petiolar node largely coarsely rugose.

Description of male genitalia and associated sclerites.

Abdominal tergum VIII without a median spine. Abdominal sternum IX (subgenital plate) slightly longer than broad, triangular, tapering toward subrectangular apex, without posterolateral corners. Dorsal outline of paramere straight, gradually sloping downward to angulate distidorsal part. Distiventral part of valviceps forming a subrectangular lobe which is longer than broad. Ventral margin of valviceps to the anterodistal corner of the lobe strongly

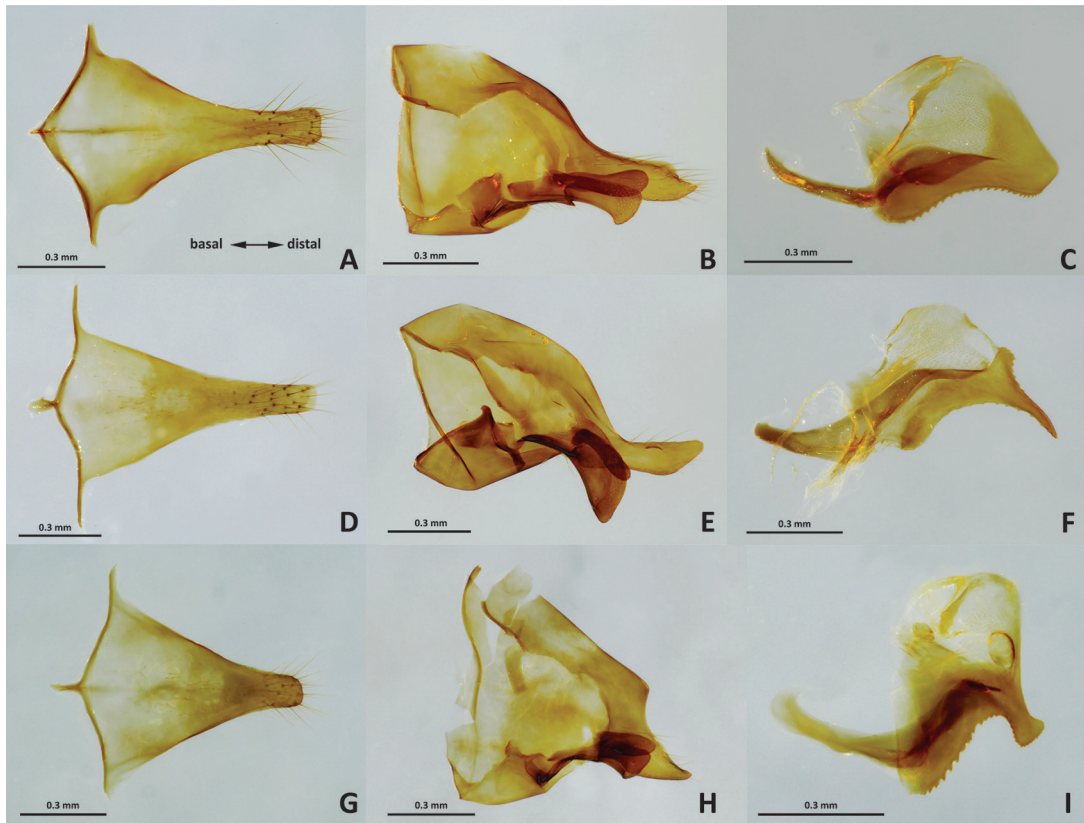


Fig. 7. *Anochetus*, male genitalia: A, D, G, abdominal sternum IX, ventral view; B, E, H, paramere and volsella, right-hand side, inner view; C, F, I, penisvalva, left-hand side, outer view; A–C, *Anochetus mixtus* Radchenko (colony: RS-100-BV16; individual: SEMUT20160525H); D–E, *Anochetus princeps* Emery (colony: RS-39-CYS16; individual: SEMUT20160525I); G–I, *Anochetus rugosus* (F. Smith) (colony: RS02-PAS-14; individual: SEMUT20160627A); arrows in A indicating direction.

concave, with 19 denticles; distal margin of the lobe very short and straight, with 9 denticles. Dorsodistal margin of valviceps weakly sinuate, without denticles.

DISCUSSION

The present study suggests the morphology of the male genitalia and associated sclerites may be useful as mentioned below for discriminating among *Anochetus* species of which the workers are similar to each other. We synonymize *A. yunnanensis* Wang, 1993 under *A. mixtus* Radchenko, 1993, and provide the first description of the queen and male of *A. mixtus* based on colony-based samples collected from Vietnam.

Species discrimination based on male genitalia and associated sclerites. *Anochetus mixtus* is easily distinguished from the other species in the *Anochetus rugosus* group by the following characters: abdominal sternum IX much longer than broad with obtuse posterolateral corners (in *A. princeps* much longer than broad, without posterolateral corners; in *A. rugosus* slightly longer than broad, without posterolateral corners); dorsal outline of paramere weakly convex (in *A. rugosus* straight, gradually sloping downward to angulate distidorsal part); distiventral part of valviceps produced but shorter than broad, truncate distally (in *A. princeps* forming an acute, pointed and slightly downcurved projection which is much longer than broad; in *A. rugosus* forming a subrectangular lobe which is longer

than broad); valviceps with 23–24 denticles on the ventral margin (in *A. princeps* with 13–14 denticles on the ventral margin, and with ca. 10 denticles on the dorsodistal margin; in *A. rugosus* strongly concave with 19 denticles on the ventral margin, and 9 denticles on the distal margin of the lobe).

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