



Description of a new species of the genus *Anochetus* Mayr (Hymenoptera: Formicidae) from Orchid Island, Taiwan



Chi-Man Leong^a, Wei-Huang Tsai^{a,1}, Mamoru Terayama^b, Shiuh-Feng Shiao^a, Chung-Chi Lin^{c,*}

^a Department of Entomology, National Taiwan University, No. 1, Roosevelt Road, Section 4, Taipei, 106, Taiwan

^b Laboratory of Applied Entomology, Graduate School of Agriculture and Agricultural Life Sciences, University of Tokyo, 1-1-1, Yayoi, Bunkyo-ku, Tokyo 113-8657, Japan

^c Department of Biology, National Changhua University of Education, No. 1, Jinde Road, Changhua 500, Taiwan

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ABSTRACT

A trap-jaw ant *Anochetus lanyuensis* sp. nov., belonging to the *graeffei* species group Brown, 1978, is described on the basis of worker and gyne castes from Orchid Island (Lanyu), Taiwan. *A. lanyuensis* sp. nov. is easily distinguishable from the other species in the *graeffei* species group by the large size of its eye, longitudinal striae on the pronotal disc, and concave dorsal margin of the petiolar node in the frontal view.

Introduction

The ant genus *Anochetus* Mayr, 1861 of the subfamily Ponerinae comprises 112 extant and eight fossil species (AntCat, 2017), mainly distributed in tropical and subtropical areas (Schmidt and Shattuck, 2014). The species in this genus have long and straight mandibles, a head with prominent ocular prominences, and a continuously curved nuchal carina on the head.

In Taiwan, two *Anochetus* species have been identified, namely *A. subcoecus* Forel, 1912 and *A. taiwaniensis* Terayama, 1989. Recently, an undescribed species collected from Orchid Island (Lanyu), which is located off the southeastern coast of Taiwan, was found when we examined specimens deposited in the Social Insect Laboratory, National Changhua University of Education. This new species apparently belongs to the *A. graeffei* species group Brown, 1978, which comprises seven species (*A. annetteae* Sharaf et al., 2017; *A. cryptus* Bharti & Wachkoo, 2013; *A. graeffei* Mayr, 1870; *A. ruginotus* Stitz, 1925; *A. shohki* Terayama, 1996; *A. validus* Bharti & Wachkoo, 2013; and *A. yerburyi* Forel, 1900), and distributed in the Oriental, Oceania, and Australian zoogeographic regions (Antmap.org, 2017). Moreover, this new species corresponds to *Anochetus* sp. 1 reported by Lin and Wu (2003) and Terayama (2009). However, this new species exhibits a distinct intercalary tooth, a large eye size, and longitudinal striae on the pronotum. Through a careful comparison, we describe *A. lanyuensis* sp. nov.

Materials and methods

Collection and preservation of specimens

Descriptions are based on nine specimens collected from Orchid Island. These specimens were dry pinned with collecting labels.

The type specimens have been deposited in the following institutes:

| | |
|--------|--|
| KUM | The Kagoshima University Museum, Kagoshima, Japan |
| NCUE | Social Insect Laboratory, Department of Biology, National Changhua University of Education, Changhua, Taiwan |
| NIAES | National Institute for Agro-Environmental Sciences, Tsukuba, Japan |
| NMNS | National Museum of Natural Science, Taichung, Taiwan |
| NTU | Department of Entomology, National Taiwan University, Taipei, Taiwan |
| SBSHKU | Insect Biodiversity and Biogeography Laboratory, School of Biological Sciences, The University of Hong Kong, Hong Kong SAR |
| TARI | Taiwan Agricultural Research Institute, Taichung, Taiwan |

Morphological study

The specimens were examined under a stereomicroscope (Leica Z16 APO, Wetzlar, Germany) and photographed using digital cameras

* Corresponding author.

E-mail address: cclin@cc.ncue.edu.tw (C.-C. Lin).

¹ Current Address: Department of Science and Technology, Council of Agriculture, Executive Yuan, No. 37, Nanhai Road, Taipei, 100 Taiwan.

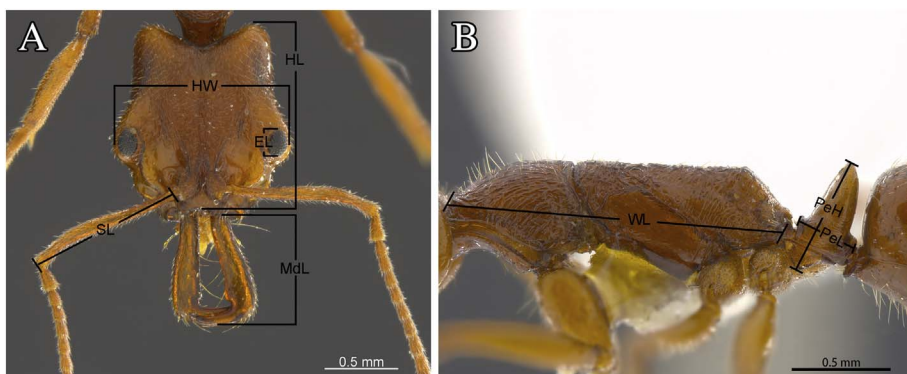


Fig. 1. Measurements of *Anochetus* worker. A: Full-face view of the head (EL, HL, HW, SL, and MdL) and B: lateral view (PeH, PeL and WL). Abbreviations are defined in the Materials and methods section.

(Leica DFC490, Wetzlar, Germany). The images were further post-processed using the Helicon Focus 6.3.5 software package (Helicon Soft., Kharkiv, Ukraine). Specimen measurements were taken with an accuracy of 0.001 mm and rounded to the nearest 0.01 mm by using the ImageJ software (Schindelin et al., 2012).

Terminology

The morphological terminology follows Brown (1978) and Zettel (2012).

The following measurements were used for morphological descriptions (Fig. 1):

| | |
|-----|---|
| EL | Eye length. Maximum length of the compound eye, measured from the uppermost point to the lowermost point. |
| HL | Head length. Maximum length of head in full-face view, measured from the anterior-most point of median clypeus margin to the posterior-most point of the femur. |
| HW | Head width. Maximum width of head in full-face view excluding the eyes. |
| SL | Scape length. Maximum length of scape excluding the basal neck and condyle. |
| MdL | Mandible length. Maximum length of mandible in frontal view of head, measured from the base of the shaft to the apex (Zettel, 2012). |
| PrW | Pronotum width. Maximum width of pronotum in dorsal view. |
| PeL | Petiole length. Maximum length of petiole in lateral view, measured from the anterior-most point to posterior-most point. |
| PeH | Petiole height. Maximum height of petiole in lateral view, measured from the uppermost point to lowermost point. |
| WL | Weber's length. Maximum length of mesosoma in lateral view, measured from the anterior-most point of the pronotum to the posterior-most point of the propodeum. |
| TL | Total length. Maximum length of the specimen, measured from the tip of the mandible to the tip of the gaster (not including sting). Due to the position of the specimen, total length = head length + mesosoma length + petiole length + gaster length. |
| CI | Cephalic Index, $(HW/HL) \times 100$. |
| PI | Pronotal Index, $(PrW/HW) \times 100$. |
| MdI | Mandibular Index, $(MdL/HL) \times 100$. |
| SI | Scape Index, $(SL/HW) \times 100$. |

Taxonomy

Anochetus graeffei species group Brown, 1978

Brown, 1978: 564

Diagnosis (worker)

The *A. graeffei* species group can be distinguished from other *Anochetus* species groups by their mandible with a strong intercalary tooth, a small to medium-sized eye, a coarsely striate pronotal disc, and a petiole with a dorsal margin largely flat in the frontal view and thin in the lateral view, tapering to a very narrowly rounded apex (Brown, 1978).

Anochetus lanyuensis sp. nov.

LSID- urn:lsid:zoobank.org:act:B1B493D9-A4D0-4A98-89DA-0F86CB778F99 (Worker: Figs. 2A, 3, and 4; dealate queen: Figs. 2B and 5).

Holotype

Worker, TAIWAN. Taitung County, Orchid Island, the coastal bush near the Lanyu airport. 10 IX 1997, W. H. Tsai (NMNS: CMAon001).

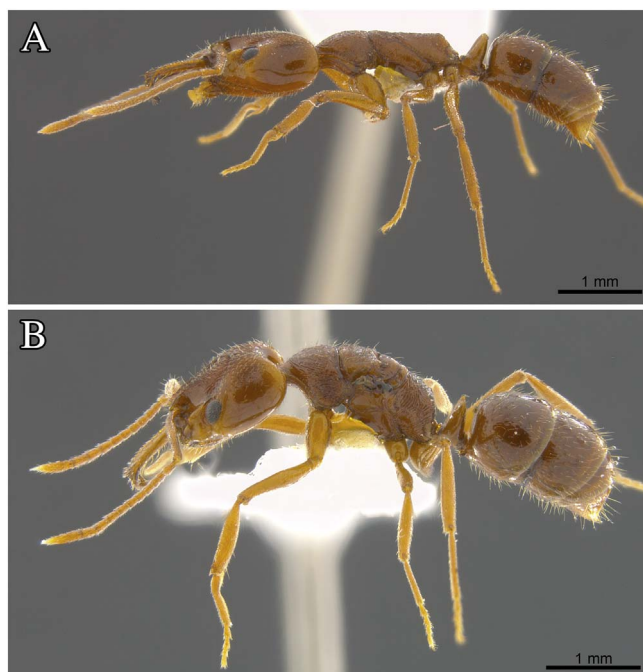


Fig. 2. Lateral view of *A. lanyuensis* sp. nov. A: holotype, worker; B: paratype, dealate queen.



Fig. 3. *A. lanyuensis* sp. nov., holotype, worker. A: Head, full-face view; B: petiolar node, frontal view; C: mandible, end-on view.

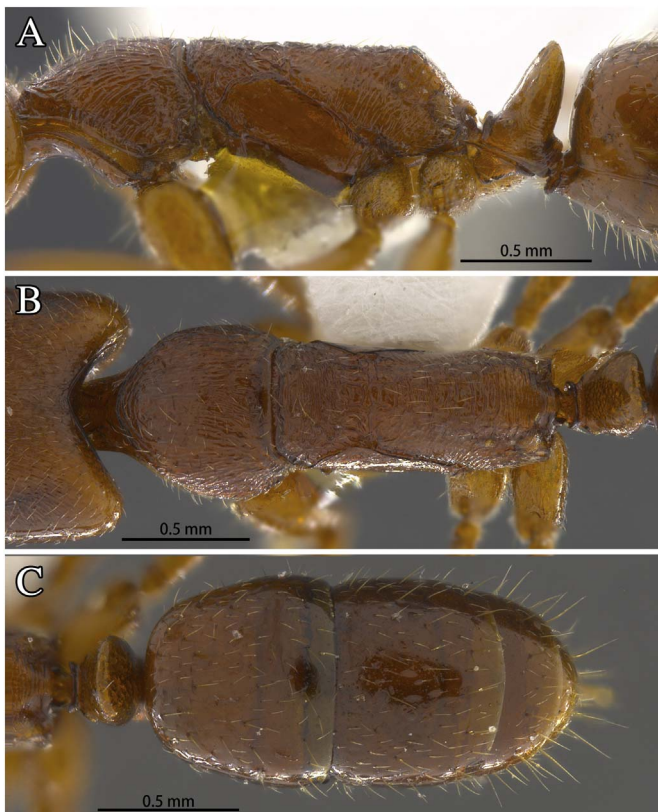


Fig. 4. *A. lanyuensis* sp. nov., holotype, worker. A: Mesosoma, lateral view; B: mesosoma, dorsal view; C: gaster, dorsal view.

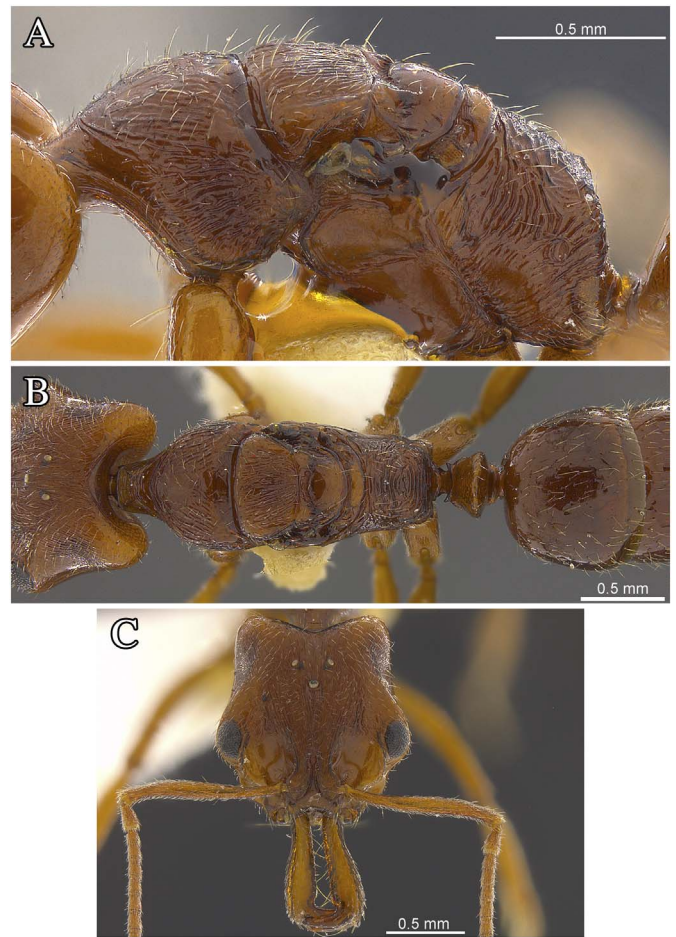


Fig. 5. *A. lanyuensis* sp. nov., paratype dealate queen. A: Mesosoma, lateral view; B: mesosoma, dorsal view; C: head, full-face view.

Paratypes

4 workers, same data as holotype (NCUE: CMAon003; NMNS: CMAon004; NIAES: CMAon005; TARI: CMAon006) and 1 dealate queen, same data as holotype (NMNS: CMAon002). 2 workers, TAIWAN. Taitung County, Orchid Island, Hungtoushan. 16 IV 2015, J. J. Liu (KUM: LCM00023; NTU: LCM00024). 1 worker, TAIWAN. Taitung County, Orchid Island, Yunghsing Organic Farm, IX 2015, F. C. Hsu (SBSHKU: LCM00025).

Measurements and indices

Holotype

Worker: EL 0.20 mm; HL 1.25 mm; HW 1.23 mm; SL 1.01 mm; MdL 0.76 mm; PrW 0.68 mm; PeH 0.61 mm; PeL 0.32 mm; WL 1.69 mm; TL 5.63 mm; CI 98, PI 55, MdI 61, SI 82.

Paratypes

Workers ($n = 7$): EL 0.16–0.21 mm; HL 1.23–1.32 mm; HW 1.16–1.23 mm; SL 1.00–1.09 mm; MdL 0.66–0.79 mm; PrW 0.65–0.70 mm; PeH 0.52–0.61 mm; PeL 0.27–0.30 mm; WL 1.54–1.72 mm; TL 5.33–5.74 mm; CI 93–95, PI 55–58, MdI 53–61, SI 86–89. Dealate queen: EL 0.39 mm; HL 1.23 mm; HW 1.26 mm; SL 1.02 mm; MdL 0.75 mm; PrW 0.76 mm; PeH 0.61 mm; PeL 0.31 mm; WL 1.75 mm; TL 5.84 mm; CI 102, PI 60, MdI 61, SI 81.

Description of worker

Structure

Head slightly longer than broad (CI: 93–98); widest at level of eyes, with deeply concave and strongly impressed ventral margin in full-face view (Fig. 3A); posterior 1/3 of head subparallel; posterodorsal corner forming dull angle and protruding posteriad; extraocular furrow gently incised. Mandible linear with shaft broadest at apical 1/3; dorsal margin without distinct teeth; apical portion with three distinct teeth (Fig. 3C); dorsal tooth longest and ca. 3.0 times as long as basal width; intercalary tooth distinct and triangular; ventral tooth ca. 2.5 times as long as basal width. Clypeus small, with gently concave anterior margin. Antenna long and slender; scape not exceeding posterior corner of head; 2nd segment 2.25 times ($n = 8$) as long as wide and as long as 3rd and 4th segments combined; 3rd to 11th segments each longer than wide, the ratio of 2nd to 5th segments nearly 2:1:1:1 in length from the base; terminal segment 3.97 times ($n = 8$) as long as wide. Eye flat and large (ca. 0.20 mm in maximum diameter), with about 12 ommatidia along the maximum diameter.

In lateral view of mesosoma, dorsal outline of pronotum weakly convex anterior half and straight posterior half; dorsal outline from mesonotum to propodeum straight (Fig. 4A); posterolateral corner of propodeum dully angulate with straight posterior margin straight. In dorsal view of mesosoma, pronotal disc slightly wider than long (Fig. 4B), with acutely convex anterior margin, neatly convex lateral side, and straight posterior margin; anterolateral corner not forming an angle.

Petiole higher than long, with acute triangular tip; anterior margin straight and posterior margin weakly convex; dorsal margin of petiole weakly concave in frontal view (Fig. 3B); subpetiolar process developed, with subtriangular ventral margin; in dorsal view, petiolar node about 0.75 times as long as wide, widest at midlength.

Gaster oval (Fig. 6C); 3rd abdominal tergum subtrapezoid with slightly convex anterior margin and straight posterior margin; its length about 0.68 mm and 0.9 times ($n = 8$) as long as wide in dorsal view; 4th abdominal tergum subrectangular; its length about 0.61 mm and 0.8 times ($n = 8$) as long as wide in dorsal view.

Sculpture

Frons and vertex of head with many thin and longitudinal striae extending to posterior lobes; malar space and gena smooth and shining.

Mandible smooth and shining. Antenna weakly microreticulate. Pronotal dorsum longitudinally striate, with carinate anterior margin. Mesonotum opaque, with weak transverse striae. Mesopleuron smooth and shining, except anterior portion weakly striate. Metapleuron and propodeum with many transverse striae. Petiole smooth and shining. Gaster smooth and shining. Legs smooth.

Pilosity

Dorsum of head with scattered and short subdecumbent pubescences. Dorsum of alitrunk and petiolar node with short erect or suberect setae. Gaster with moderately abundant long suberect setae about 0.15–0.24 mm in length and moderately abundant decumbent setae about 0.04–0.08 mm in length. Antennae and legs with short pubescences.

Color

Body reddish brown; mandible and antenna brown; legs yellowish brown.

Description of gyne (dealate queen)

Structure

General shape and mandible similar to worker caste (Fig. 5C). Ocelli forming a right-angled triangle; median ocellus larger than lateral ocelli. Eye large and circular, with 20 ommatidia along the maximum diameter. Antennal scape not reaching posterior corner of head; 2nd segment almost as long as 3rd and 4th segments combined.

In lateral view of mesosoma, dorsal outline of mesosoma well convex and arching from anterior margin of pronotum to posterior margin of propodeum (Fig. 5A); pro-mesonotal suture distinctly incised; transcutal suture distinct; mesopleural sulcus present; dorsolateral margin of propodeum forming a blunt angle. In dorsal view of mesosoma (Fig. 5B), pronotal disc with acutely convex anterior margin and broadly convex lateral margins; scutum inverted-subtrapezoidal; scutellum semicircular; metanotum with convex posterior margin; propodeal disc wider than long and widest at anterior end, with straight sides and posterior margin.

Petiole similar to with worker caste. Gaster oval, first gastral tergum wider than long in dorsal view.

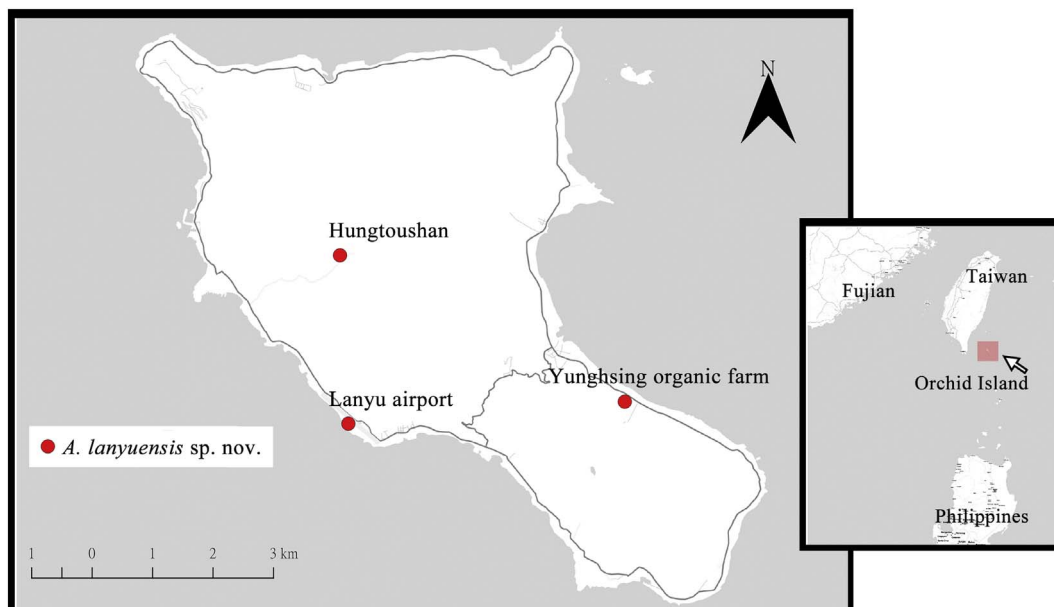


Fig. 6. Distribution map of *A. lanyuensis* sp. nov. in Orchid Island (Lanyu), Taiwan. The right small map presents the location of Orchid Island (Lanyu) in East Asia.

Sculpture

Frons and vertex of head with many thin longitudinal striae extending to posterior lobes; maler space and genal area smooth and shining. Pronotum with oblique striae, excepting anteromedian portion smooth and shining. Scutum with longitudinal striae. Scutellum and metanotum smooth and shining. Mesopleuron smooth and shining. Propodeal disc and declivity with transverse striae. 3rd abdominal tergum largely smooth and shining, with a few shallow weak punctures.

Pilosity

Similar to worker caste, but shorter and less abundant.

Color

Body reddish brown; legs yellowish brown.

Etymology

Named after Orchid Island (Lanyu), the type locality of this new species.

Distribution

Orchid Island (Taiwan), as shown in Fig. 6.

Diagnosis

Among the *A. graeffei* species group, *A. lanyuensis* sp. nov. can be distinguished from the other species by its large body size (HL + MdL \geq 1.89 mm), longitudinally striate pronotal disc, large eye (EL = 0.16–0.21 mm, 12 ommatidia along the maximum diameter), weakly concave dorsal margin of the petiole in the frontal view, and relatively longer 2nd antennal segment (as long as the length of the 3rd and 4th segments combined). *Anochetus lanyuensis* sp. nov. is particularly similar to *A. ruginotus* Stitz, 1925 from the Philippines. Both species are easily distinguishable from the others in the *graeffei* group by the large body size (HL + MdL $>$ 1.75 mm in *A. ruginotus*; HL + MdL \geq 1.89 mm in *A. lanyuensis* sp. nov.) and the longitudinally

striate pronotal disc (irregularly striate or smooth in the other species). *A. lanyuensis* sp. nov. is distinguishable from *A. ruginotus* through the following characteristics of the worker caste: in *A. lanyuensis* sp. nov., 1) larger eye [EL = 0.16–0.21 mm, 12 ommatidia along the maximum diameter (Fig. 7B); EL $<$ 0.10 mm in *A. ruginotus* (Fig. 7A)]; 2) mesonotum with weak transverse striae (Fig. 7D) (strong reticulate striae in *A. ruginotus*; Fig. 7C); 3) dorsal margin of the petiole weakly concave in the frontal view (convex in *A. ruginotus*); 4) 2nd antennal segment as long as the 3rd and 4th segments combined (2nd antennal segment as long as the 3rd and 5th segments combined in *A. ruginotus*); and 5) shorter setae on the gasteral surface (Fig. 7F) (longer in *A. ruginotus*; Fig. 7E).

Remark

The collected specimens indicate that *A. lanyuensis* sp. nov. inhabits coastal bushes, organic farms, primary forests, and nests in soil, sand, or under small stones. Although the genus of *Anochetus* is typically found in forests, this species exhibits a wide habitat range from natural forests to open areas such as farms or coasts.

Key to Taiwanese species of the genus *Anochetus* (worker)

1. Antennal scape long, exceeding posterior lobe of head by more than twice length of 2nd antennal segment; petiolar node conical shape and sharp; intercalary tooth very small... *A. taiwaniensis* Terayama, 1989.
 - Antennal scape short, not reaching posterior lobe; petiole node without conical shape in frontal view; intercalary tooth distinctly large and comparable with dorsal and ventral teeth... 2.
2. Eye small, consisting of 7–10 facets; propodeal corner with a pair of spines... *A. subcoecus* Forel, 1912.
 - Eye large, consisting of $>$ 20 facets; propodeal corner without spine... *A. lanyuensis* sp. nov.

Conflict of interest

There are no conflicts of interest to declare.

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References

- AntCat.org, 2017. Available from: <https://antcat.org>, Accessed date: 12 April 2017.
- Antmap.org, 2017. Available from: <https://antmaps.org>, Accessed date: 9 September 2017.
- Bharti, H., Wachkoo, A.A., 2013. Two new species of trap jaw ant *Anochetus* (Hymenoptera: Formicidae), with a key to known species from India. *J. Asia Pac. Entomol.* 16, 137–142. <http://dx.doi.org/10.1016/j.aspen.2012.12.008>.
- Brown, W.L., 1978. Contributions toward a reclassification of the Formicidae. Part VI. Ponerinae, tribe Ponerini, subtribe *Odontomachiti*. Section B. Genus *Anochetus* and bibliography. *Stud. Entomol.* 20, 549–638.
- Forel, A., 1900. Les Formicides de l'Empire des Indes et de Ceylan. Part VI. *J. Bombay Nat.*

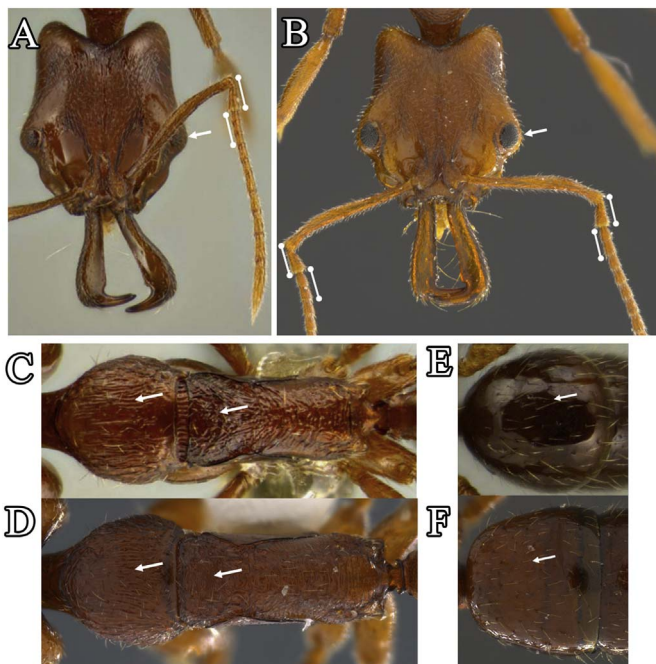


Fig. 7. *A. lanyuensis* sp. nov. (B, D, F; holotype) and *A. ruginotus* Stitz, 1925 (A, C, E; from Zettel, 2012); A, B: head, full-face view; C, D: mesosoma, dorsal view; E, F: gaster, dorsal view.

- Hist. Soc. 13, 52–65.
- Forel, A., 1912. H. Sauter's Formosa-Ausbeute. Formicidae (Hym.). Entomol. Mitt. 1, 45–81.
- Lin, C.C., Wu, W.J., 2003. The ant fauna of Taiwan (Hymenoptera: Formicidae), with keys to subfamilies and genera. Ann. Nat. Mus. Taiwan 46, 5–69.
- Mayr, G., 1861. Die europäischen Formiciden: Nach der analytischen Methode bearbeitet. C. Gerolds Sohn, Wien.
- Mayr, G., 1870. Neue Formiciden. Verh. K. K. Zool.-Bot. Ges. Wien 20, 939–996.
- Schindelin, J., Arganda-Carreras, I., Frise, E., Kaynig, V., Longair, M., Pietzsch, T., Preibisch, S., Rueden, C., Saalfeld, S., Schmid, B., Tinevez, J.Y., White, D.J., Hartenstein, V., Eliceiri, K., Tomancak, P., Cardona, A., 2012. Fiji: an open-source platform for biological-image analysis. Nat. Methods 9, 676–682. <http://dx.doi.org/10.1038/nmeth.2019>.
- Schmidt, C.A., Shattuck, S.O., 2014. The higher classification of the ant subfamily Ponerinae (Hymenoptera: Formicidae), with a review of Ponerine ecology and behavior. Zootaxa 3817, 1–242. <http://dx.doi.org/10.11646/zootaxa.3817.1.1>.
- Sharaf, M.R., Monks, J., Aldawood, A.S., Polaszek, A., 2017. *Anochetus* (Hymenoptera: Formicidae) in the Arabian Peninsula, with description of a new species from Oman. Proc. Entomol. Soc. Wash. 119, 78–89. <http://dx.doi.org/10.4289/0013-8797.119.1.78>.
- Stitz, H., 1925. Ameisen von den Philippinen, den malayischen und ozeanischen Inseln. Sitzungsber. Ges. Naturf. Freunde 1923, 110–136.
- Terayama, M., 1989. The ant tribe Odontomachini (Hymenoptera: Formicidae) from Taiwan, with a description of a new species. Edaphologia 40, 25–29.
- Terayama, M., 1996. Taxonomic studies on the Japanese Formicidae, part 2 seven genera of Ponerinae, Cerapachyinae and Myrmicinae. Nat. Hum. Act. 1, 9–32.
- Terayama, M., 2009. A synopsis of the family Formicidae of Taiwan (Insecta, Hymenoptera). Liberal Arts, Bull. Kanto Gakuen Univ. 17, 81–266.
- Zettel, H., 2012. New trap-jaw ant species of *Anochetus* Mayr, 1861 (Hymenoptera: Formicidae) from the Philippine Islands, a key and notes on other species. Myrmecol. News 16, 157–167.