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DESCRIPTION OF THE MALE CASTE OF *LEPTOGENYS BORNEENSIS* (HYMENOPTERA, FORMICIDAE), WITH ITS FIRST DISCOVERY IN SUMATRA

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Description of the Male Caste of *Leptogenys borneensis* (Hymenoptera, Formicidae), with Its First Discovery in Sumatra. Satria, R., Nugraha, F. A. D., Achyar, A., Zulyetti, D. & Eguchi, K. — Males of *Leptogenys* (*Lobopelta*) *borneensis* Wheeler, 1919 are described, including their genital morphology, which is important for diagnostics and morphological phylogeny of the genus *Leptogenys* Roger, 1861. The mtDNA COI barcoding sequence of 607 bp obtained and uploaded to GenBank and BOLD. The species was previously known from Borneo (Malaysia: Sarawak — type locality), Thailand and Vietnam and is recorded for the first time from Sumatra (Indonesia).

Key words: ants, *Leptogenys*, new record, male, morphology.

Introduction

The genus *Leptogenys* Roger, 1861 includes 316 valid nominal species and 14 subspecies and is widespread in tropical and subtropical regions, with some species distributed in Holarctics (Lattke, 2011; Janicki et al., 2016; Guénard et al., 2017; Arimoto & Yamane 2018). Previously in Sumatra Island, the sixth largest island of the world, nine species and three subspecies have been recorded (Janicki et al., 2016; Guénard et al., 2017), but the total species richness of the genus seems to be underestimated if compared with other localities of Indonesia or other parts of Southeast Asia, such as 15 species in Java (Karavaiev, 1925, 1926; Chapman & Capco, 1951; Ito et al., 2001), 14 species in Thailand (Jaitrong & Nabhitabhata, 2005; Khachonpisitsak et al., 2020), 18 species in Borneo (Bakhtiar & Chiang, 2011; Pfeiffer et al., 2011), 17 species and two subspecies in West Malaysia and Singapore (Imai et al., 1983; Maruyama et al., 2010; Arimoto, 2017; Wang et al., 2022). Then, in our course of inventory and taxonomic studies of ants in Sumatra, we have newly recorded species and genera from Sumatra (Satria et al., 2015; Satria et al., 2017; Satria & Yamane, 2019; Satria & Herwina, 2020; Satria & Jannatan, 2021; Musfira et al., 2022; Satria et al., 2022), and we herein record *Leptogenys borneensis* Wheeler, 1919 as new to Sumatra Island. Furthermore, we also describe the hitherto unknown male of this species for the first time, with a special attention to genital morphology.

Material and Methods

In our surveys of leaf-litter ants conducted in December 2021 in Mount Sago (0°19'16.1472" S 100°39'39.2472" E, ca. 1500 m alt.), Situjuah Banda Dalam, Situjuah Limo Nagari, 50 Kota District, West Sumatra, Indonesia, a colony (colony code: RS-SG-02) of *Leptogenys borneensis* was found by visual searching and collected. All specimens were deposited in the Laboratory of Ecology, Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Negeri Padang which is managed by Rijal Satria (RSC).

Species determination of *Leptogenys borneensis* was made by referring to the original description by Wheeler (1919), and images of the type material (MCZ cotype no. 20498) provided by the Database of the Zoological Collections, Museum of Comparative Zoology, Harvard University (MCZbase, 2022).

The genitalia of the males preserved in 70 % ethanol were slide-mounted by following Satria et al. (2015). The genitalia were dissected into several main components using forceps in a small amount of Euparal (Waldeck GmbH & Co. KG) on a slide glass, and covered with a cover-slip. These slide-mounted specimens were examined with a Nikon SMZ1270 stereomicroscope.

Multi-focused montage image were produced using Helicon Focus Pro. (Helicon Soft Ltd., <http://www.heliconsoft.com/>) from a series of source images taken by a Canon EOS KissX5 digital camera attached to a Nikon SMZ1270 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 parts of the bodies were measured using ImageJ 1.49 m (National Institute of Mental Health, USA, available at <http://imagej.nih.gov/ij/>) based on the photographs taken using a Canon EOS KissX5 digital camera attached to the Nikon SMZ1270 stereomicroscope under suitable magnifications. Morphological terminology, abbreviations of measurements and indices follow Boudinot (2013, 2018), and Satria et al. (2015) for genitalia, and Arimoto & Yamane (2018) for body: HW = head width; HL = head length; EL = eye length; EW = eye width; OL = median ocellus length; OED = ocellus-eye distance; SL = scape length; WL = Weber's length; PW = pronotum width; PTH = petiole height; PTL = petiole length; CI = HW×100/HL; SI = SL×100/HW; PTHI = PTH×100/PTL.

Taxonomy

Leptogenys borneensis Wheeler, 1919 (figs 1–3)

Leptogenys (Lobopelta) borneensis Wheeler, 1919: 59, worker, type locality: Malaysia (Sarawak: Kuching)

Diagnosis of the worker

Head in frontal view with its posterior margin slightly convex; mandible triangular; clypeus strongly carinate. Mesosoma in lateral view, long and slender; dorsal margin of mesothorax slightly concave; posterior margin of petiole weakly convex. Petiolar node in frontal and lateral views with a bluntly pointed apex, in lateral view with anterior slope

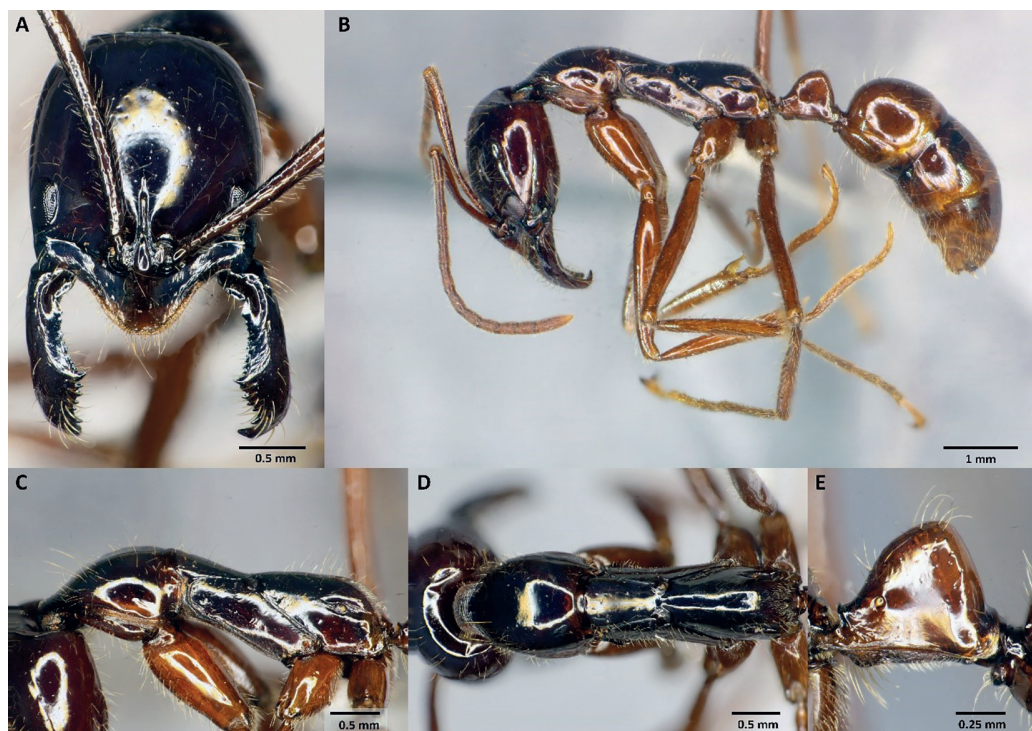


Fig. 1. *Leptogenys borneensis* Wheeler, 1919 (worker, individual code: SEMUT13xii2021-A, colony code: RS-SAGO-02): A — head in full-face view; B — body in lateral view; C — mesosoma in lateral view; D — mesosoma in dorsal view; E — petiole in lateral view.

broadly convex and posterior slope weakly convex or almost straight; subpetiolar process not developed. The body dark brown with legs and antennae paler.

Material examined. **Indonesia:** West Sumatra, 50 Kota District, Situjuh Limo Nagari, Situjuh Banda Dalam, Mt. Sago, 0°19'16.1472" S 100°39'39.2472" E, ca. 1500 m alt., 13.12.2021, colony code RS-SG-02, 15 workers and 4 males (individual code: RJ6-8vi22, RJ7-8vi23, SEMUT13xii2021-B, Rj-6-COI-ext. 6.12.2022) (leg. R. Satria) (RSC).

Material used for DNA barcoding

One male, colony code RS-SG-02, individual code: Rj-6-COI-ext6vii2022. The 607 bp of barcode sequence is available at GenBank NCBI (accession number: OP872668) and BOLD System (<https://www.boldsystems.org/>, Project name: UNP, Process ID: UNP002-23).



Fig. 2. *Leptogenys borneensis* Wheeler, 1919 (male, individual code: SEMUT13xii2021-B, colony code: RS-SAGO-02): habitus in lateral view.

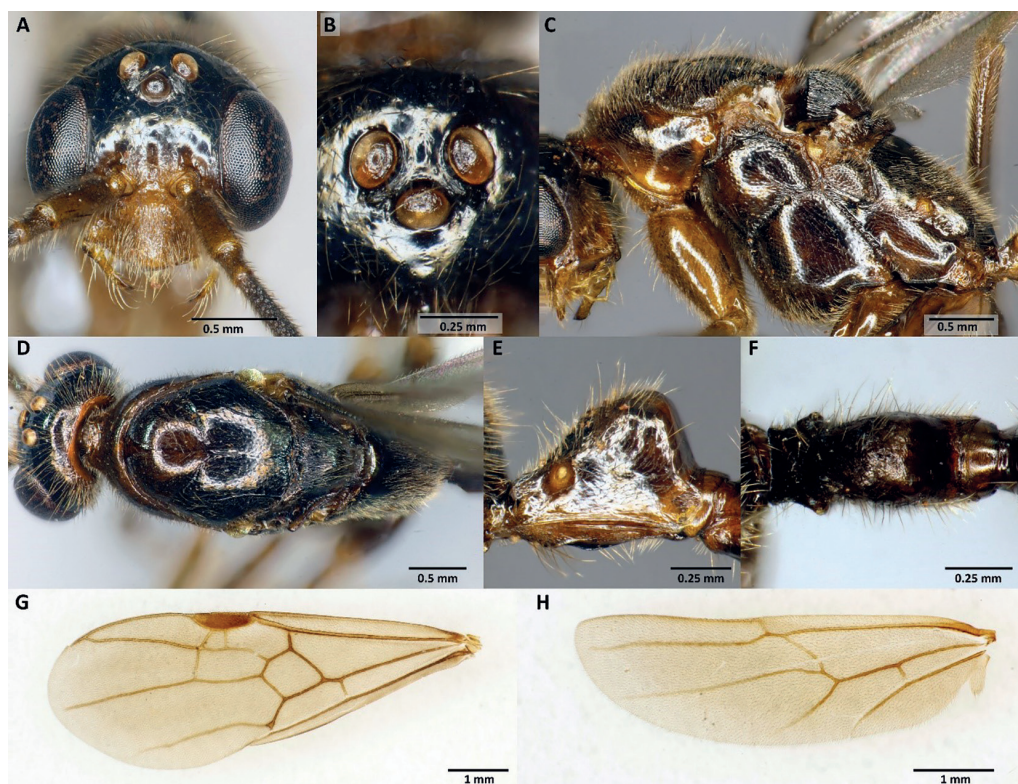


Fig. 3. *Leptogenys borneensis* Wheeler, 1919 (male, individual code: SEMUT13xii2021-B, colony code: RS-SAGO-02): A — head in full-face view; B — ocelli; C — mesosoma in lateral view; D — mesosoma in dorsal view; E — petiole in lateral view; F — petiole in dorsal view; G — forewing; H — hind wing.

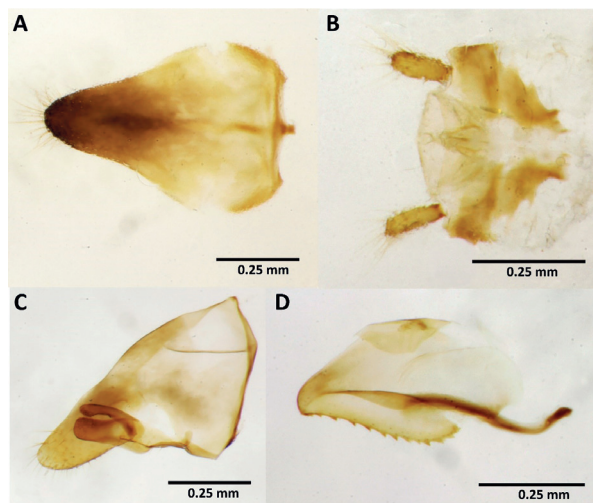


Fig. 4. *Leptogenys borneensis* Wheeler, 1919 (male, individual code: RJ7-8vi22, colony code: RS-SAGO-02): A — abdominal sternite IX; B — abdominal tergite IX; C — Gonopod (paramere) and volsella, left-side, inner view; D — penisvalva, left-side, inner view.

Description of the male

Head in full-face view oval, slightly shorter than wide; posterior margin of head convex. Preoccipital carina distinct dorsally and laterally, but not forming a flange. Mandible without basal angle and teeth, apex rounded. Palp formula: 4, 4. Eye large and occupies $2/3$ of head length. Ocelli large; major axis of median ocellus longer than minimum distance between lateral ocelli; major axis of lateral ocellus shorter than minimum distance between lateral ocellus and eye. Antenna 13-merous; scape length less than half of head width, $2/3$ as long as 3rd antennomere; 2nd antennomere 0.25 as long as scape; 3rd to 12th antennomeres each extremely long and cylindrical; 13th antennomere extreme-

ly long, tapering apically. Clypeus without longitudinal median carina; anterior margin broadly convex.

Mesoscutum in dorsal view longer than wide, widest posterior to mid-length, broadly convex in lateral view; notaulus scrobiculate; parapsidal line longer than half length of mesoscutal sulcus; transscutal line sinuous. Mesopleuron distinct and complete. Metapleuropropodeal suture present. Propodeal dorsum in lateral view straight, longer than length of declivity; propodeal declivity broadly convex; propodeal spiracle circular. Wing venation as in figs 2, G, H, with stigma; fore wing approximately 3 times as long as wide, approximately 1.3 times as long as hind wing length; hind wing approximately 3.5 times as long as wide. Fore tibia with single spur, each middle and hind tibia with two spurs. Pretarsal claw multidentate.

Petiole in lateral view longer than height, in dorsal view longer than wide (fig. 3, F); lateral margin straight in dorsal view; petiolar node in lateral view subtrapezoidal, anterior margin inclined posterad, posterior margin slightly inclined anterad. Anterior lobe of subpetiolar process in lateral view short, with postero-ventral angle sharpened; posterior extension in lateral view long and low, separated from anterior lobe by shallow notch, with ventral margin broadly convex. Pygostyle digitiform with long setae on apical half (fig. 3, A). Abdominal sternite 9 with elongate, subtriangular apical lobe of which apex is round (fig. 3, B).

Genital capsule longer than broad. Gonopod apex in lateral view longer than high (fig. 3, C). Lateropenite in lateral view rectangular with rounded corners and long, its posterior margin as long as cuspis. Cuspis in lateral view elongate and weakly arched dorsal of lateropenite, apically slightly swollen, rounded. Apicoventral apex of valviceps strongly produced; basiventral corner of valviceps distinctly produced; ventral margin of valviceps with 13 denticles (fig. 3, D).

Head entirely smooth and shiny, except on area between median and lateral ocelli finely striate. Mandible and clypeus weakly sculptured. Pronotum, mesoscutum, mesopleuron, propodeum, petiole and gaster smooth and shiny; mesoscutellum with longitudinal striation.

Head, mesosoma, legs, petiole and gaster with fine dense subdecumbent to decumbent various length of hairs; hairs on head longer than other.

For color pattern see in figs 2, A–F; body basically dark brown; clypeus, mandible, antennal scape, and legs paler.

Measurements of the Males (n = 3)

HW 1.54–1.56 mm, HL 1.31–1.32 mm, EL 0.82 mm, EW 0.61–0.62 mm, OL 0.18 mm, OED 0.24 mm, SL 1.17 mm, WL 3.30 mm, PTH 0.69–0.70 mm, PTL 0.80 mm, CI 84–85, SI 88, PTHI 86–87.

Remarks

Leptogenys borneensis is recorded for the first time in Sumatra Island. The colony was found in decayed wood stump along the hiking trails (ca. 1500 m a.s.l.). Workers and males were found but no queen was found from the colony.

So far, based on Forel (1913), Karavaiev (1925, 1926) and this paper, the male caste is known for the following four species and one subspecies of the genus *Leptogenys* from the island of Sumatra: *Leptogenys diminuta* (F. Smith, 1857); *Leptogenys diminuta fruhstorferi* Emery, 1896; *Leptogenys kraepelini* Forel, 1905; *Leptogenys myops* (Emery, 1887),

including *Leptogenys borneensis* in the present study. However, the morphology of the male genitalia of these species remains unknown, except for *L. borneensis*, which is provided in this study.

The morphology of male genitalia provides useful characteristics to confirm and delimitate the species of ants, and to predict evolutionary trends in behavior and reproductive biology (Boudinot, 2013). The important characteristic of male morphology and genitalia that used for species delimitation were highlighted in the following previous studies: in the genus *Odontomachus* (Satria et al., 2015); in the genus *Opamyрма* (Yamada et al., 2020); in the genus *Metapone* (Wang et al., 2019); in the genus *Pheidole* (Wang et al., 2018); in the genus *Dinoponera* (Lenhart et al., 2013; Tozetto & Lattke, 2020); in the genus *Cardiocondyla* (Schmidt & Heinze, 2017). In the case of the genus *Odontomachus*, where the taxonomy problems of *Odontomachus rixosus* complex confused the myrmecologist for decades, then it can be resolved by using the information of the morphology and genitalia of the male caste (Satria et al., 2015). However, the study of the male genitalia in the genus *Leptogenys* is still limited, Trager & Johnson (1988) confirmed the status of *Leptogenys elongata* (Buckley, 1866) and *L. manni* (Buckley, 1866). They stated that the study of male genitalia is important in future revisionary work on *Leptogenys* (Trager & Johnson 1988). Lattke (2011) used male morphology as part of his argument for synonymising *L. mexicana* (Mayr, 1870) with *L. elongata* (Buckley, 1866).

Distribution. Indonesia: Sumatra (new record); Malaysia; Thailand; Vietnam.

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References

- Arimoto, K. 2017. Taxonomy of the *Leptogenys modiglianii* species group from southeast Asia (Hymenoptera, Formicidae, Ponerinae). *ZooKeys*, 651, 79–106. <https://doi.org/10.3897/zookeys.651.10366>
- Arimoto, K. & Yamane, Sk. 2018. Taxonomy of the *Leptogenys chalybaea* species group (Hymenoptera, Formicidae, Ponerinae) from Southeast Asia. *Asian Myrmecology*, 10: e010008. <https://doi.org/10.20362/am.010008>
- Bakhtiar, E. Y. & Chiang, S. L. 2011. *Leptogenys* ants (Hymenoptera: Formicidae: Ponerinae) of Sabah. *Serangga*, 15 (1–2), 37–54.
- Boudinot, B. E. 2013. The male genitalia of ants: musculature, homology, and functional morphology (Hymenoptera, Aculeata, Formicidae). *Journal of Hymenoptera Research*, 30, 29–49. <https://doi.org/10.3897/jhr.30.3535>
- Boudinot, B. E. 2018. A general theory of genital homologies for the Hexapoda (Pancrustacea) derived from skeletomuscular correspondences, with emphasis on the Endopterygota. *Arthropod Structure & Development*, 47, 563–613. <https://doi.org/10.1016/j.asd.2018.11.001>
- Chapman, J. W. & Capco, S. R. 1951. Check list of the ants (Hymenoptera: Formicidae) of Asia. *Monographs of the Institute of Science and Technology, Manila*, 1, 1–327.
- Emery, C. 1887. Catalogo delle formiche esistenti nelle collezioni del Museo Civico di Genova. Parte terza. Formiche della regione Indo-Malese e dell'Australia (continuazione e fine). *Annali del Museo Civico di Storia Naturale Giacomo Doria (Genova)*, 5 (25), 427–473. <https://doi.org/10.5281/zenodo.25420>
- Emery, C. 1896. Formicides récoltés à Buitenzorg (Java), par M. Massart. *Annales De La Société Entomologique De Belgique*, 40, 245–249. <https://doi.org/10.5281/zenodo.25469>

- Forel, A. 1905. Ameisen aus Java. Gesammelt von Prof. Karl Kraepelin 1904. *Jahrbuch Der Hamburgischen Wissenschaftlichen Anstalten*, 22, 1–26. <https://doi.org/10.5281/zenodo.14415>
- Forel, A. 1913. Wissenschaftliche Ergebnisse einer Forschungsreise nach Ostindien ausgeführt im Auftrage der Kgl. Preuss. Akademie der Wissenschaften zu Berlin von H. v. Buttel-Reepen. II. Ameisen aus Sumatra, Java, Malacca und Ceylon. Gesammelt von Herrn Prof. Dr. v. Buttel-Reepen in den Jahren 1911–1912. *Zoologische Jahrbücher. Abteilung für Systematik, Geographie und Biologie der Tiere*, 36, 1–148.
- Guénard, B., Weiser, M., Gomez, K., Narula, N. & Economo, E. P. 2017. The Global Ant Biodiversity Informatics (GABI) database: a synthesis of ant species geographic distributions. *Myrmecological News*, 24, 83–89. https://doi.org/10.25849/myrmecol.news_024:083
- Imai, H. T., Brown, W. L., Kubota, M., Yong, H. S. & Tho, Y. P. 1983. Chromosome observations on tropical ants from Western Malaysia. II. *Annual Report of the National Institute of Genetics (Japan)*, 34, 66–69.
- Jaitrong, W. & Nabhitabhata, J. 2005. A list of known ant species of Thailand (Formicidae: Hymenoptera). *The Thailand Natural History Museum Journal*, 1 (1), 9–54.
- Janicki, J., Narula, N., Ziegler, M., Guénard, B. & Economo, E. P. 2016. Visualizing and interacting with large-volume biodiversity data using client-server web-mapping applications: The design and implementation of antmaps.org. *Ecological Informatics*, 32, 185–193. <https://doi.org/10.1016/j.ecoinf.2016.02.006>
- Karavaiev, V. 1925. Ponerinen (Fam. Formicidae) aus dem Indo-Australischen Gebiet. (Schluss). *Konowia*, 4, 276–296. <https://doi.org/10.5281/zenodo.25961>
- Karavaiev, V. 1926. Ameisen aus dem Indo-Australischen Gebiet. *Treubia*, 8, 413–445. <https://doi.org/10.5281/zenodo.25966>
- Ito, F., Yamane, S., Eguchi, K., Tsuji, K., Ohkawara, K., Yamauchi, K., Nishida, T. & Nakamura, K. 2001. Ant species diversity in the Bogor Botanic Garden, West Java, Indonesia, with descriptions of two new species of the genus *Leptanilla*. *Tropics*, 10, 379–404. <https://doi.org/10.3759/tropics.10.379>
- Lattke, E. J. 2011. Revision of the New World species of the genus *Leptogenys* Roger (Insecta: Hymenoptera: Formicidae: Ponerinae). *Arthropod Systematics & Phylogeny*, 69 (3), 127–264. <https://doi.org/10.3897/asp.69.e31744>
- Maruyama, M., von Beeren, C. & Witte, V. 2010. Aleocharine rove beetles (Coleoptera, Staphylinidae) associated with *Leptogenys* Roger, 1861 (Hymenoptera, Formicidae) II. Two new genera and two new species associated with *L. borneensis* Wheeler, 1919. *ZooKeys*, 59, 61–72. <https://doi.org/10.3897/zookeys.59.511>
- MCZbase. 2022. MCZBASE: The Database of the Zoological Collections. https://mczbase.mcz.harvard.edu/MediaSearch.cfm?action=search&media_id=1378737,1383948,1381363 (accessed on 14 June 2022).
- Musfira, S. H., Rafi, M., Gusti, M., Putri, D. H. & Satria, R. 2022. New data on the genus *Strumigenys* (Hymenoptera: Formicidae) from Sumatra. *Zoosystematica Rossica*, 31 (1), 74–86. <https://doi.org/10.31610/zsr/2022.31.1.74>
- Pfeiffer, M., Mezger, D., Hosoiishi, S., Yahya, B. E. & Kohout, R. 2011. The Formicidae of Borneo (Insecta: Hymenoptera): a preliminary species list. *Asian Myrmecology*, 4, 9–58. <https://doi.org/10.20362/am.004002>
- Roger, J. 1861. Die Ponera-artigen Ameisen (Schluss). *Berliner Entomologische Zeitschrift*, 5, 1–54. <https://doi.org/10.5281/zenodo.25617>
- Satria, R., Jannatan, R., Musfira, S. H., Rafi, M., Gusti, M., Sakdiah, H. T. & Putri, D. H. 2022. First discovery of the genus *Discothyrea* Roger, 1863 (Hymenoptera: Formicidae: Proceratiinae) From Sumatra, Indonesia. *Serangga*, 27 (2), 93–100.
- Satria, R., Kurushima, H., Herwina, H., Yamane, S. & Eguchi, K. 2015. The trap-jaw ant genus *Odontomachus* Latreille from Sumatra, with a new species description. *Zootaxa*, 4048, 1–36. <https://doi.org/10.11646/zootaxa.4048.1.1>
- Satria, R., Viet, B. T. & Eguchi, K. 2017. New synonymy and redescription of *Anochetus mixtus* Radchenko, 1993, and distinction from the other members of the *Anochetus rugosus* Group (Hymenoptera: Formicidae: Ponerinae). *Asian Myrmecology*, 9(e009006), 1–16. <https://doi.org/10.20362/am.009006>
- Satria, R. & Yamane, S. 2019. Two New Species of the Ant Genus *Myrmecina* (Hymenoptera: Formicidae: Myrmicinae) from Sumatra. *Zoosystematica Rossica*, 28 (1), 183–193. <https://doi.org/10.31610/zsr/2019.28.1.183>
- Satria, R. & Herwina, H. 2020. *New distribution record of ants species (Hymenoptera: Formicidae) to the fauna of Sumatra island, Indonesia*. International Conference on Biology, Sciences, and Education (ICoBioSE 2019), 10, 82–84. <https://doi.org/10.2991/absr.k.200807.020>
- Satria, R. & Jannatan, R. 2021. Dealate queens of the ant genus *Eurhopalothrix* Brown et Kempf, 1961 (Hymenoptera: Formicidae: Myrmicinae) from Sumatra. *Far Eastern Entomologist*, 430, 11–16. <https://doi.org/10.25221/fee.430.3>
- Schmidt, C. V. & Heinze, J. 2017. Genital Morphology of Winged and Wingless Males in the Ant Genus *Cardiocondyla* (Formicidae, Myrmicinae). *Insect Systematics & Evolution*, 49 (1), 59–80. <https://doi.org/10.1163/1876312X-48022163>

- Smith, F. 1857. Catalogue of the hymenopterous insects collected at Sarawak, Borneo; Mount Ophir, Malacca; and at Singapore, by A. R. Wallace [part]. *Journal of the proceedings of the Linnean Society: Zoology*, 2, 42–88. <https://doi.org/10.1111/j.1096-3642.1857.tb01759.x>
- Tozetto, L. & Lattke, J. E. 2020. Revealing male genital morphology in the giant ant genus *Dinoponera* with geometric morphometrics. *Arthropod Structure & Development*, 57, 1–12. <https://doi.org/10.1016/j.asd.2020.100943>
- Trager, J. C. & Johnson, C. 1988. The ant genus *Leptogenys* (Hymenoptera: Formicidae, Ponerinae) in the United States. In: Trager, J. C., ed. *Advances in myrmecology*. E. J. Brill, Leiden, 29–34. https://doi.org/10.1163/9789004630765_007
- Wang, Y. W., Soh, E. J. Y., Yong, G. W. J., Wong, M. K. L., Guénard, B., Economo, E. P. & Yamane, Sk. 2022. Remarkable diversity in a little red dot: a comprehensive checklist of known ant species in Singapore (Hymenoptera: Formicidae) with notes on ecology and taxonomy. *Asian Myrmecology*, e015006. <https://doi.org/10.20362/am.015006>
- Wang, W. Y., Yamada, A. & Eguchi, K. 2018. First discovery of the mangrove ant *Pheidole sexspinosa* Mayr, 1870 (Formicidae: Myrmicinae) from the Oriental region, with redescription of the worker, queen and male. *Raffles Bulletin of Zoology*, 66, 652–663. <https://doi.org/10.5281/zenodo.5360652>
- Wang, W. Y., Yamada, A. & Eguchi, K. 2019. Discovery of a new ant species of the elusive termitophilous genus *Metapone* in Singapore (Hymenoptera, Formicidae, Myrmicinae), with the first detailed description of male genitalia of the genus. *ZooKeys*, 876, 125–141. <https://doi.org/10.3897/zookeys.876.35739>
- Wheeler, W. M. 1919. The ants of Borneo. *Bulletin of the Museum of Comparative Zoology*, 63, 43–147.
- Yamada, A., Nguyen, D. D. & Eguchi, K. 2020. Unveiling the morphology of the Oriental rare monotypic ant genus *Opamyrma* Yamane, Bui & Eguchi, 2008 (Hymenoptera: Formicidae: Leptanillinae) and its evolutionary implications, with first descriptions of the male, larva, tentorium, and sting apparatus. *Myrmecological News*, 30, 27–52. https://doi.org/10.25849/myrmecol.news_030:027

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