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# TREUBIA

*A JOURNAL ON ZOOLOGY  
OF THE INDO-AUSTRALIAN ARCHIPELAGO*

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December 2020



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CONTENT

<b>Pipit Pitriana, Andreas Wessel, Tina Aschenbach, and Kristina von Rintelen</b> Exploring sponge-inhabiting barnacles of eastern Indonesia using micro-CT scanning .....	<b>77–98</b>
<b>Jarulis, Choirul Muslim, Dedy Duryadi Solihin, Ani Mardiasuti, and Lilik Budi Prasetyo</b> Characters of mitochondrial DNA D-loop hypervariable III fragments of Indonesian Rhinoceros Hornbill ( <i>Buceros rhinoceros</i> ) (Aves: Bucerotidae) .....	<b>99–110</b>
<b>Eka Kartika Arum Puspita Sari, Moch. Affandi, and Sucipto Hariyanto</b> Diversity of fruit flies (Tephritidae: <i>Bactrocera</i> spp.) in campus C of Airlangga University, Surabaya, Indonesia .....	<b>111–122</b>
<b>Sih Kahono, Dewi M. Prawiradilaga, Djunijanti Peggie, Erniwati, and Eko Sulistyadi</b> First report on hunting behavior of migratory Oriental Honey-buzzard ( <i>Pernis ptilorhynchus</i> <i>orientalis</i> ) towards migratory giant honeybee ( <i>Apis dorsata dorsata</i> ) (Hymenoptera: Apidae) on Java Island, Indonesia .....	<b>123–132</b>
<b>Fuki Saito-Morooka, Hari Nugroho, Alan Handru, and Jun-ichi Kojima</b> Taxonomic notes on the hover wasp genus <i>Eustenogaster</i> (Vespidae, Stenogastrinae), with description of two new species from Sumatra Island, Indonesia .....	<b>133–154</b>





## TREUBIA

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UDC: 593.4:595.35(594)

Pipit Pitriana

### Exploring sponge-inhabiting barnacles of eastern Indonesia using micro-CT scanning

TREUBIA, December 2020, Vol. 47, No. 2, pp. 77–98.

We present a morphological study of Indonesian sponge-inhabiting barnacles using standard light microscopy in combination with micro-CT scanning and computer-aided 3D-reconstruction of the external shell morphology. A taxonomic analysis of the material detected four different genera of sponges inhabited by five different species of balanomorph barnacles, two of which are undescribed. Together with conventional morphological examination by dissection, we provide modern non-destructive imaging methods, using micro-CT scanning to enhance our knowledge of the morphological characters of sponge-inhabiting barnacles from eastern Indonesia. Although there were some methodological limitations regarding the contrast-enhancing technique, this study demonstrates micro-CT as a useful non-destructive technique of integrative taxonomy, for the examination of sponge-inhabiting barnacles.

(Pipit Pitriana, Andreas Wessel, Tina Aschenbach, and Kristina von Rintelen)

**Keywords:** Cirripedia, Indonesian biodiversity, integrative taxonomy, micro-computer tomography, shell morphology

UDC: 598.89:577.2

Jarulis

### Characters of mitochondrial DNA D-loop hypervariable III fragments of Indonesian Rhinoceros Hornbill (*Buceros rhinoceros*) (Aves: Bucerotidae)

TREUBIA, December 2020, Vol. 47, No. 2, pp. 99–110.

The Rhinoceros Hornbill (*Buceros rhinoceros*) genetic characteristics consist of nucleotide polymorphisms, haplotypes, genetic distances, and relationships which are important for their conservation effort in Indonesia. We sequenced mitochondrial DNA D-loop hypervariable III fragments from five Rhinoceros Hornbill individuals at Safari Park Indonesia I and Ragunan Zoo, which were isolated using Dneasy® Blood and Tissue Kit Spin-Column Protocol, Qiagen. D-loop fragment replication was done by PCR technique using DLBuce F (5'-TGGCCTTTCTCCAAGGTCTA-3') and DLBuce R (5'-TGAAGG AGTTCATGGGCTTAG-3') primer. Thirty SNP sites were found in 788 bp D-loop sequences of five Rhinoceros Hornbill individuals and each individual had a different haplotype. The average genetic distance between individuals was 3.09% and all individuals were categorized into two groups (Group I: EC6TS, EC1RG, EC2TS and Group II: EC9TS, EC10TS) with a genetic distance of 3.99%. This result indicated that the two groups were distinct subspecies. The genetic distance between Indonesian and Thai Rhinoceros Hornbills was 10.76%. Five Indonesian Rhinoceros Hornbill individuals at Safari Park Indonesia I and Ragunan Zoo probably came from different populations, ancestors, and two different islands. This study can be of use for management consideration in captive breeding effort at both zoos. The D-loop sequence obtained is a

useful character to distinguish three Rhinoceros Hornbill subspecies in Indonesia.

(Jarulis, Choirul Muslim, Dedy Duryadi Solihin, Ani Mardiasuti, and Lilik Budi Prasetyo)

**Keywords:** Bucerotidae, control region, phylogenetic, Rhinoceros Hornbill conservation, zoo

UDC: 595.773.4(594.59)

Eka Kartika Arum Puspita Sari

**Diversity of fruit flies (Tephritidae: *Bactrocera* spp.) in campus C of Airlangga University, Surabaya, Indonesia**

TREUBIA, December 2020, Vol. 47, No. 2, pp. 111–122.

This research aims to get information about the species of host plants and fruit flies, composition and structure of community, distribution pattern, and impact of environmental factors to fruit flies in Campus C, Airlangga University. Research was conducted from August to November 2019. A modification of Steiner trap with methyl eugenol 1.5 ml bait was installed in nine sites. Each Steiner trap was placed on a mango tree 1-2 meters above ground level. Trapped fruit fly specimens were collected after one week. Four replications were made, with intervals between two periods of installation. As many as 682 host plants of the fruit flies were found at the study site consisting of 25 species from 15 families. Results showed that 1121 individuals of *Bactrocera* fruit flies were found, consisting of 5 species, namely *B. carambolae*, *B. dorsalis*, *B. minuscula*, *B. occipitalis*, and *B. musae*. The most abundant species was *B. carambolae* (62.8%), followed by *B. dorsalis* (27.3%), *B. minuscula* (8.4%), *B. occipitalis* (1%), and the lowest was *B. musae* (0.5%). *B. occipitalis* has an even distribution pattern, while four other species have aggregated distribution patterns. The diversity index at nine locations ranged from 0.772 (low) to 1.151 (moderate). *B. carambolae* and *B. dorsalis* were the dominant species. The presence of fruit flies was influenced by environmental (humidity, temperature, sunlight intensity, wind) and host plant factors.

(Eka Kartika Arum Puspita Sari, Moch. Affandi, and Sucipto Hariyanto)

**Keywords:** Dacinae, diversity, fruit flies, methyl eugenol, Steiner trap

UDC: 595.799:598.836:591.5(594.5)

Sih Kahono

**First report on hunting behavior of migratory Oriental Honey-buzzard (*Pernis ptilorhynchus orientalis*) towards migratory giant honeybee (*Apis dorsata dorsata*) (Hymenoptera: Apidae) on Java Island, Indonesia**

TREUBIA, December 2020, Vol. 47, No. 2, pp. 123–132.

Both migratory Oriental Honey-buzzard (*Pernis ptilorhynchus orientalis*) and migratory giant honeybee (*Apis dorsata dorsata*) can be found in South-east Asia. The Oriental Honey-buzzard is the main predator of the giant honeybee, prey upon its honeycomb, larvae, and honey. Its existence always follows the migration of the giant honeybee. They stay on Java island during the migratory season. The giant honeybee lives in a large colony and has a powerful sting that is useful for defence against its predators. The bee is among the most dangerous animals since its threatening defensive behavior causes severe impact on the eagle and is even frequently fatal for human beings. Data collections on hunting behavior of the Oriental Honey-buzzard were based on irregular observations and interviews between the year 2003 to 2019. We categorized five hunting behaviors during data collections: flying orientation around the bee's nest, attack on living nest, failure to collect the living nest, preying upon the newly empty nest, and transferring attack of the angry bee to people nearby. The safest hunting for the Oriental Honey-buzzard is to prey upon newly empty nest left by the honeybee. When the nest was still occupied by the bee colonies, the eagle should develop a strategy to avoid and reduce the risk of being attacked. It sometimes transfers the attack to people nearby.

(Sih Kahono, Dewi M. Prawiradilaga, Djunijanti Peggie, Erniwati, and Eko Sulistyadi)

**Keywords:** hunting behavior, Java, migratory giant honeybee, Oriental Honey-buzzard

UDC: 595.798:57.06(594.4)

Fuki Saito-Morooka

**Taxonomic notes on the hover wasp genus *Eustenogaster* (Vespidae, Stenogastrinae), with description of two new species from Sumatra Island, Indonesia**

TREUBIA, December 2020, Vol. 47, No. 2, pp. 133–154.

Wasps of the genus *Eustenogaster* van der Vecht, 1969, with 17 species currently recognized, are distributed from the Indian subcontinent in the west to the Philippines, Sulawesi Island and Java Island in the east. Two new species of hover wasp genus *Eustenogaster* (*E. multifolia* sp. nov., *E. sumatraensis* sp. nov.) are described from specimens collected in Sumatra Island. The female of *E. vietnamensis* occurring in Vietnam are described for the first time. The lectotypes of *Paravespa eva* Bell, 1936 and *Ischnogaster ornatifrons* Cameron, 1902 are designated. The new taxonomic status is proposed for *Stenogaster eximioides* Dover and Rao, 1922 as a good (=valid) species of *Eustenogaster*. The synonymy of *Ischnogaster ornatifrons* Cameron, 1902 with *Eustenogaster micans* (de Saussure, 1852) has been confirmed. A revised key to species and a taxonomic and distributional checklist of all the species of *Eustenogaster* are provided.

(Fuki Saito-Morooka, Hari Nugroho, Alan Handru, and Jun-ichi Kojima)

**Keywords:** distributional checklist, lectotype, new status, revised key, synonym

**TAXONOMIC NOTES ON THE HOVER WASP GENUS *EUSTENOGASTER* (VESPIDAE, STENOGASTRINAE), WITH DESCRIPTION OF TWO NEW SPECIES FROM SUMATRA ISLAND, INDONESIA**

**Fuki Saito-Morooka<sup>\*1</sup>, Hari Nugroho<sup>2</sup>, Alan Handru<sup>3</sup>, and Jun-ichi Kojima<sup>3</sup>**

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**ABSTRACT**

Wasps of the genus *Eustenogaster* van der Vecht, 1969, with 17 species currently recognized, are distributed from the Indian subcontinent in the west to the Philippines, Sulawesi Island and Java Island in the east. Two new species of hover wasp genus *Eustenogaster* (*E. multifolia* **sp. nov.**, *E. sumatraensis* **sp. nov.**) are described from specimens collected in Sumatra Island. The female of *E. vietnamensis* occurring in Vietnam are described for the first time. The lectotypes of *Paravespa eva* Bell, 1936 and *Ischnogaster ornatifrons* Cameron, 1902 are designated. The new taxonomic status is proposed for *Stenogaster eximioides* Dover and Rao, 1922 as a good (=valid) species of *Eustenogaster*. The synonymy of *Ischnogaster ornatifrons* Cameron, 1902 with *Eustenogaster micans* (de Saussure, 1852) has been confirmed. A revised key to species and a taxonomic and distributional checklist of all the species of *Eustenogaster* are provided.

**Keywords:** distributional checklist, lectotype, new status, revised key, synonym

**ABSTRAK**

Tawon dari genus *Eustenogaster* van der Vecht, 1969, yang terdiri dari 17 spesies yang saat ini dikenal, tersebar dari anak benua India di bagian barat hingga Filipina, Pulau Sulawesi dan Pulau Jawa di bagian timur. Dua spesies baru tawon genus *Eustenogaster* (*E. multifolia* **sp. nov.**, *E. sumatraensis* **sp. nov.**) dipertelakan dari spesimen yang dikoleksi di Pulau Sumatera. Individu betina dari *E. vietnamensis* yang tercatat dari Vietnam dipertelakan untuk pertama kalinya. Lectotype dari *Paravespa eva* Bell, 1936 dan *Ischnogaster ornatifrons* Cameron, 1902 ditetapkan. Status taksonomi baru diusulkan untuk *Stenogaster eximioides* Dover and Rao, 1922 sebagai valid spesies dari genus *Eustenogaster*. *Ischnogaster ornatifrons* Cameron, 1902 dikonfirmasi sebagai sinonim dari *Eustenogaster micans* (de Saussure, 1852). Revisi dari kunci identifikasi untuk spesies, dan checklist taksonomi dan distribusi dari semua spesies *Eustenogaster* disediakan.

**Kata kunci:** Ceklist distribusi, lektotipe, status baru, revisi kunci, sinonim

**INTRODUCTION**

The hover wasps of the vespidae subfamily Stenogastrinae, with 72 species currently recognized in seven genera, are distributed from the Indian subcontinent in the west to the Philippines, Sulawesi Island and Flores Island in the Lesser Sunda Islands in the east and also in New Guinea Island and its adjacent small islands including Aru Islands (Turillazzi, 2012; Selis, 2014, 2018; Huang et al., 2019). Recent phylogenomic studies of the family Vespidae (Piekarski et al., 2018; Huang et al., 2019) showed that the subfamily Stenogastrinae is the most basal clade in the family and that eusociality evolved twice independently in the family,

once in the Stenogastrinae and once in the terminal clade, Polistinae + Vespinae. Hence, the subfamily Stenogastrinae could be the group key to understanding evolution of social behavior and life in wasps.

Wasps of the genus *Eustenogaster* van der Vecht, 1969 are relatively large in body size in the Stenogastrinae and are distributed from the Indian subcontinent in the west to the Philippines, Sulawesi Island and Java Island in the east. Van der Vecht (in Yoshikawa et al., 1969) established genera *Eustenogaster* and *Liostenogaster* without any statement of species-level taxonomy. Then the late Dr. van der Vecht continued species-level taxonomic study of the three Oriental stenogastrine genera: *Eustenogaster*, *Liostenogaster* and *Parischnogaster* until the end of his scientific activity (see van Achterberg, 1992), but the results of such of his work have never been published. In *Eustenogaster* 10 species had been recognized as valid at the time of year 2005, and all but *E. calyptodoma* (Sakagami and Yoshikawa, 1968) and *E. palavanica* Reyes, 1988 were described during the period from mid-1800s to early 1900s. One species was added by Hashim et al. (2006), but the species-level taxonomy of *Eustenogaster* had been more or less poorly studied until the work of Saito & Kojima (2007). Some of the biological information described by that time was given under “unidentified species” or even erroneously identified specific names. During the period from 2006 to 2009, taxonomic works of the genus were successively published (Hashim et al., 2006; Saito et al., 2006; Saito & Kojima, 2007; Saito, 2009) and 18 species are currently recognized in the genus and some unique biological features have also been reported (Hashim et al., 2006; Saito et al., 2006).

In the present paper, two new species from Sumatra Island are described based mainly on the specimens that the late Dr. Jacobus van der Vecht mentioned of belonging to undescribed species in his unpublished notes. The female of *E. vietnamensis* Saito, 2009, which was described based only on the males, is described for the first time. Based on the observation of their type specimens, taxonomic statuses of *Ischnogaster micans* de Saussure, 1852, *Ischnogaster eximius* Bingham, 1890, *Ischnogaster ornatifrons* Cameron, 1902, *Stenogaster eximioides* Dover and Rao, 1922 and *Paravespa eva* Bell, 1936, are discussed and revised. An identification key to all the *Eustenogaster* species modified from those in Saito & Kojima (2007) and Saito (2009), and as an appendix an updated taxonomic and distributional checklist of *Eustenogaster* species are also provided.

## MATERIALS AND METHODS

The adult external (morphological and color) characters were observed on pinned and dried specimens under a stereoscopic dissecting microscope. The photos were taken with a digital camera (LUMIX DMC-GF3; Panasonic Corporation, Japan) installed to a stereoscopic

microscope (OLYMPUS SZ9; OLYMPUS Corporation, Japan), and multiple layers were stacked using Helicon Focus ver. 7.6.1 (Helicon Soft Ltd.). The observation of the type specimen of *Stenogaster eximoides* in the collection of the Zoological Survey of India was made on the digital pictures sent from Dr. S. Sheela. Each measurement was taken as the maximal length of each body part measured. The body length is the length of head, mesosoma and the first two metasomal terga together.

Acronyms of the museums/institutions are as follows: **AMNH**, American Museum of Natural History, New York, USA; **BMNH**, The Natural History Museum, London, UK; **IEBR**, Institute of Ecology and Biological Resources, Hanoi, Vietnam; **IUNH**, Natural History Collection of Ibaraki University, Mito, Japan, including the specimens tentatively deposited in the IUNH as a long-term loan from the IEBR (**IUNH/IEBR**); **IUNH/SEHU**, tentatively deposited in the IUNH as a long-term loan from Systematic Entomology, Hokkaido University Museum; **MZB**, Museum Zoologicum Bogoriense, Indonesian Institute of Sciences, Cibinong, Bogor, Indonesia; **NIAES**, National Institute for Agro-Environmental Sciences, Tsukuba, Japan; **RMNH**, National Museum of Natural History Naturalis (previously, Rijkmuseum van Natuurlijke Historie), Leiden, The Netherlands; **ZSI**, Zoological Survey of India, Kolkata, India.

Abbreviations for body parts and collectors used in this paper are as follows: **T1-7** and **S1-7**, respectively the first to seventh metasomal tergum and sternum; **FM**, Fuki Saito-Morooka; **JK**, Jun-ichi Kojima.

## TAXONOMIC ACCOUNTS

### *Eustenogaster multifolia* Saito-Morooka, sp. nov.

Figs 1–5

**Material examined.** **HOLOTYPE:** Female, deposited in the **MZB**, INDONESIA, Sumatra Island, labeled “HOLOTYPE *Eustenogaster multifolia* Saito-Morooka”, “25.x.80, Tekuk Kabung [= Teluk Kabung], nest 1 [“1” circled]”, “E. Teka-1”, “Sakagami”. **PARATYPE**, ♀ (**RMNH**), South Sumatra, [alt.] 600m, Res. Benkoelen [= Bengkulu], Tandjung Sakti, 26-31.V.1935, M.E.Walsh.

**Diagnosis.** The characters with which this species can be distinguished from other *Eustenogaster* species are given in the form of key to species presented in this paper. This species is similar to *E. calyptodoma* and *E. hauxwellii*, but is easily distinguished from them by the supraclypeal area medially impunctured, from *E. calyptodoma* by the genal yellow spot absent and the clypeus sharply pointed apically, and from *E. hauxwellii* by the posterolateral yellow spot of the T1 absent.

**Description.** Female: body length *ca.* 15.5 mm (Holotype and Paratype), forewing length *ca.* 12.5 mm (Holotype and Paratype)

Head. Head in frontal view, as wide as high (Fig. 1). Anterior ocellus larger than posterior ocellus; distance between anterior and posterior ocelli shorter than diameter of posterior ocellus; distance between posterior ocelli shorter than their diameter (Fig. 2). Clypeus finely and shallowly punctate, broadly covered with short hairs, apically sparsely covered with long hairs; apex sharply pointed; apically with median ridge. Supraclypeal area shallowly punctate except for median impunctate area. Frons and vertex coarsely punctate, sparsely covered with long hairs.

Mesosoma. Pronotum ventrolaterally with furrows. Mesoscutum finely and densely punctate, space between punctures less than diameter of puncture (Fig. 3). Scutellum strongly convex, with median carina, hairy, densely punctate. Pronotum, metanotum, propodeum, mesopleuron, metapleuron shiny, hairy, finely and shallowly punctate.

Metasoma. T1 narrow and long, 6.0 mm in length (Fig. 4), 1.1 mm in maximum width, 1.0 mm in maximum height. T6 posteriorly with tubercle (Fig. 5).

Color. Body black, with following markings yellow: large V-shaped mark on clypeus and supraclypeal area, spot above antennal socket, spot in eye emargination, spot inside top of eye, paired small spots on pronotal collar, band along posterodorsal margin of pronotum, which is narrowly interrupted medially and reaches tegulae, basal spot on tegula, paired spots on scutellum, anterior transverse band on metanotum, scrobal spot and inverted L-shape large marking below it on mesepisternum, paired large posterolateral markings on propodeum, anterior band and paired lateral spots on T2, anterior band on T3, paired markings on T4 and T5, paired spots on S2 to S5. Legs dark brown, with following parts yellow: fore-leg: anteroventral spot on coxa, lateral side of femur, tibia, tarsi; mid-leg: anterolateral half of coxa, lateral side of tibia, spot on femur, tibia; hind-leg: posterolateral half of coxa, small spots on tibia, tarsi. Wings brown, semi-hyaline.

Male. Unknown.

**Distribution.** Sumatra Island.

**Etymology.** The specific name, *multifolia*, is compound name formed with a masculine Latin adjective, *multi* (= many) and a neuter Latin noun *folium* (= leaf) to refer to the nest shape of this species (see Ohgushi et al., 1983, fig.28; 1990, fig. 23).

### ***Eustenogaster sumatraensis* Saito-Morooka, sp. nov.**

Figs 6–10

**Material examined.** INDONESIA; Sumatra, HOLOTYPE, ♀ (MZB), “*Eustenogaster sumatraensis* Saito-Morooka”, “21.x.80, Muko Muko [ca. 2°50’S 101°25’E; Sumatra Island] nest (1)”, “E. Muko-1”, “Sakagami”, “♀”; PARATYPE, **Indonesia**, 1♀ (IUNH), “21.x.80, Muko-muko nest 2, E. Muko-1, Sakagami”. **Malaysia**, 2♀ (IUNH/SEHU), Frasers Hill, Selangor, [1♀, FH10-1-1; 1♀, FH10-1-2: listed as *E. micans* in Saito & Kojima (2007)].

**Diagnosis.** The characters with which this species can be distinguished from other *Eustenogaster* species are given in the form of key to species presented in this paper. This species is similar to *E. clypeata* and *E. micans*, but is easily distinguished from the former by the clypeus and supraclypeal area less strongly convex, and from the latter by the yellow facial mark extended and the crescent-shape yellow mark on the tegula present.

**Description.** Female: body length *ca.* 15.5 mm (Holotype) and *ca.* 16.0 mm (Paratype), forewing length *ca.* 13.0 mm (Holotype and Paratype).

**Head.** Head in frontal view, as wide as high (Fig. 6). Anterior ocellus larger than posterior ocellus; distance between anterior and posterior ocelli shorter than diameter of posterior ocellus; distance between posterior ocellus shorter than their diameter (Fig. 7). Clypeus in lateral view, slightly convex; hairy and shallowly punctate, apically sparsely covered with long hairs; apically with median ridge. Supraclypeal area shallowly punctate except for median small impunctate area. Frons and vertex coarsely punctate, covered with long hairs.

**Mesosoma.** Pronotum laterally with furrows behind pronotal neck (Fig. 8), shallowly punctate. Mesoscutum finely and densely punctate, space between punctures as long as diameter of puncture. Scutellum strongly convex, with median carina, hairy, densely punctate. Metanotum, propodeum, mesopleuron, metapleuron shiny, hairy, finely and shallowly punctate.

**Metasoma.** T1 narrow and long, 7.0 mm in length (Fig. 9), 1.0 mm in maximum width, 1.0 mm in maximum height. T6 posteriorly with sharp spine (Fig. 10).

**Color.** States for the paratype are given in square brackets. Body black, with following parts yellow; clypeus and supraclypeal area, except for median line [except for median small spot], spot above antennal socket, spot in eye emargination, paired spots on vertex, basal small spot on mandible, [small spot posterior to each posterior ocellus], [paired small spots on pronotal collar], band along posterodorsal margin of pronotum reaching tegulae, basal crescent-shaped mark on tegula, paired spot on scutellum, anterior band on metanotum, scrobal spot and inverted L-shape large marking below it on mesepisternum, [small spot on metapleuron], paired large posterolateral markings on propodeum, [small ventrolateral spots on propodeum], anterior band and paired lateral spots on T2, anterior band on T3, paired markings on T4 and T5, paired spots on S2 to S5 [to S6]. Legs brown, but following parts yellow: fore-leg: anterior side of coxa, femur, tibia; mid-leg: coxa, lines on femur, anterior side of tibia, anteroventral half of first tarsomere; hind-leg: large spot on anterior face of coxa [entire surface of coxa], anterior side of femur, apical and basal small spots of tibia, anteroventral half of first tarsomere. Wings brown, semi-hyaline.

Male. Unknown.

**Distribution.** Sumatra Island, Malay Peninsular south of Isthmus of Kra.

**Etymology.** The specific name refers to the type locality.





Figures 1–10. Two new species of *Eustenogaster*. 1–5, *Eustenogaster multifolia* **sp. nov.**; 1, head in frontal view. 2, ocelli. 3, mesoscutum in dorsal view. 4, first metasomal tergum in lateral view. 5, tubercle on T6. 6–10, *Eustenogaster sumatraensis* **sp. nov.**; 6, head in frontal view. 7, ocelli. 8, furrows on pronotal neck. 4, first metasomal tergum in lateral view. 9, spine on T6. Scale bars show 1.0 mm for figures 1, 3–4, 6 and 10, 0.5 mm for figures 2, 5 and 7–9, respectively.

***Eustenogaster vietnamensis* Saito, 2009**

Figs 11–13

**Material examined.** VIETNAM; 2♀2♂ (IUNH/IEBR), Muong Phang, Dien Bien Province, 21°27.5'N, 103°07'E (alt. ca. 700 m), 25.vii.2006, Nest#VN-E-2006-5, LPT Nguyen, F. Saito [= FM] & JK.

Saito (2009: 20) described *Eustenogaster vietnamensis* based on five male specimens collected in southern part of Vietnam (Lam Dong Province, Dong Nai Province). Based on the two female specimens collected from a nest, where two males of *E. vietnamensis* were also collected, in northwestern part of Vietnam we describe below the female of this species for the first time.

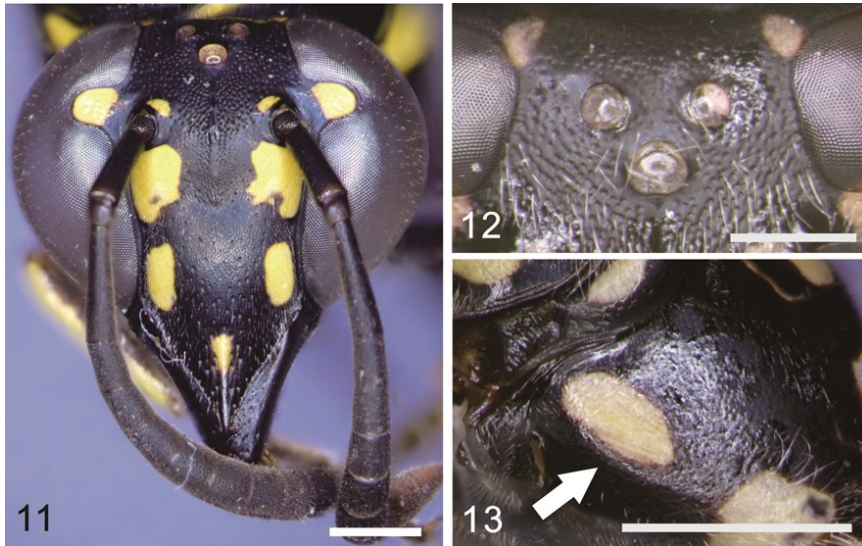
**Description of female.** Body length ca. 15.0 mm (n = 2), forewing length ca. 13.0 mm (n = 2).

**Head.** In frontal view, about as wide as high (Fig. 11). Anterior ocellus about 1.2 times larger than diameter of posterior ocellus (Fig. 12); distance between anterior and posterior ocelli shorter than diameter of posterior ocellus; posterior ocelli separated from each other by distance about 1.4 times their diameter. Clypeus finely and shallowly punctate, apically sparsely covered with long hairs; apically with median ridge. Supraclypeal area finely punctate except for median small impunctate area. Frons and vertex coarsely punctate, covered with long hairs.

**Mesosoma.** Pronotum ventrolaterally with shallow furrows; shallowly punctate. Mesoscutum finely and densely punctate, space between punctures as long as diameter of puncture. Scutellum convex, with median short carina, hairy. Metanotum, propodeum, mesopleuron, metapleuron, shiny, hairy, finely and shallowly punctate. Propodeum posterolaterally angulate (Fig. 13).

**Metasoma.** T1 narrow and long, ca. 6.5 mm in length (n = 2), ca. 1.0 mm in maximum width (n = 2), ca. 0.9 mm in maximum height (n = 2). T6 posteriorly with tubercle.

**Color.** Body black, following parts yellow: small median spot and paired lateral markings on clypeus, paired lateral markings on supraclypeal area, spot above each antennal socket, spot in eye emargination, paired spots on vertex, band along posterodorsal margin of pronotum, which does not reach tegulae, paired spot on scutellum, paired anterior marking on metanotum, scrobal spot and inverted L-shape marking below it on mesepisternum, two pairs of posterolateral markings on propodeum, paired posterolateral markings on T1, paired anterior spots and lateral spots on T2, paired anterior bands on T3. Legs dark brown, but following parts yellow: fore-leg: dorsal 2/3 of lateral side of femur, lateral side of tibia, first tarsomere; mid-leg: posterior small spot on coxa, apical small spot on femur, basal small spot of first tarsomere; hind-leg: paired posterior spots on coxa, apical small spot on tibia. Wings brown, semi-hyaline.



Figures 11–13. *Eustenogaster vietnamensis*; 11, head in frontal view. 12, ocelli. 13, dorsolateral corner of propodeum. Scale bars show 1.0 mm for figures 11 and 13, 0.5 mm for figures 12, respectively

***Eustenogaster eximioides* (Dover and Rao, 1922)**

Figs 14–17

*Stenogaster eximioides* Dover and Rao, 1922: 242. Male, “Nilgiri Hills” [India] (lectotype in IZS) - Das and Gupta, 1989, Or. Ins. Monogr. 11: 28 (designation of lectotype).

*Paravespa eva* Bell, 1936: 803, fig. 1, female, male, “N. Kanara District, Bombay” (syntype (s) in BMNH).

*Eustenogaster eximia eximioides*; Das and Gupta, 1984 (1983): 402 (syn.: *Paravespa eva* Bell).

*Paravespa eva* Bell, 1936; van der Vecht and Carpenter, 1990: 44 (designation as type species of *Paravespa* Bell; syn. of *Eustenogaster eximia eximioides*).

Designation of the lectotype of *Paravespa eva* Bell, 1936:

*Paravespa eva* Bell, 1936 was described from unspecified number of female and male specimens collected in “forest-clad hills of the Western Ghats” in “N. Kanara District [= Uttara Karnada District with its administrative headquarter in Karwar (14°50’N 74°08’E), in State of Karnataka], Bombay Presidency”. Das and Gupta 1984 (1983) treated this taxon as a synonym of “*Eustenogaster eximia eximioides*”. Van der Vecht and Carpenter (1990) designated *Paravespa eva* Bell, 1936 as the type species of *Paravespa* Bell, 1936 and proposed *Eustenogaster* van der Vecht, 1966 as a subjective synonym of this generic name, which is unavailable by homonymy. We have located only a female specimen that should be from the type series in in the Hymenoptera Collection of the BMNH. The specimen possesses the BMNH “lectotype” label and also a lectotype designation label, but such the lectotype designation has not been formally published. Herein we designate the specimen as the lectotype of *Paravespa eva* Bell, 1936: A female syntype of *Paravespa eva* Bell, 1936, in the Hymenoptera Collection of the BMNH, labeled “LECTO-TYPE [encircled with purple]”, “Gerusoppe 3.11.05, “B.M.TYPE HYM. 18.975”, “Lectotype of *Paravespa eva*

Bell 1936 ♀ desig. by J.v.d. Vecht 1958”, “T.R.Bell Coll. B.M. 1934-394”.

We examined the lectotype female of *Paravespa eva* Bell, 1936 deposited in BMNH (as mentioned above). The holotype male of *Stenogaster eximioides* Dover and Rao, 1922 deposited in ZSI was also examined with the high-resolution photographs (Figs. 14–17). We also examined female specimens identified by the late Dr. van der Vecht as “*E. eximioides*” or “*E. eximia eximioides*” and we have found no characters in these type specimens different enough to consider *eximioides* and *eva* as different species. Thus the synonymy of *Stenogaster eximioides* Dover and Rao, 1922 and *Paravespa eva* Bell, 1936 has been confirmed.

We also examined the holotype male of *Ischnogaster eximia* Bingham, 1890 collected in Ceylon [= Sri Lanka], and we have found many characters distinctly different from those of *eximioides*, allowing us to consider that the two taxa are different species. We propose to retrieve the species status of *E. eximioides* (Dover and Rao, 1922), with *Paravespa eva* Bell, 1936 as its synonym.

Diagnostic characters for *E. eximioides* (Dover and Rao, 1922) [states of *E. eximia* are given in square brackets] are as follows: mesoscutum (except for dorsomedial area) dull, with punctures well defined, interspace between them shorter than diameter of puncture (Fig. 14) [shiny, with punctures fine and shallow]; T6 without spine, but with sharp protrusion [with small tubercle]; male mandible with three teeth (Fig. 15) [single tooth]; scutellum yellow but black median line and posterior margin (Fig. 16) [black, with paired small yellow spots].

**Type specimens examined.** *Paravespa eva* Bell, 1936: Lectotype female (BMNH; designated herein), labeled “LECTO-TYPE (circled with purple)”, “Gairsappa 3.11.05”, “B.M.TYPE HYM. 18.975”, “Lectotype of *Paravespa eva* Bell 1936 ♀, desig. by J.v.d. Vecht 1958”, “T.R.Bell Coll. B.M. 1934-394 [BMNH]”. *Stenogaster eximioides* Dover and Rao, 1922: Lectotype male [second to seventh metasomal segments lost] (IZS), labeled “Nilgiri Hills./H.L.Andrewes/Nadgan/IV.10. 2500”, “1870/H3”, “*Stenogaster/eximioides*/Type sp. nov. /det.Dover & Rao ‘21” (Fig. 17). *Ischnogaster eximia* Bingham, 1890: Holotype male (BMNH) [detached metasomal segments in a capsule pinned with the main body part], labeled “Holotype [circled with red]”, “Ceylon. Pundaloya [green label]” “Bingham coll, *Ischnogaster eximius* Bingh Type♂, Col. C.T.Bingham 96-30, B.M.TYPE HYM. 18.722”.

**Other specimens examined.** *E. eximia*: 1♀4♂ (BMNH) Ceylon, Kandy [1♂, 1905-125; 1♂, 1902-271; 1♂, 1902-277; 1♂, 92-128]. *E. eximioides*: all specimens in BMNH: 1♂, Amarambalam Forest, 500-1500m, Malabar, South India, 20.ix.1938, *E. eximioides* ♂ det. J.v.d. Vecht 1977; 1♀, Tenmalai, 500-800m, Travancore, South India, 11-17.X.1938, *E. eximia eximioides* det. J.v.d. Vecht 1977; 4♀2♂, West India, T.R. Bell, 1908-186; 4♀, Kabra, 1♀, no.241; 1♀, Gerusoppe [= Jog Falls]; 2♀, Kaarmar 10.L.36.



Figures 14–17. *Eustenogaster eximioides* holotype male; 14, mesoscutum in dorsal view. 15, head in frontal view. 16, head, mesosoma and T1 in dorsal view. 17, labels. Photos taken by Dr. Sheela at ZSI.

### *Eustenogaster micans* (de Saussure, 1852)

*Ischnogaster micans* de Saussure, 1852: 24, female, “Java” (RMNH).

*Ischnogaster ornatifrons* Cameron, 1902: 105, female, “Santubong, Kuching, Sarawak” (BMNH).

Designation of the lectotype of *Ischnogaster ornatifrons* Cameron, 1902:

Cameron (1902) described *Ischnogaster ornatifrons* based on unspecified number of “female” specimen(s) from “Santubong, Kuching, Sarawak [Borneo Island]”. In the BMNH, there are two specimens with the label “*Ischnogaster ornatifrons* Cam. Type, Borneo”, one is female and the other is male. For the stability of the nomenclature, although Cameron (1902) referred to (possibly because of erroneous sex identification) only the female, the male specimen is herein designated as the lectotype of *Ischnogaster ornatifrons* Cameron, 1902, and the female specimen as a paralectotype, as the International Code of Zoological Nomenclature does not govern the erroneous identification of the sexes of the type specimens. The more practical reason for this treatment is that the present male specimen belongs to “*Ischnogaster ornatifrons*” of currently accepted concept, while the female specimen belongs to recently described another species, *E. latebricola* Saito, 2007. The lectotype is labeled as follows: “LECTO-TYPE (circled with purple)”, “B.M.TYPE HYM. 18.716a”, “*Ischnogaster ornatifrons* Cam. Type Borneo”, “Lectotype selectes by J.v.d. Vecht

1958”, “*Eustenogaster* ♂ *micans* (Sauss.) det. J.v.d. Vecht 1977”. The paralectotype [second and posterior metasomal segments lost] is labeled “Paralectotype”, “Kuching Jan. 24. 1898”, “P. Cameron Coll. 1914-10”, “*Ischnogaster ornatifrons* Cam. Type Borneo”, “B.M.TYPE HYM. 18.716b” and “*Eustenogaster latebricola* m. det. J.v.d. Vecht 1977”.

Saito and Kojima (2007: 24) tentatively treated *Ischnogaster ornatifrons* Cameron, 1902 as a synonym of *Eustenogaster micans* (de Saussure, 1852). As the result of our detailed observations of type specimens of *I. micans* and *I. ornatifrons*, any notable diagnostic characters to distinguish them as belonging to different species were not found. Thus, we have confirmed synonymy of *Ischnogaster ornatifrons* Cameron, 1902 and *Eustenogaster micans* (de Saussure, 1852).

**Type specimens examined. *Ischnogaster micans* de Saussure, 1862:** Lectotype female (RMNH) designated by Kojima and Achterberg (1997), labelled “♀”, “K. & v. H, Java”, “Museum Leiden *Stenogaster micans* Sauss. DET”, “Lectotype desig. by J.v.d. Vecht 1957”, and “*Eustenogaster micans* (Sauss.) det. J.v.d. Vecht 1957”. ***Ischnogaster ornatifrons* Cameron, 1902:** Lectotype male (BMNH).

**Other specimens examined. Thailand:** 1♀ (IUNH/ SEHU), Sungai Ladung, 4.xi.1980, KCN depign; 1♀ (IUNH/ SEHU), Maeklong Watershed, Research Station, Kanchanaburi Prov., 29.xi.2003, Sk. Yamane [small yellow spot on gena]. **Malaysia: Peninsular Malaysia:** 1♂ (RMNH) Kuala Seleh, Selangor, 6.vii.1947, H.T. Pagden; 21♂ (RMNH), Surgei Jaham, Pahang, FMS, 22.xi.1922; **Borneo:** 1♀1♂ (SKYC), Sarawak, Sk. Yamane [1♂, Kubah NP, 5.xii.1993; 1♀, Bako NP, 21–22.iv.1993]. **Singapore:** 1♂ (RMNH), Coll. Barker. **Indonesia: Sumatra: South Sumatra:** 1♂ (RMNH), Gn. [= Mt.] Betoeno, 400m, S. Oenoeilangta Est, 27.iii.1937, J. van der Vecht; **Lampung:** 2♂, Mt. Tanggamoos, Giesting, S.W. Lampungs, 27.vi.1933, [1♂ (RMNH), 500m, Toxopeus; 1♂ (MZB), 600m, M.A. Lieftinck & Toxopeus]; **West Sumatra:** 3♂ (RMNH), Anei Kloof, 500m, 1926, E. Jacobson; 2♂ (IUNH/ SEHU), Teluk Kabung, 8.x.1980; 1♀ (IUNH/ SEHU), Air Manis, 21.xii.1980, Sô. Yamane; **Bangka Is.:** 1♀ (RMNH), Tjeloeak, 13.iii.1935, J. van der Vecht; 1♂ (RMNH), Mt. Matas, 600m, Banka, 15.vi.1930, J. van der Vecht; **Java:** 1♀ (RMNH; lectotype of *Stenogaster micans* by designation of Kojima & van Achterberg [1997: 163]); **West Java:** 2♀2♂ (MZB), Mt. Gede, i.1935, native collected; 1♀ (RMNH), iii.1935, Wynkoopsbaai, Mrs. M. Walsh; 1♀1♂ (RMNH), Djampang Tengah, iv.1935, M.E. Walsh; 1♀ (RMNH), Preanger, 335m, Redjamandala, vi.1935; 1♀ (RMNH), 800m, Mt. Gedeh Tapos, 1–16.viii.1936, J. van der Vecht; 1♀ (RMNH), 500m, G. [= Mt.] Pantjar, i.1937, F. Dupont; 1♀ (MZB), 100–250m, Buitenzorg, Djasinga, 18.vii.1937, M.A. Lieftinck; 1♂ (RMNH), 5–600m, G. [= Mt.] Gocha, Djampang Koelon, xii.1939, M.E. Walsh; 1♀ (MZB), 100m, Dungus Iwul, 9.i.1953, A.M.R. Wegner; 2♀ (RMNH), 0–50m, Pelambuan Ratu, 5–6.viii.1972, J. van der Vecht; **Central Java:** 2♂ (RMNH), Noesa Kambangan, iii.1911, E. Jacobson; **East Java:** 1♂ (RMNH), Marang, Coll. Gribodo; **Kalimantan: East Kalimantan:** 1♀ (MZB), 125m, Tabang, 24.x.1956, Bengen River, A.M.R. Wegner; 1♀3♂ (MZB), 02°52’N, 115°49’E, Pujungan, Kayan Mentarang Nature Reserve, WWF station, Malaise trap, D.C. Darling & R. Ubaidillah [1♀, Lalut Paro, 310m, v.1993; 3♂, Lalut Birai, Puncak, 650m, (1♂, viii.1993; 1♂, x.1993; 1♂, v.1993)]; 3♂ (MZB), 01°02’S, 117°20’E, 60m, Wanariset Research Station, Kutai, 38km, N Balikpapan, Samboja, Malaise trap, iv.1992, D.C. Darling, R. Ubaidillah & Sutrisno; 1♂ (NIAES), Bukit Soeharto, 13–17.iii.1994, K. Matsumoto & K. Konishi; 1♂ (MZB), Kersik Kerbangan, Kee. Melak, 8.i.1982, Ouchar.

**Key to species of the genus *Eustenogaster***

The present key is based on those of Saito and Kojima (2007) and Saito (2009) [cited as SK07 and S09, respectively, together with the figure number(s) in the respective papers], with the addition of a few couplets to include the two new species and the female of *E. vietnamensis* described in this paper. As most of the species other than the two new species are illustrated in Saito and Kojima (2007) and Saito (2009), this key may be used in combination with those works.

1. Female ..... 2
- Male ..... 21
2. Lateral furrow of pronotum deep (SK07: fig. 8) ..... 3
- Lateral furrow of pronotum shallow or absent (SK07: figs. 23, 44) ..... 4
3. Lateral furrow of pronotum reaching humeral tubercle (SK07: fig. 8) ..... *E. fulvipennis* (Cameron, 1902)
- Lateral furrow of pronotum not reaching humeral tubercle ..... *E. agilis* (Smith, 1860)
4. Lateral sides of pronotum and dorsal part of mesepisternum dull, densely and sometimes rugosely punctate. T2 in lateral view distinctly convex dorsally (SK07: figs. 11, 17, 19) ..... 5
- Lateral sides of pronotum and dorsal part of mesepisternum finely punctate. T2 in lateral view only slightly convex dorsally (SK07: figs. 24, 33, 40, 56) ..... 7
5. T1 in dorsal view barely widened some distance behind level of spiracles, then abruptly widening in posterior one-fifth; T2 weakly convex dorsally (SK07: fig. 11) ..... *E. fraterna* (Bingham, 1897)
- T1 in dorsal view gradually widening posteriorly from level of spiracles; T2 strongly convex dorsally (SK07: figs. 17, 19) ..... 6
6. Clypeus (SK07: fig. 57) and propodeum entirely black ..... *E. nigra* Saito and Nguyen, 2006
- Clypeus usually with yellow spot of variable size, rarely entirely black (SK07: fig. 57); propodeum with paired apical yellow spots ..... *E. scitula* (Bingham, 1897)
7. Space between antennal sockets with rather sparse, shallow punctures. Scutum with sparse, shallow punctures ..... *E. eximia* (Bingham, 1890)
- Space between antennal sockets densely, sometimes rugosely punctate. Scutum densely covered with well-defined punctures ..... 8
8. Frons clearly demarcated from clypeus by suture (SK07: fig. 41; S09: fig. 1) ..... 9
- Frons barely demarcated from clypeus ..... 10
9. Clypeus with short hairs. T6 with sharp spine. Clypeus and supraclypeal area yellow, with median dark line. Eye emargination black (SK07, fig. 58) ..... *E. latebricola* Saito, 2007
- Clypeus with long hairs. T6 with small tubercle (S09, fig. 6). Clypeus black, with paired lateral yellow spots; supraclypeal area black, with yellow spot below antennal socket. Eye emargination with yellow spot (S09, fig. 1) ..... *E. panaiensis* Saito, 2009

- 10 T6 with spine (Fig. 9; SK07: figs. 28, 50; S09: fig. 17) ..... 11
- T6 with tubercle or sharply projected protrusion (Fig. 5) .....16
- 11. Clypeus and supraclypeal area strongly convex (S09: fig. 14)... *E. clypeata* Saito, 2009
- Clypeus and supraclypeal area less convex (SK07: fig. 53) ..... 12
- 12. Area below each antennal socket covered with long, dense hairs. Scutum sparsely punctate ..... 13
- Area below each antennal socket covered with short hairs. Scutum densely punctate; interspace between punctures narrower than puncture diameter ..... 14
- 13. Space between antennal sockets rugosely punctate. Clypeus extensively marked with yellow (SK07: fig. 58) ..... *E. spinicauda* Saito, 2007
- Space between antennal sockets with dense, fine punctures. Clypeus black except for small lateral yellow spots (SK07: fig. 57) ..... *E. fumipennis* Saito, 2007
- 14. Clypeus and supraclypeal area mostly yellow. Eye emargination marked with yellow ..... 15
- Clypeus black, with median and paired lateral yellow markings; supraclypeal area black, with paired yellow markings. Eye emargination black ..... *E. palavanica* Reyes, 1988
- 15. Clypeus and supraclypeal area yellow, with median black band (SK07: fig. 58). Tegula entirely black or at most with small yellow spot ..... *E. micans* (de Saussure, 1852)
- Clypeus and supraclypeal area yellow, with median narrow black line (Fig. 6). Tegula with crescent-shape yellow marking ..... *E. sumatraensis* **sp. nov.**
- 16. T2 with distinct transverse impression [sometimes weak in specimens from Mentawai Islands], separating somewhat swollen posterior two-fifths from the anterior part (SK07: fig. 33) ..... *E. gibbosa* Starr and van der Vecht, 2006
- T2 without transverse impression ..... 17
- 17. Extreme apex of clypeus truncate (SK07: fig. 21). Yellow spot on gena present ..... *E. calyptodoma* (Sakagami and Yoshikawa, 1968)
- Extreme apex of clypeus sharply pointed (Fig. 1). Yellow spot on gena absent ..... 18
- 18. Posterolateral yellow spot on T1 absent (Fig. 4). T6 with sharply projected protrusion (Fig. 5) ..... 19
- Posterolateral yellow spots on T1 present. T6 with blunt tubercle ..... 20
- 19. Supraclypeal area and clypeus yellow but black edge of clypeus (Fig. 1). Vertex with paired yellow spots (Fig. 2) ..... *E. multifolia* **sp. nov.**
- U-shaped yellow marking present over clypeus and supraclypeal area. Vertex entirely black ..... *E. eximioides* (Dover and Rao, 1922)
- 20. U-shaped yellow marking present over clypeus and supraclypeal area (SK07: fig. 58) ..... *E. hauxwellii* (Bingham, 1894)
- Clypeus and supraclypeal area black, with yellow small median spot and paired lateral markings on clypeus and paired yellow lateral markings on supraclypeal area (Fig. 11) ..... *E. vietnamensis* Saito, 2009



- 21. Mandible with three teeth (SK07: figs. 5, 13) ..... 22
  - Mandible single-toothed (SK07: fig. 25) ..... 26
- 22. Mandible with median tooth reduced to slight convexity and proximal tooth reduced in size (SK07: fig. 5) ..... *E. agilis* (Smith, 1860)
  - All three mandibular teeth more or less distinct, apically blunt (SK07: fig. 13) ..... 23
- 23. Clypeus and supraclypeal area entirely yellow (Fig. 15). T2 in lateral view hardly convex dorsally ..... *E. eximoides* (Dover and Rao, 1922)
  - Supraclypeal area with or without paired yellow markings or spots. T2 in lateral view more or less convex dorsally ..... 24
- 24. T2 in lateral view weakly convex dorsally (SK07: fig. 14) .....
  - ..... *E. fraterna* (Bingham, 1897)
  - T2 in lateral view strongly convex dorsally (SK07: figs. 18, 20) ..... 25
- 25. T2 in lateral view strongly swollen dorsally in anterior half (SK07: fig. 18). Clypeus (SK07: fig. 57) and propodeum entirely black ..... *E. nigra* Saito and Nguyen, 2006
  - T2 less strongly convex dorsally (SK07: fig. 20). Clypeus usually with median yellow spot of variable size, rarely entirely black (SK07: fig. 57); propodeum with paired apical yellow spots ..... *E. scitula* (Bingham, 1897)
- 26. Lateral furrow of pronotum deep, distinctly striate, reaching humeral tubercle (SK07: fig. 8). Clypeal apex with median impunctate ridge (SK07: fig. 7) ..... *E. fulvipennis* (Cameron, 1902)
  - Lateral furrow of pronotum shallow or absent. Clypeal apex medially convex or flattened, with no medial ridge (SK07: fig. 46) ..... 27
- 27. Clypeus in lateral view of head flattened dorsally, smoothly passing into supraclypeal area (SK07: fig.36). Digitus without median spine and densely set apically with long hairs (SK07: fig. 59T) ..... 28
  - Clypeus in lateral view of head weakly convex dorsally (SK07: figs. 47, 51), separated from supraclypeal area by shallow depression or short suture. Digitus with median spine and set apically with short hairs (SK07: fig. 59V) ..... 29
- 28. Supraclypeal area between antennal sockets densely punctate; interspace between punctures narrower than puncture diameter. Yellow spots present above antennal sockets and on vertex and pronotal collar ..... *E. hauxwellii* (Bingham, 1894)
  - Supraclypeal area between antennal sockets sparsely punctate; some interspaces between punctures wider than puncture diameters. All yellow spots above antennal sockets and on vertex and pronotal collar absent ..... *E. panaiensis* Saito, 2009
- 29. Clypeus separated from supraclypeal area by short suture (SK07: fig. 46) ..... *E. latebricola* Saito, 2007
  - Clypeus separated from supraclypeal area by shallow depression ..... 30
- 30. Median impunctate area in supraclypeal area as large as or larger than anterior ocellus (sometimes slightly smaller than anterior ocellus in *E. micans*) ..... 31
  - Median impunctate area in supraclypeal area somewhat smaller than anterior ocellus ..... 34

31. T2 in lateral view with dorsal margin barely convex. Supraclypeal area finely punctate and covered with short hairs ..... 32
- T2 in lateral view more or less distinctly convex dorsally. Supraclypeal area medially without hairs and impunctate ..... 33
32. Area around ocelli with dense, fine punctures. Eye emargination filled with yellow (SK07: fig. 58) ..... *E. micans* (de Saussure, 1852)
- Area around ocelli with larger punctures. Eye emargination with small yellow spot or entirely black (SK07: fig. 58) ..... *E. palavanica* Reyes, 1988
33. T2 with transverse impression separating swollen posterior two-fifths from the anterior part. T1 lacking dorsolateral yellow spots ..... *E. gibbosa* Starr and van der Vecht, 2006
- T2 without transverse impression (Fig. 20). T1 with small dorsolateral yellow spots ..... *E. vietnamensis* Saito, 2009
34. Pronotum with paired deep dorsolateral furrows behind pronotal collar (SK07: fig. 23) ..... *E. calyptodoma* (Sakagami and Yoshikawa, 1968)
- Pronotum without such furrows ..... 35
35. 35. Head with yellow spot above each antennal socket and paired yellow spots on vertex (SK07: fig. 58) ..... *E. spinicauda* Saito, 2007
- Head without yellow spots above antennal socket or on vertex (SK07: fig. 58) ..... *E. luzonensis* (Rohwer, 1919)

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#### AUTHOR CONTRIBUTION

FM, designed research and examined specimens (including the type specimens). All authors wrote drafts of the manuscript and critically revised the report and approved the final report.

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## APPENDIX

### Taxonomic and distributional checklist of *Eustenogaster* species

Based on the checklist of Carpenter and Kojima (1997; Journal of the New York Entomological Society 104: 21-36), the present checklist adds nomenclatural changes and descriptions of new taxa (species) that have been made after Carpenter and Kojima (1997). Distribution records given under “Distribution” are presented according to mainly geographical rather than administrative divisions.

Each publication is cited in abbreviated form and is not listed in “References” unless it is cited in the main text.

Acronyms of the museums/institutions where the name-bearing type specimens are deposited are as follows: **AMNH**, American Museum of Natural History, New York, USA; **BMNH**, The Natural History Museum, London, UK; **BPBM**, Bernice P. Bishop Museum, Honolulu, USA; **IEBR**, Institute of Ecology and Biological Resources, Hanoi, Vietnam; **IUNH**, Natural History Collection of Ibaraki University, Mito, Japan, including the specimens tentatively deposited in the IUNH as a long-term loan from the IEBR (**IUNH/IEBR**); **MSNF**, Museo di Storia Naturale – Zoologia “La Specola”, Firenze, Italy; **MZB**, Museum Zoologicum Bogoriense, The Indonesian institute of Science, Cibinong, Bogor, Indonesia; **NMNH**, U. S. National Museum of Natural History, Washington DC, USA; **OUM**, Hope Entomological Collection, University Museum, Oxford, UK; **RMNH**, Biodiversity Center, Naturalis (previously the Rijksmuseum van Natuurlijke Historie), Leiden, The Netherlands; **SEHU**, Systematic Entomology, Hokkaido University Museum, Sapporo, Japan; **UMM**, Museum of the University of Malaya, Kuala Lumpur, Malaysia; **ZSI**, Zoological Survey of India, Kolkata, India.

*Eustenogaster* van der Vecht, 1969, in Nature and Life in S. E. Asia 6: 165, genus.

Type species: *Ischnogaster micans* de Saussure, 1852, by original designation.

*Paravespa* Bell, 1936, J. Bombay Nat. Hist. Soc. 38: fig. 1, 803, 806, genus (2 species).

Type species: *Paravespa eva* Bell, 1936 [= *Stenogaster eximioides* Dover and Rao, 1922], by subsequent designation of van der Vecht and Carpenter, 1990, Zool. Verh., Leiden 260: 44.

Junior homonym of *Paravespa* Radoszkowski, 1886.

*Eustenogaster* [!] Saito *et al.*, 2006. Amer. Mus. Novitat. (3534): 1. Incorrect spelling of *Eustenogaster* van der Vecht, 1969.

#### *agilis* (Smith)

*Ischnogaster agilis* Smith, 1860, J. Proc. Linn. Soc., Zool. 5, Suppl.: 89, male – “Makassar” (OUM).

*Stenogaster agilis*; von Schulthess, 1927, Suppl. Ent. 16: 85.

*Eustenogaster agilis*; Carpenter, 1988, J. New York Ent. Soc. 96: 174.

Distribution: Sulawesi I. [except for northern parts (Gorontalo, North Sulawesi) of the island] (Saito & Kojima, 2007).

#### *calyptodoma* (Sakagami and Yoshikawa)

*Stenogaster calyptodoma* Sakagami and Yoshikawa, 1968, Annot. Zool. Japon. 41 (2): 77, figs. 1-2, 4, 6, female – “Kampong Astana near Kuching, Sarawak, Malaysian Borneo” (SEHU).

*Eustenogaster calyptodoma*; Yoshikawa *et al.*, 1969, in Nature and Life in S. E. Asia 6: 157.

Distribution: Malay Peninsula [south of the Isthmus of Kura], Borneo I., Sumatra I. (Saito & Kojima, 2007).

***clypeata*** Saito

*Eustenogaster clypeata* Saito, 2009, Spec. Div. 14: 18, 19 (figs 1-12), 20, 23 (key), female - "Chantaburi, Thailand" (RMNH).

Distribution: Chantaburi Province in southeastern Thailand (Saito, 2009).

***eximia*** (Bingham)

*Ischnogaster eximius* Bingham, 1890, J. Bombay Nat. Hist. Soc. 5: 244, male - "Ceylon" (BMNH). – von Schulthess, 1914, Zool. Jahrb. (Abt. Syst. Geogr. Biol. Tiere) 37 (3): 256 (in subgenus *Ischnogaster*).

*Ischnogaster eximia*; Dalla Torre, 1904, Genera Insect. 19: 83 (catalogue).

*Stenogaster eximia*; Dover and Rao, 1922, J. Asiat. Soc. Bengal (N. S.) 18: 241. – Dover, 1925 (1924), J. Asiat. Soc. Bengal (N. S.) 20: 301 (syn.: *Stenogaster eximoides* Dover and Rao); 1931, J. Fed. Malay St. Mus. 16: 256 (syn.: *Ischnogaster ornatifrons* Cameron).

*Stenogaster eximius*; von Schulthess, 1927, Suppl. Ent. 16: 85.

*Eustenogaster eximia*; Iwata, 1976, Evol. Instinct: 275 (ethology). – Krombein, 1976, Loria 13 (6): 303. – Saito-Morooka *et al.*, 2020, Treubia 47(2): 141.

*Eustenogaster eximia eximia*; Das and Gupta, 1984 (1983), Or. Ins. 17: 401 (catalogue).

Distribution: Sri Lanka; [Yunnan, recorded by Dong and Otsuka, 1997, but its occurrence needs confirmation]; Thailand; Malay Peninsula (Saito & Kojima, 2007).

***eximoides*** (Dover and Rao)

*Stenogaster eximoides* Dover and Rao, 1922, J. Proc. Asiat. Soc. Bengal (N. S.) 18: 242, male – "Nadgani, Nilgiri Hills. 2,500 ft." (lectotype ZSI). – Dover, 1925 (1924), J. Asiat. Soc. Bengal (N. S.) 20: 301 (syn. of *Stenogaster eximia* (Bingham)). – Das and Gupta, 1989, Or. Ins. Monogr. 11: 28 (designation of lectotype).

*Paravespa eva* Bell, 1936, J. Bombay Nat. Hist. Soc. 38: 803, fig. 1, female, male – "N. Kanara District, Bombay" (lectotype female BMNH). – Das and Gupta, 1984 (1983), Or. Ins. 17: 402 (syn. of *Eustenogaster eximia eximoides*). – Saito-Morooka *et al.*, 2020, Treubia 47(2): 140–141. (designation of lectotype; syn. of *Eustenogaster eximoides* (Dover and Rao))

*Eustenogaster eximoides*; Iwata, 1976, Evol. Instinct: 275 (ethology). – Saito-Morooka *et al.*, 2020, Treubia 47(2): 140–141.

*Eustenogaster eximia eximoides*; Das and Gupta, 1984 (1983), Or. Ins. 17: 402 (syn.: *Paravespa eva* Bell; cat.).

"*Ischnogaster eximia eximoides*"; van der Vecht and Carpenter, 1990, Zool. Verh., Leiden 260: 44 (designation as type species of *Paravespa* Bell).

Distribution: Western Ghats of the Indian subcontinent (Dover and Rao, 1922; Bell, 1936; Saito & Kojima, 2007).

***fraterna*** (Bingham)

*Ischnogaster fraterna* Bingham, 1897, Fauna Brit. India, Hym. 1: 377 (key), 378, female, male – "Tenasserim" (BMNH).

*Stenogaster fraterna*; Dover and Rao, 1922, J. Proc. Asiat. Soc. Bengal (N. S.) 18: 240. – Dover, 1925 (1924), J. Asiat. Soc. Bengal (N. S.) 20: 301 (syns.: *Ischnogaster scitula* Bingham, *Stenogaster scitula* var. *assamensis* Dover and Rao).

*Eustenogaster fraterna*; Iwata, 1976, Evol. Instinct: 275 (ethology).

Distribution: Eastern slope of the Himalaya [Northeastern India (Assam, Sikkim); northern Myanmar]; Thailand; Malay Peninsula (Saito & Kojima, 2007).

**fulvipennis** (Cameron)

*Ischnogaster fulvipennis* Cameron, 1902, J. Straits Branch R. Asiat. Soc. 37: 106, female, male – “Mt. Penrissen, Sarawak” (BMNH). – Dover, 1929, Bull. Raffles Mus. 2: 45 (syn. of *Stenogaster micans* (de Saussure)).

? *Ischnogaster fuscipes* Cameron, 1903, J. Straits Branch R. Asiat. Soc. 39: 171, sex not stated – “Klackang” (BMNH). – Carpenter and Kojima, 1997 (1996), J. New York Entomol. Soc. 104: 25 (? syn. of *Eustenogaster fulvipennis* (Cameron)).

*Stenogaster fulvipennis*; von Schulthess, 1927, Suppl. Ent. 16: 86.

*Eustenogaster fulvipennis*; Carpenter, 1988, J. New York Ent. Soc. 96: 175.

Distribution: Borneo I. [Sarawak] (Carpenter and Kojima, 1997; Saito & Kojima, 2007).

**fumipennis** Saito

*Eustenogaster fumipennis* Saito, in Saito and Kojima, 2007, Zootaxa 1556: 1, 7, 10 (figs. 26-31), 16 (fig. 57), 21, female, – The Philippines; Panay Island “Antique: Alojipan, Culasi” (AMNH). – Selis, 2018, Zootaxa 4514 (3), 384, 385, 386 (figs.), female, male.

Distribution: Luzon I., Panay I., Negros I., Mindanao I. (Saito & Kojima, 2007; Selis, 2018).

**gibbosa** Starr and van der Vecht

*Eustenogaster gibbosa* Starr and van der Vecht, in Hashim *et al.* 2006, Tropical Zoology 19: 289, female, – “Malaysia, Gombak FSC” (holotype female UMM, now MSNF as long-term loan). – Selis, 2018, Zootaxa 4514 (3), 385.

Distribution: Malay Peninsula; Singapore; Borneo I.; Sumatra I., Mentawai Is., Krakatau I., Java I., Bangka Is.; Palawan I. (Hashim *et al.* 2006; Saito & Kojima, 2007; Selis, 2018).

**hauxwellii** (Bingham)

*Ischnogaster rufo-maculata* Bingham, 1894, J. Bombay Nat. Hist. Soc. 8: 385, female – “Tenasserim (Salween Valley, Tavoy)” (BMNH); 1897, Fauna Brit. India, Hym. 1: 377, 379 (*rufomaculata*). – Das and Gupta, 1984 (1983), Or. Ins. 17: 402 (syn. of *Eustenogaster hauxwellii* (Bingham), acting as first reviser).

*Ischnogaster hauxwellii* Bingham, 1894, J. Bombay Nat. Hist. Soc. 8 (3): 386, pl. 1 fig. 4, female, male – “Tenasserim (Ataran and Ye Valleys)” (BMNH).

*Ischnogaster hauxwelli* [!]; Dalla Torre, 1904, Gen. Ins. 19: 84 (syn. of *Ischnogaster micans* de Saussure).

? *Stenogaster bicarinata* Dover and Rao, 1922, J. Proc. Asiat. Soc. Bengal (N. S.) 18: 242, male – “Ten miles south of Kuching, Sarawak, Borneo” (ZSI). – Carpenter and Kojima, 1997 (1996), J. New York Entomol. Soc. 104: 26 (? syn. of *Eustenogaster hauxwellii* (Bingham)).

*Stenogaster rufomaculata*; Dover and Rao, 1922, J. Proc. Asiat. Soc. Bengal (N. S.) 18: 241.

*Stenogaster micans* var. *hauxwelli* [!]; von Schulthess, 1927, Suppl. Ent. 16: 85.

*Stenogaster rufomaculatus*; von Schulthess, 1927, Suppl. Ent. 16: 86 (catalogue).

*Stenogaster nigromaculata* [!]; Dover, 1931, J. Fed. Malay. St. Mus. 16: 256.

*Eustenogaster hauxwellii*; Iwata, 1976, Evol. Instinct: 274. - Das and Gupta, 1984 (1983), Or. Ins. 17: 402 (syn.: *Ischnogaster rufomaculata* Bingham, acting as first reviser; catalogue; distribution).

Distribution: Eastern slope of the Himalaya [Northeastern India (Sikkim); northern Myanmar; northern Thailand]; Cambodia; Singapore; Borneo I.; Sumatra I.; Bangka I.; Krakatau Is.; Java I.: Bali I.; Mindanao I. (Saito & Kojima, 2007).

**latebricola** Saito

*Eustenogaster latebricola* Saito, in Saito and Kojima, 2007, *Zootaxa* 1556: 1, 6, 8, 13 (figs. 39-45), 14 (figs. 46-49), 17 (fig. 58), 18 (fig. 59J, V), 25, female, male – holotype female “S. Sumatra, 250 m, Res. Benkoelen, Mocara Tenam” (RMNH).

Distribution: Malay Peninsula; Borneo I.; Sumatra I., Krakatau I., Java I., Bangka I. (Saito & Kojima, 2007).

**luzonensis** (Rohwer)

*Stenogaster micans* var. *Luzonensis* Rohwer, 1919, Bull. Hawaii. Sugar Pltrs. Assoc. Exp. Stat., Ent. Ser. 14 (1): 3a, 16, male, female - “Mt. Makiling, Luzon, P. I.” (holotype female NMNH).

*Stenogaster micans* var. *luzonicus* [!]; von Schulthess, 1927, Suppl. Ent. 16: 85.

*Eustenogaster luzonensis*; Carpenter, 1988, J. New York Ent. Soc. 96: 175.

Distribution: Luzon I. (Saito & Kojima, 2007).

**micans** (de Saussure)

*Ischnogaster micans* de Saussure, 1852, Ann. Soc. Ent. France (2) 10: 24, female - “Java” (RMNH). – von Schulthess, 1914, Zool. Jahrb. (Abt. Syst. Geogr. Biol. Tiere) 37 (3): 254 (in subgenus *Ischnogaster*). – Kojima and van Achterberg, 1997, Zool. Meded., Leiden, 71: 163 (designation of lectotype).

*Ischnogaster ornatifrons* Cameron, 1902, J. Straits Branch R. Asiat. Soc. 37: 105, female - “Santubong, Kuching, Sarawak” (BMNH). – Meade-Waldo, 1914, Ann. Mag. Nat. Hist. (8) 14: 463 (in subgenus *Parischnogaster*). – Carpenter and Kojima, 1997, J. New York Entomol. Soc. 104: 26 (? syn. of *Eustenogaster micans* (de Saussure)). – Saito-Morooka *et al.*, 2020, *Treubia* 47(2): 142–143. (syn. of *Eustenogaster micans* (de Saussure)).

*Stenogaster micans*; von Schulthess, 1927, Suppl. Ent. 16: 81, 85. - Dover, 1929, Bull. Raffles Mus. 2: 45 (syn.: *Ischnogaster fulvipennis* Cameron).

*Stenogaster ornatifrons*; von Schulthess, 1927, Suppl. Ent. 16: 86.

*Eustenogaster micans*; van der Vecht, 1969, *in Nature and Life in S. E. Asia* 6: 165.

*Holischnogaster micans*; Lee, 1982, *Hornets Agric. Regions China*: 133.

Distribution: Yunnan (?); Myanmar; Thailand; Singapore; Malay Peninsula; Borneo I.; Sumatra I.; Bangka Is.; Java I. (Saito & Kojima, 2007).

**multifolia** Saito-Morooka

*Eustenogaster multifolia* Saito-Morooka, in Saito-Morooka *et al.*, 2020, *Treubia* 47(2): 135–136, 138 (MZB).

Distribution: Sumatra I. (Saito-Morooka *et al.*, 2020, *Treubia* 47(2): 135–136, 138).

**nigra** Saito and Nguyen

*Eustenogaster nigra* Saito and Nguyen, in Saito *et al.*, 2006, *Amer. Mus. Novitat.* (3534): 2, female, male, nest. Holotype female - “Viet Nam: Tam Dao (outside town), ca. 900 m, Vinh Phuc” (IUNH/IEBR).

Distribution: Yanping in Fujian of China; possibly Yunnan; Hong Kong; northern Vietnam; northern Thailand (Saito & Kojima, 2007).

**palavanica** Reyes

*Eustenogaster palavanica* Reyes, 1988, *Philipp. Ent.* 7 (4): 387, 392 (key), figs. 25-29, female, male - “Irawan River, 2000 ft, Mt. Beaufort, Palawan” (holotype male BPBM).

Distribution: Palawan I. (Reyes, 1988).



**panaiensis** Saito

*Eustenogaster panaiensis* Saito, 2009, Spec. Div. 14: 16, 17 (figs 1-12), 18, 23 (key), 24 (key), female, male - “Panay Island, Philippine” (AMNH). – Selis, 2018, Zootaxa 4514 (3), 385.  
Distribution: Luzon I.; Panay I.; Mindanao I. (Saito, 2009; Selis, 2018).

**scitula** (Bingham)

*Ischnogaster scitula* Bingham, 1897, Fauna Brit. India, Hym. 1: 377 (key), 379, female – “Rangit Valley, Sikkim; Margherita, Assam” (BMNH). – Dover, 1925 (1924), J. Asiat. Soc. Bengal (N. S.) 20: 301 (syn. of *Stenogaster fraterna* (Bingham)).

*Stenogaster scitula*; Dover and Rao, 1922, J. Proc. Asiat. Soc. Bengal (N. S.) 18: 240.

*Stenogaster scitula* var. *assamensis* Dover and Rao, 1922, J. Proc. Asiat. Soc. Bengal (N. S.) 18: 240, male – “Margherita, Assam” (ZSI). – Dover, 1925 (1924), J. Asiat. Soc. Bengal (N. S.) 20: 301 (syn. of *Stenogaster scitula* (Bingham)).

*Stenogaster seitula* [!]; Lee, 1982, Hornets Agric. Regions China: 130.

*Eustenogaster scitula*; Das and Gupta, 1984 (1983), Or. Ins. 17: 402 (syn.: *Stenogaster scitula* var. *assamensis* Dover and Rao).

Distribution: Northeastern parts of Indian subcontinent [India (Assam, Meghalaya, Sikkim)]; Yunnan; Myanmar; Vietnam; Malay Peninsula (Saito & Kojima, 2007).

**spinicauda** Saito

*Eustenogaster spinicauda* Saito, in Saito and Kojima, 2007, Zootaxa 1556: 1, 7, 8, 15 (figs. 50-56), 17 (fig. 58), 18 (fig. 59M, Y), 27, female, male – holotype female “Catbalogan, Samar” (RMNH). – Selis, 2018, Zootaxa 4514 (3), 385.

Distribution: Cebu I.; Samar I.; Leyte I.; Mindoro I.; Mindanao I. (Saito & Kojima, 2007; Selis, 2018).

**sumatraensis** Saito-Morooka

*Eustenogaster sumatraensis* Saito-Morooka, in Saito-Morooka *et al.*, 2020, Treubia 47(2): 136–138 (MZB).

Distribution: Sumatra I.; Malay Peninsula (Saito-Morooka *et al.*, 2020, Treubia 47(2): 136–138).

**vietnamensis** Saito

*Eustenogaster vietnamensis* Saito, 2009, Spec. Div. 14: 20, 21 (figs 18-22), 22, 24 (key), male - “Dambri-BLōc-LDong, Vietnam” (IUNH/IEBR). – Saito-Morooka *et al.*, 2020, Treubia 47(2): 139–140 (description of female).

Distribution: Vietnam (Saito, 2009; Saito-Morooka *et al.*, 2020, Treubia 47(2): 139–140).

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MacKinnon, J. & Phillips, K. 1993. *Field Guide to the Birds of Borneo, Sumatra, Java and Bali*. Oxford: Oxford University Press: 491 pp.

Natural History Museum 2013. Wallace100 - celebrating Alfred Russel Wallace's life and legacy. <http://www.nhm.ac.uk/nature-online/science-of-natural-history/wallace/index.html> 11 October 2013.

Higgins, P., Christidis, L., Ford, H. & Bonan, A. 2017. Honeyeaters (Meliphagidae). In: J. del Hoyo, A. Elliott, J. Sargatal, D.A. Christie & E. de Juana, eds. *Handbook of the Birds of the World Alive*. Barcelona: Lynx Edicions. <http://www.hbw.com>.

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VOL. 47, NO. 2, DECEMBER 2020

CONTENT

<b>Pipit Pitriana, Andreas Wessel, Tina Aschenbach, and Kristina von Rintelen</b> Exploring sponge-inhabiting barnacles of eastern Indonesia using micro-CT scanning .....	<b>77–98</b>
<b>Jarulis, Choirul Muslim, Dedy Duryadi Solihin, Ani Mardiasuti, and Lilik Budi Prasetyo</b> Characters of mitochondrial DNA D-loop hypervariable III fragments of Indonesian Rhinoceros Hornbill ( <i>Buceros rhinoceros</i> ) (Aves: Bucerotidae) .....	<b>99–110</b>
<b>Eka Kartika Arum Puspita Sari, Moch. Affandi, and Sucipto Hariyanto</b> Diversity of fruit flies (Tephritidae: <i>Bactrocera</i> spp.) in campus C of Airlangga University, Surabaya, Indonesia .....	<b>111–122</b>
<b>Sih Kahono, Dewi M. Prawiradilaga, Djunijanti Peggie, Erniwati, and Eko Sulistyadi</b> First report on hunting behavior of migratory Oriental Honey-buzzard ( <i>Pernis ptilorhynchus orientalis</i> ) towards migratory giant honeybee ( <i>Apis dorsata dorsata</i> ) (Hymenoptera: Apidae) on Java Island, Indonesia .....	<b>123–132</b>
<b>Fuki Saito-Morooka, Hari Nugroho, Alan Handru, and Jun-ichi Kojima</b> Taxonomic notes on the hover wasp genus <i>Eustenogaster</i> (Vespidae, Stenogastrinae), with description of two new species from Sumatra Island, Indonesia .....	<b>133–154</b>