

TAXONOMIC STUDY ON SELECTED SPECIES OF STINGLESS BEE (HYMENOPTERA: APIDAE: MELIPONINI) IN PENINSULAR MALAYSIA

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ABSTRACT

A total of 19 species of stingless bee (Apidae: Meliponini) from eight genera were examined and revised, based on 145 specimens from the collection of Malaysian Agricultural Research and Development Institute (MARDI), Malaysian Genome Institute (MGI) and a sampling done in several stingless bee farms in Peninsular Malaysia. This study aims to revise a taxonomic character and provide a redescription of stingless bee based on morphological characters and morphometric measurements of 24 parameters, in order to prepare a dichotomous key to the genus and species in Peninsular Malaysia. The genera and species identification of stingless bee were based on morphological characters and coloration such as the structure and color of antenna, head, thorax, wing, leg and abdomen. Finding of the research shows that, *Geniotrigona* appeared as the largest genus in term of size and thus supported by the previous report. It was represented by two species namely *Geniotrigona thoracica* and *Homotrigona fimbriata* with mean body length 8.44 and 8.24 mm, respectively. *Tetragonula fuscobalteata* appeared as the smallest species of stingless bee with an average of body length 3.26mm. *Lepidotrigona* can be differentiated from other genera of stingless bees by having a yellowish scale-like structure on a mesoscutum while *Tetragonula* can be categorized by having a hairband on a mesoscutum. This hairband character is peculiar for *Tetragonula* while their species differentiation can be made whether it is obviously seen or not. *Tetragonula* was recorded as the most abundant genus with highest species richness accordingly to the previous literature, and represented here by eight described species. Each recorded species of stingless bee were successfully distinguished by distinct morphological characters and coloration possess by the species itself. Thus, it is hope that this study would be very useful as a guideline and reference for further studies of stingless bee in future.

Key word: Stingless bee, Malaysia, taxonomy, description.

ABSTRAK

Sejumlah 19 spesies kelulut (Apidae: Meliponini) daripada lapan genus telah diperiksa dan disemak, berdasarkan 145 spesimen daripada koleksi di Institut Penyelidikan dan Kemajuan Pertanian Malaysia (MARDI), Insititut Genom Malaysia (MGI) dan hasil persampelan di beberapa pusat penternakan kelulut di Semenanjung Malaysia. Kajian ini bertujuan untuk

semakan semula ciri taksonomi dan menyediakan perihalan semula kelulut berdasarkan ciri morfologi dan ukuran morfometrik ke atas 24 parameter morfologi dalam usaha menghasilkan kekunci genus dan spesies di Semenanjung Malaysia. Pengecaman lebah kelulut di peringkat genus dan spesies adalah berdasarkan ciri morfologi dan pewarnaan seperti struktur dan warna antena, kepala, toraks, sayap, kaki dan abdomen. Penemuan kajian ini menunjukkan bahawa *Geniotrigona* muncul sebagai genus yang bersaiz paling besar dan bertepatan dengan laporan terdahulu. Ia diwakili oleh dua spesies iaitu *Geniotrigona thoracica* dan *Homotrigona fimbriata* dengan purata panjang badan masing-masing 8.44 dan 8.24 mm. *Tetragonula fuscobalteata* pula muncul sebagai spesies lebah kelulut yang paling kecil dengan purata panjang badan 3.26 mm. *Lepidotrigona* boleh dibezakan daripada genus lebah kelulut yang lain dengan kehadiran struktur seperti sisik kekuningan pada mesoskutum manakala *Tetragonula* pula boleh dicirikan oleh kehadiran jalur berbulu pada mesoskutum. Ciri jalur berbulu ini adalah khusus bagi *Tetragonula* manakala pembezaan antara spesies dapat dilakukan sama ada ianya jelas atau tidak kelihatan. *Tetragonula* telah direkodkan sebagai genus yang paling melimpah dengan kekayaan spesies yang paling tinggi, bertepatan dengan kajian terdahulu, dan diwakili oleh lapan spesies dalam kajian ini. Setiap spesies kelulut yang direkodkan telah berjaya dibezakan melalui ciri morfologi jelas berbeza dan warna badan yang khusus untuk spesies tersebut. Oleh itu, adalah diharapkan kajian ini akan menjadi garis panduan dan rujukan sangat berguna untuk kajian lebah kelulut yang selanjutnya di masa akan datang.

Kata kunci : Kelulut, Malaysia, taksonomi, perihalan

INTRODUCTION

Stingless bee is a group of bee which possesses unfunctional sting for defense (Wille 1983) and highly distributed in both tropical and subtropical regions. It is an eusocial insect that live in a perennial colony together with queen, worker (sterile female) and drone (male bee). Workers are responsible to build and protect their nest and act as a forager to maintain the stability of reproduction rate and metabolism (Nagamitsu & Inoue 2005). Stingless bee is a generalist, female bee fly and collecting the pollens and carcasses as well as inorganic salt from various sources (Roubik 1989). The flight activity particularly of two species namely, *Heterotrigona itama* and *Geniotrigona thoracica* were significant affected by temperature, relative humidity, moderate light intensity and hours of treatments (Wan Nur Asiah et al. 2015). Nectar is known as a main food source for bees but sometimes they consume honey produced by aphid as energy resources. On the other hand, stingless bee is a well-known pollinator in tropical rainforest (Eltz et al. 2003) and used as a pollinator for strawberry in Japan (Kukutani et al. 1993).

Stingless bee can be easily differentiated with honey bee by having a penicilium, a long setae on hind tibia and possesses a weak wing venation (Wille 1983). Furthermore, stingless bee has a corbicula structure on hind leg used to carry pollen, similar to other bees including honey bee (Apini), bumble bee (Bombini) and orchid bee (Euglossini) (Michener 2007). It is known as a smallest bee which able to produce honey in subfamily Meliponinae. The bee hives are made of the mixture of wax, resin and gum, however there are some species that used mud which collecting by workers (Klaskasikorn et al. 2005). The nest entrance for each species of stingless bee is a species-specific, while the size can be controlled under a certain pressure (Dananaddi et al. 2009). Some of the species built underground nest but most of them built nests inside the tree cavities (Velthuis 1997).

A total of 45 species of stingless bees from 14 genera have been recorded and identified in Malaysia (Rasmussen 2008), while 30 species in Thailand (Michener & Boongird 2004). According to Schwarz (1937) the abundance of stingless bee is highest in Malaysia and Thailand, including Borneo due to the high diversity of dipterocarp forest which produce resin (Dipterocarpaceae) and tropical forest moisture (Rasmussen 2008). There are five species of stingless bees, *Geniotrigona thoracica*, *Heterotrigona itama*, *Lepidotrigona terminata*, *Tetragonula fuscobalteata* and *Tetragonula leviceps* being commercialized in meliponiculture industry for honey production and pollination in Malaysia (Kelly et al. 2014). As stated by Norowi et al. (2010), *Geniotrigona thoracica* is the largest stingless bee in the world which endemic in Malaysia. Herein this paper, a revision based on the taxonomic character of selected stingless bee in Malaysia have been made possible. Redescription of the genera and species, a dichotomous key of genera and species of selected stingless bees in Peninsular Malaysia were produced.

MATERIALS AND METHODS

The materials of this study are collections of stingless bee specimens deposited in the repository of Malaysian Agricultural Research and Development Institute (MARDI), Malaysian Genome Institute (MGI) and new samples collected from several stingless bee farms in Peninsular Malaysia have been examined. Classification and identification of stingless bees were based on the morphological characters such as head, antenna, thorax, wing, leg and abdomen with coloration (Figure 1).

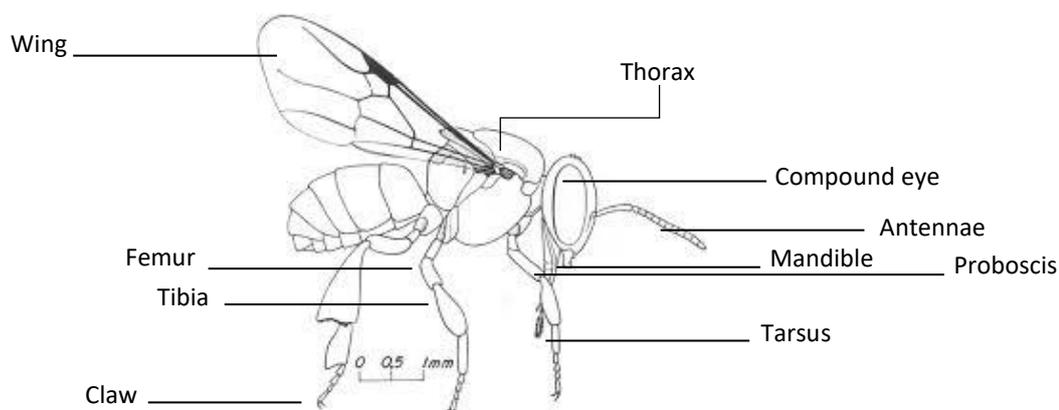


Figure 1 Diagram of stingless bee showing principal body parts for measurements.

RESULT AND DISCUSSION

A total of 24 morphological characters of stingless bee have been chosen as parameters for morphometric measurement (Table 1) following Rasmussen (2013). Measurements were carried out in the laboratory of Centre for Insect Systematics (CIS), National University of Malaysia (UKM). A few specimens from each species were taken for the inspection and measurement which involve both absolute and relative measurements. Species re-description is an update from a previous study with additional of morphometric measurement and coloration. A photographs for each species were taken and included in a re-description such as head, thorax, forewing and hind leg.

Table 1 List of parameters used for morphometric measurement

No.	Parameter (mm)
1.	Total length
2.	Head width
3.	Head length
4.	Compound eye length
5.	Compound eye width
6.	Scape length
7.	Length of pedicel and entire flagella
8.	Length of first flagellomere
9.	Length of second flagellomere
10.	Length of third flagellomere
11.	Length of forewing (include tegula)
12.	Forewing width
13.	Forewing length
14.	Pterostigma length
15.	Pterostigma width
16.	Hamuli
17.	Mesoscutum length
18.	Mesoscutum width
19.	Scutellum width
20.	Scutellum length
21.	Length of hind tibia
22.	Width of hind tibia
23.	Length of hind basitarsus
24.	Width of hind basitarsus

A total of 19 species of stingless bee under eight genera was recorded, based on 145 specimens deposited in the repository of MARDI and MGI, and collected specimens from various stingless bee farms in Peninsular Malaysia were successfully examined (Table 2). They key to genera and species were prepared and provided while the description of all genera and species were revised and re-described.

Table 2 Species checklist of stingless bee and total number of specimens examined

No.	Species	Total
1	<i>Geniotrigona thoracica</i> (Smith, 1857)	10
2	<i>Heterotrigona erythrogastra</i> (Cameron, 1902)	10
3	<i>Heterotrigona itama</i> (Cockerell, 1918)	10
4	<i>Homotrigona fimbriata</i> (Smith, 1857)	5
5	<i>Lepidotrigona doipaensis</i> (Schwarz, 1939)	14
6	<i>Lepidotrigona nitidiventris</i> (Smith, 1857)	2
7	<i>Lepidotrigona terminata</i> (Smith, 1857)	3
8	<i>Lophotrigona canifrons</i> (Smith, 1857)	10

9	<i>Tetragonilla collina</i> (Smith, 1857)	7
10	<i>Tetragonilla fuscibasis</i> (Cockerell, 1920)	9
11	<i>Tetragonula drescheri</i> (Schwarz, 1939)	6
12	<i>Tetragonula fuscobalteata</i> (Cameron, 1908)	10
13	<i>Tetragonula geissleri</i> (Cockerell, 1918)	8
14	<i>Tetragonula laeviceps</i> (Smith, 1857)	8
15	<i>Tetragonula minangkabau</i> (Sakagami & Inoue, 1985)	10
16	<i>Tetragonula testaceitarsis</i> (Cameron, 1902)	7
17	<i>Tetrigona apicalis</i> (Smith, 1857)	4
18	<i>Tetrigona binghami</i> (Schwarz, 1937)	10
19	<i>Tetrigona melanoleuca</i> (Cockerell, 1929)	2
Total		145

Key to Genera

- 1 - Mesoscutum bordering with a scale-like yellowish to golden hairs. An enclosing short setae yellow to brown *Lepidotrigona*
 - Mesoscutum without a scale-like hairs. An enclosing long setae brown to black **2**
- 2 - Forewing with uniform coloration and semi-transparent. Hindwing semi-transparent similar to forewing **3**
 - Forewing uneven coloration, half of forewing brown to blackish brown, another half semi-transparent. Hindwing brown to blackish brown similar to forewing **7**
- 3 - Mesoscutum with horizontal stripes or bands. Body size from medium to largest **4**
 - Mesoscutum with small spots and immaculate. Body size from smallest to large **5**
- 4 - Mesoscutum brown entirely, two brown vertical stripes located at the middle of mesoscutum. Genus that possess a largest body size. Long forewings *Geniotrigona*
 - Mesoscutum entirely black, having a smooth and black vertical bands. Moderate length of forewings *Tetragonula*
- 5 - Mandible with one tooth *Heterotrigona*
 - Mandible with two teeth **6**
- 6 - Head fully covered with mosses-like, white and thick hairs, hairs that covering the antennal sockets quite thick *Lophotrigona*
 - Head sparsely covered with fine hairs. One of genus that possess a large body size *Homotrigona*
- 7 - Contrast of blackish brown forewings is weak. Sternite covered with a brown to yellowish brown setae *Tetragonilla*
 - Contrast of blackish brown forewings is stronger. Sternite covered with a blackish brown to brown setae *Tetrigona*

Redescription of Genera and Species

Lepidotrigona Schwarz, 1939

Type species: *Trigona nitidiventris* Smith, 1857

Head. Long setae at apical. Clypeus and frons separated by distinct epistomal sulcus. Antennae geniculate, 10 segmented flagella, uniformly covered with short setae. The mandibles broader on their basal half, narrower on their apex half, possess two teeth.

Thorax. Mesoscutum coarser, setae on the mesoscutum longer especially on the anterior edge. Scutellum coarser, convex, does not fully covering propodeum. **Wings.** Tegulae rounded, highly sclerotized and obvious. Wing venation weak, covered with short and fine setae. Pterostigma opaque on costal margin edge of forewing. Total of hamuli on anterior edge of hindwing usually 6, 7 and 8 on certain species. **Legs.** Hindleg possess a widened corbicula, rounded on certain species.

Abdomen. Smaller than thorax, elongated, first to third gastral tergite usually shiny.

Measurement. Total length 4.06 – 6.55 mm (mean: 5.31 mm). Width of head 2.15 – 2.97 mm (mean: 2.56 mm) and length 1.55 – 2.16 mm (mean: 1.86 mm). Length of tibia 1.50 – 2.55 mm (mean: 2.03 mm), width of tibia 0.58 – 1.36 mm (mean: 0.97 mm).

Coloration. Head black, frons sparsely covered with white to brown hairs, thick white hairs approaching antennal sockets and clypeus. Clypeus black and fully covered with white to brown thin hairs. Compound eyes blackish red, ocelli blackish red and large. Antennal sockets grey to yellowish, scape black and brown at basal half, pedicel and entire flagella blackish brown. Mandible almost blackish brown entirely except black at basal part. Mesoscutum wholly black, frame with a scalelike yellow to golden hairs, three vertical black stripes at anterior edge on certain species, enclosing brown setae at anterior edge, scutellum black entirely, posterior edge covered with a thick golden yellow scalelike for certain individuals, covered with brown setae. Tegulae brown, uniform coloration of forewings, wing venation dark brown and semi-transparent. Hindwings semitransparent as forewings. Tibia black entirely. Basitarsus black entirely as tibia. Gastral tergite yellowish white to light brown entirely and blackish brown at dorsal part. Sternite yellowish white to light brown entirely.

Diagnosis. Stingless bee that belongs to this genus can easily differentiated from another genera by presence of tessellation over the head, thorax, propodeum, abdominal tergite and leg. On the other hand, the peculiar character possess by this genus is having a mesoscutum which framing with a scalelike yellow to golden hairs. It is enclosing with a short yellow to brown setae. However, all species under this genus quite difficult to differentiate from one another.

Key to Species

- 1 - Mesoscutum black entirely, frame with a thin and yellow scalelike, three black lines lie vertically at anterior edge. Scutellum black entirely.....*L. doipaensis*
 - Mesoscutum black entirely, frame with a thick and golden yellow scalelike. Scutellum black entirely, covered with a thick and golden yellow scale like2

- 2 - Scutellum covered with a thick and golden yellow scalelike at posterior edge. Frons and clypeus black and fully covered with white hairs. Corbicula pear shape *L. terminata*
 - Scutellum 3/4 covered with a thick and golden yellow scalelike and fully covered with a scalelike for certain individuals. Frons and clypeus black and fully covered with brown hairs. Corbicula rounded *L. nitidiventris*

Lepidotrigona doipaensis* (Scharwz, 1939)*Figure 2 (a-e)**

Trigona (*Lepidotrigona*) *ventralis* variety *doipaensis* Schwarz 1939a: 85, 94, 136*: Holotype (USNM 53563): examined, "Doi Pa / Mai Deng / Siam 750m / 12-2932", "HughSmith / Coll", "Type No./ 53563 / U.S.N.M.", "Holotype", "*Trigona ventralis* / var. *doipaensis* / H.F. Schwarz". Type Locality: THAILAND "SIAM.Doi Pa, Mai Deng, 750 meters, Dec. 29, 1932 (H. M. Smith)".

Lepidotrigona indet. Drumond et al. 1996a: 399 (comparative behavior); Roubik 2006: 127 (nest).

Material examined. 10 ex., SELANGOR, Serdang, 20 April 2016, Fahimiee. 4 ex., SELANGOR, Bangi, Malaysia Genome Institute, 21 November 2017, Fatimah.

Head. Length almost twice than width of head, ratio length to the width 0.72 – 0.77 mm (mean: 0.75 mm), covered with long setae at apical. Clypeus and frons separated by a distinct epistomal sulcus. Compound eyes large, ratio width to the length of compound eyes 0.37 – 0.46 mm (mean: 0.42 mm) (Figure 2b). Antennae geniculate, 10 segmented flagella, enclosing uniformly by short erecting setae, long antennal scape, length of pedicel and entire flagella about twice the scape, ratio scape length to entire flagella and pedicel 0.58 – 0.68 mm (mean: 0.61 mm), length of first and second flagellomeres are equal, ratio length of first antennomere to second 0.92 – 1.17 mm (mean: 1.02 mm), length of second flagellomeres equal to third flagellomeres, ratio length of second flagellomeres to third 1.00 – 1.08 mm (mean: 1.01 mm). The mandibles broader on their basal half, narrower on their apex, possess two teeth located at apex of mandible.

Thorax. Mesoscutum coarser, covered with long setae at anterior part, mesoscutum length almost equal to width, ratio of mesoscutum length to width 0.78 – 0.90 mm (mean: 0.85 mm), anterior part broadened than posterior (Figure 2c). Scutellum coarser, convex, scutellum length almost three times than width, ratio scutellum length to width 0.30 – 0.42 mm (mean: 0.36 mm), sparsely enclosing with long setae. **Wings.** Tegulae rounded, highly sclerotized and obvious. Wing venation weak, forewings length almost three times than width, ratio width to length 0.36 – 0.39 mm (mean: 0.38 mm), enclosing with short and fine setae. Pterostigma opaque on costal margin of forewings (Figure 2d). Total of hamuli on anterior margin of hindwings usually 6 but sometimes 7 in certain individuals. **Legs.** Corbicula slightly rounded and obvious, wholly covered with long setae at apical edge but sparsely

covered with short setae at basal edge. (Figure 2e). Hind basitarsi long, length of tibia about twice than basitarsus, ratio length of basitarsus to tibia 0.38 – 0.44 mm (mean: 0.41 mm), covered with short setae.

Abdomen. Gastral tergite first to sixth shiny. Sternite wholly shiny as tergite.

Measurement. Total length 4.06 – 6.55 mm (mean: 5.31 mm, n = 14) (Figure 2a). Head width 2.70 – 2.87 mm (mean: 2.76 mm) and length 2.00 – 2.16 mm (mean: 2.08 mm). Length 0.51 – 0.65 mm (mean: 0.60 mm) and pterostigma width 0.15 – 0.20 mm (mean: 0.18 mm). Tibia length 1.50 – 1.79 mm (mean: 1.63 mm), tibia width 0.58 – 0.76 mm (mean: 0.66 mm).

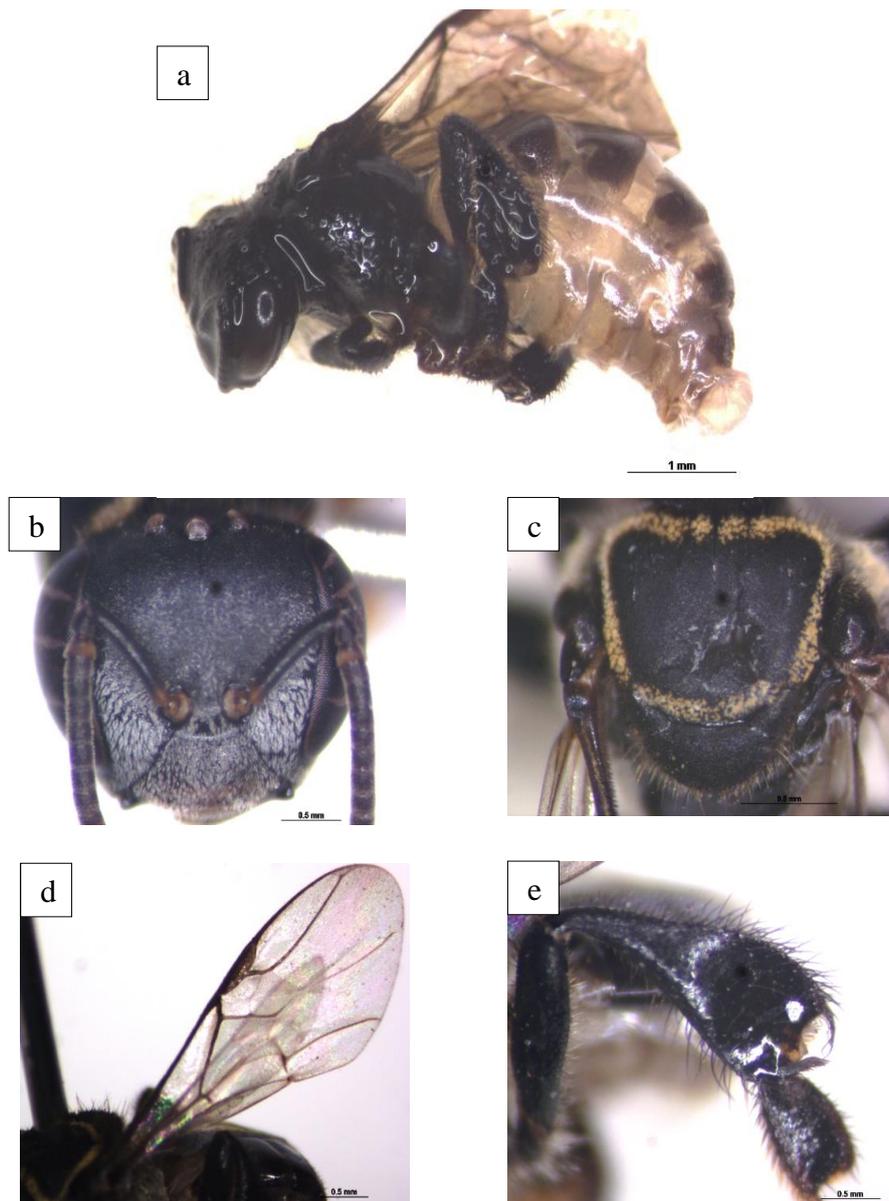


Figure 2 *Lepidotrigona doipaensis* (Scharwz, 1939); a, Habitus, Lateral view; b, Frons; c, Mesoscutum; d, Forewing; e, Hind tibia and basitarsus, Scale: 0.5 mm and 1.0 mm.

Coloration. Head black, frons fully covered with fine white hairs, thick white hairs approaching antennal sockets and clypeus. Clypeus black and covered with fine white hairs. Compound eyes blackish, ocelli blackish as compound eyes and large. Antennal sockets grey, scape black but brown at basal, pedicel and flagella blackish brown entirely. Mandible black at basal half and blackish brown on the other half. Mesoscutum wholly black, frame with a yellow scalelike, possesses three vertical black lines at anterior edge, covered with brown setae at anterior margin, scutellum black entirely and covered with brown setae. Tegulae brown, uniform coloration of forewings, forewings venation dark brown and semi-transparent. Hindwings semi-transparent as forewings. Tibiae and basitarsis black entirely. Gastral tergite yellowish white entirely but blackish brown on dorsal part. Sternite yellowish white entirely.

Diagnosis. *Lepidotrigona doipaensis* possesses a black mesoscutum which framing with a yellow scalelike that make it looks similar to another species *L. nitidiventris* and *L. terminata*. Nevertheless, *L. doipaensis* can be distinguished by having a three vertical black lines at anterior edge and covered with brown setae. While *L. nitidiventris* and *L. terminata* does not possess that peculiar character. Besides, *L. doipaensis* also possesses a black scutellum entirely without being covered with a golden yellow scalelike as *L. nitidiventris* and *L. terminata*. The venation of forewings of this species is dark brown which quite similar to *L. terminata*.

Lepidotrigona terminata (Smith, 1878)

Figure 3 (a-e)

Trigona terminata Smith 1878: 169: Type (BMNH 17b.1100). Type Locality: MYANMAR no precise locality, presumably "Maulmain, Tenasserim Provinces".

Trigona fulvomarginata Cockerell 1919c: 78: Holotype (BMNH 17b.1083); Type Locality: MALAYSIA "Penang".

Lepidotrigona indet. Drumond et al. 1996a: 399 (comparative behavior); Roubik 2006: 127 (nest).

Material examined. 1 ex., SELANGOR, Serdang, 20 April 2016, Fahimiee. 3 ex., SELANGOR, Bangi, Malaysia Genome Institute, 21 November 2017, Fatimah.

Head. Head length about twice than width, ratio length to width of head 0.72 – 0.73 mm (mean: 0.72 mm), covered with setae at apical. Clypeus and frons separated by a distinct epistomal sulcus. Compound eyes large, ratio width to the length of compound eyes 0.46 – 0.47 mm (mean: 0.47 mm) (Figure 3b). Antennae geniculate, 10 segmented flagella, uniformly covered with short erecting setae, long antennal scape, length of pedicel and entire flagella about twice than scape, ratio scape length to entire flagella and pedicel 0.55 – 0.58 mm (mean: 0.57 mm), length of first and second flagellomeres are equal, ratio length of first antennomere to second 0.92 – 1.04 mm (mean: 0.98 mm), length of second and third flagellomeres are similar, ratio length of second flagellomeres to third 1.00 – 1.00 mm (mean: 1.00 mm). The mandibles broader on their basal half, narrower on their apex, possesses two teeth.

Thorax. Mesoscutum coarser, covered with long setae at anterior part, mesoscutum length almost equal to width, ratio of mesoscutum length to width 0.84 – 0.85 mm (mean: 0.85 mm), anterior part broadened than posterior (Figure 3c). Scutellum coarser, convex, scutellum length almost twice than width, ratio scutellum length to width 0.37 – 0.41 mm (mean: 0.40

mm), covered with long setae. **Wings.** Tegulae rounded, highly sclerotized and obvious. Wing venation weak, forewings length about three times than width, ratio width to length 0.34 – 0.36 mm (mean: 0.35 mm), covered with short and fine setae. Pterostigma opaque at costal margin of forewings (Figure 3d). Total of hamuli on anterior margin of hindwings usually 6 but sometimes 7 in certain individuals. **Legs.** Hind tibiae long, corbicula pear shape and obvious, wholly covered with long setae at apical but sparsely covered with short setae at basal. (Figure 3e). Hind basitarsi long, length of tibia almost twice than length of basitarsus, ratio length of basitarsus to tibia 0.41 – 0.50 mm (mean: 0.44 mm), covered with a short setae.

Abdomen. Gastral tergite first to sixth shiny. Sternite wholly shiny as tergite.

Measurement. Total length 6.11 – 6.49 mm (mean: 6.29 mm) (Figure 3a). Head width 2.15 – 2.22 mm (mean: 2.16 mm) and length 1.55 – 1.60 mm (mean: 1.57 mm). Length 0.71 – 0.76 mm (mean: 0.74 mm) and pterostigma width 0.19 – 0.20 mm (mean: 0.19 mm). Tibia length 1.87 – 2.10 mm (mean: 2.03 mm), tibia width 0.79 – 0.85 mm (mean: 0.83 mm).

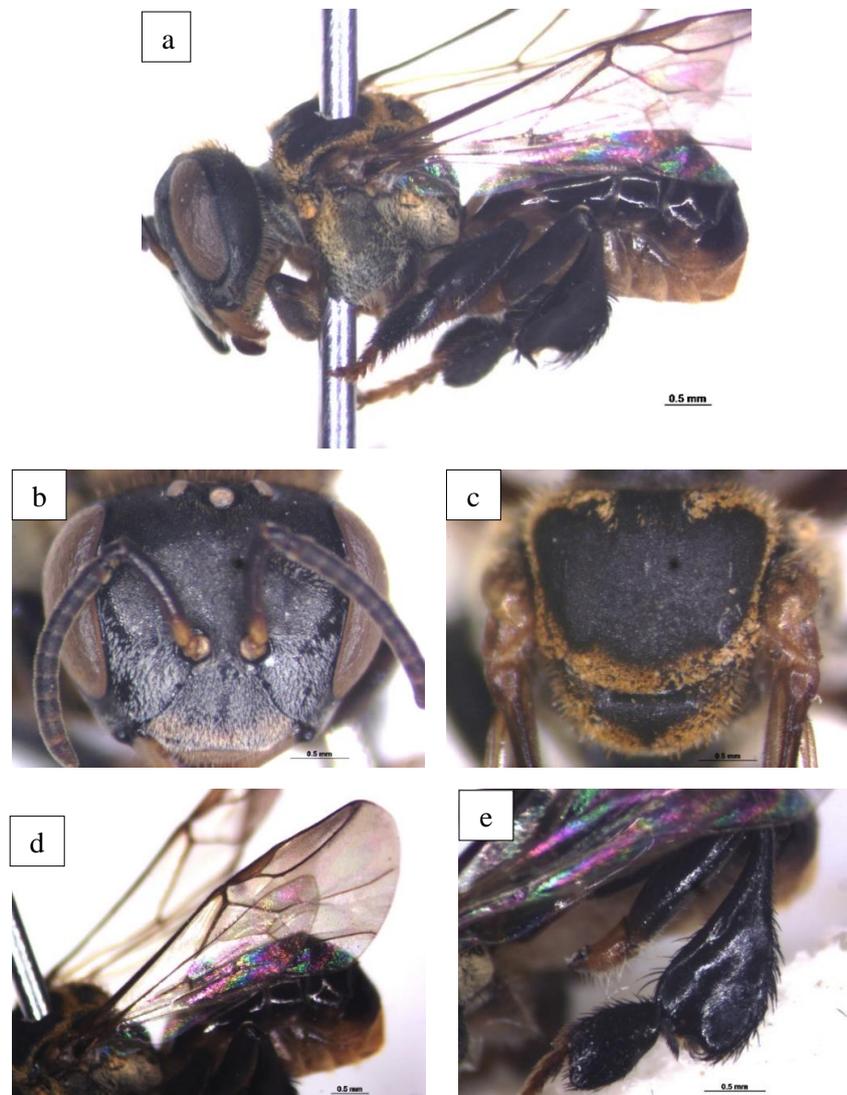


Figure 3 *Lepidotrigona terminata* (Smith, 1878); a, Habitus, Lateral view; b, Frons; c, Mesoscutum; d, Forewing; e, Hind tibia and basitarsus, Scale: 0.5 mm.

Coloration. Head black, frons fully covered with fine white hairs, thick white hairs approaching antennal sockets and clypeus. Clypeus black and covered with fine white hairs. Compound eyes blackish, ocelli blackish as compound eyes and large. Antennal sockets yellowish grey, scape black but brown at basal, pedicel and flagella blackish brown entirely. Mandible black at basal half and brown on the other half. Mesoscutum wholly black, frame with a thick golden yellow scalelike, covered with brown setae at anterior margin, scutellum black entirely, frame with a golden yellow scalelike at posterior margin and covered with brown setae. Tegulae brown, uniform coloration of forewings and semi-transparent. Hindwings semi-transparent as forewings. Tibiae and basitarsis black entirely. Gastral tergite light brown entirely but dark brown on dorsal part. Sternite light brown entirely.

Diagnosis. *Lepidotrigona terminata* is a stingless bee that possesses a similar appearance with *L. nitidiventris*. Both of these species have a black mesoscutum which framing with a thick golden yellow scalelike. However, *L. terminata* can be differentiated by having a black scutellum entirely which framing with a golden yellow scalelike at posterior. On the other hand, the ratio of head size of this species is smaller than *L. nitidiventris*. It has a black color of frons and clypeus covered with thick white hairs while *L. nitidiventris* has a black frons and clypeus but covered with brown hairs. The best character that can be seen to distinguish both of these species is the shape of corbicula, *L. terminata* possesses a pear shape corbicula while *L. nitidiventris* possesses a rounded corbicula.

***Lepidotrigona nitidiventris* (Smith, 1857)**

Figure 4 (a-e)

Trigona nitidiventris Smith 1857: 50-51: Tip (OUMNH (=Wilson Saunders collections). Type locality: MALAYSIA "Malacca (Mount Ophir)".
Trigona fulvopilosella Cameron 1908: 193, 194: Syntypes (BMNH 17b.1101). Type locality: MALAYSIA "Kuching, May and October (John Hewitt)".
Lepidotrigona indet. Drumond et al. 1996a: 399 (comparative behaviour); Roubik 2006: 127 (nest).

Material examined. 2 ex., SELANGOR, Serdang, 20 April 2016, Fahimiee.

Head. Small, width of head almost twice than length, ratio length to width 0.67 – 0.71 mm (mean: 0.69 mm), sparsely covered with short setae. Clypeus and frons separated by a distinct epistomal sulcus. Compound eye large, ratio width to length 0.45 – 0.46 mm (mean: 0.46 mm) (Figure 4b). Antennae geniculate, 10 segmented flagella, uniformly covered with a short erecting setae, long antennal scape, scape long, length of pedicel and entire flagella about twice scape, ratio scape to entire flagella and pedicel 0.48 – 0.62 mm (mean: 0.55 mm), second flagellomeres almost equal to first, ratio length of first to second flagellomeres 0.85 – 0.95 mm (mean: 0.90 mm), length of second and third flagellomeres are equal, ratio second to third flagellomeres 1.00 – 1.00 mm (mean: 1.00 mm). The mandibles broader on their basal half, narrower on their apex, possesses two teeth.

Thorax. Mesoscutum punctate and large, anterior edge covered with long setae, length almost equal to width, ratio length to width 0.85 – 0.97 mm (mean: 0.91 mm) (Figure 4c). Scutellum large, extremely convex, width about three times length, ratio length to width 0.32 – 0.34 mm (mean: 0.33 mm), covered with short setae at posterior margin. **Wings.** Tegulae rounded, large and highly sclerotized. Wing venation weak, length almost three times width of forewing, ratio width to length 0.36 – 0.37 mm (mean: 0.36 mm), covered with short and

fine setae. Pterostigma slightly opaque and large on costal margin of forewings (Figure 4d). Total of hamuli on anterior margin of hindwings usually 7 and 8. **Legs.** Hind tibiae long, corbicula rounded and obvious, sparsely covered with short setae at apical and short setae at basal (Figure 4e). Hind basitarsi long, length of tibia about twice length of basitarsus, ratio length of basitarsus to tibia 0.41 – 0.41 mm (mean: 0.41 mm), covered with short setae.

Abdomen. Gastral tergite first to fifth shiny, sixth tergite coarser and covered with fine and short setae. Sternite wholly covered with short setae.

Measurement. Total length 5.81 – 6.41 mm (mean: 6.11 mm) (Figure 4a). Head width 2.75 – 2.97 mm (mean: 2.86 mm) and length 1.95 – 2.00 mm (mean: 1.98 mm). Length 0.88 – 0.91 mm (mean: 0.90 mm) and pterostigma width 0.21 – 0.23 mm (mean: 0.22 mm). Tibia length 2.52 – 2.55 mm (mean: 2.54 mm), tibia width 1.31 – 1.36 mm (mean: 1.34 mm).

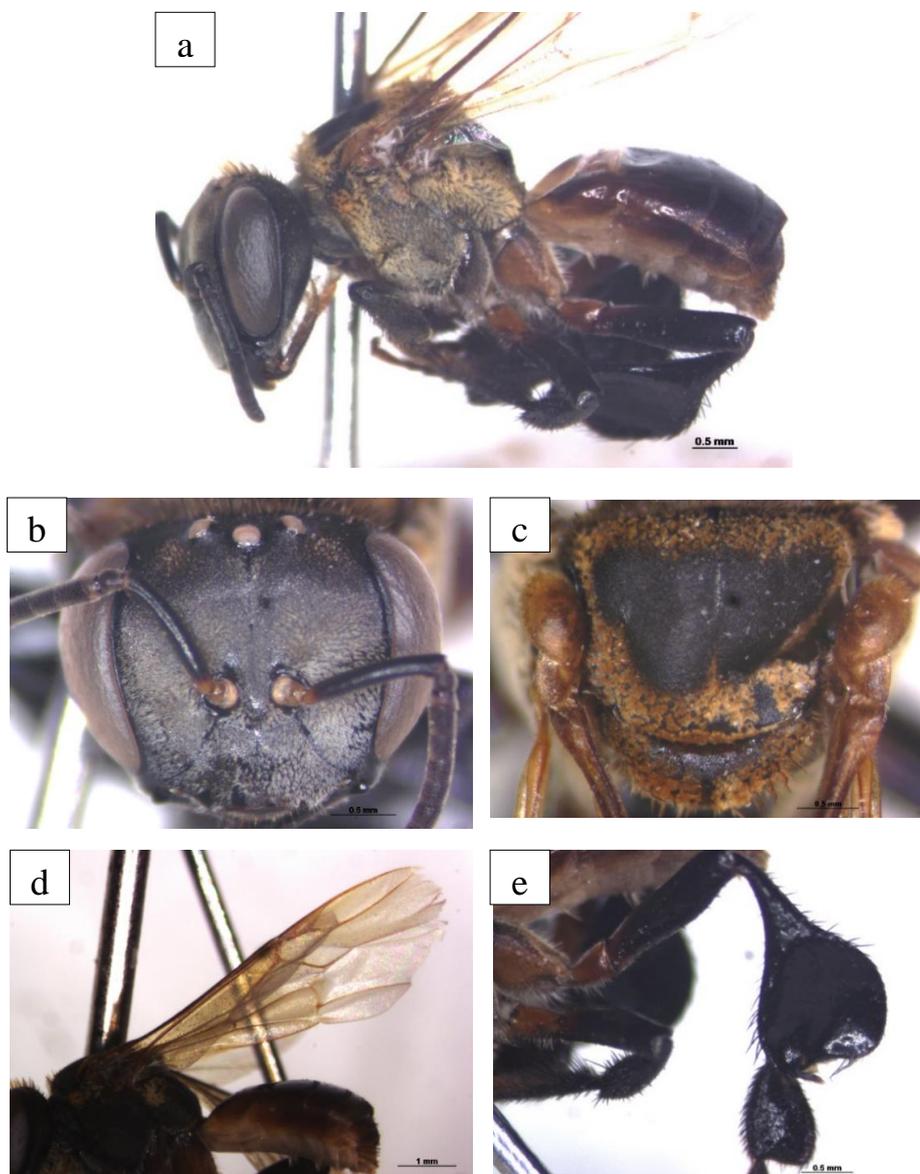


Figure 4 *Lepidotrigona nitidiventris* (Smith, 1857); a, Habitus, Lateral view; b, Frons; c, Mesoscutum; d, Forewing; e, Hind tibia and basitarsus, Scale: 0.5 mm and 1.0 mm.

Coloration. Head black, frons covered with brown hairs, clypeus black covered with brown hairs. Compound eyes reddish, ocelli big and blackish. Antennal sockets fuscous, scape black and slightly brown at basal, pedicel and entire flagella blackish brown. Mandible wholly black. Mesoscutum black, framing with a thick golden yellow scalelike at margin, fully covered with brown setae at anterior edge, scutellum entirely black, 3/4 of posterior edge covered with a thick golden yellow scalelike while in certain individual, scutellum wholly covered with a golden yellow scalelike, covered with black setae. Tegulae brown, uniform coloration of forewings and semi-transparent. Hindwings semi-transparent as forewings. Tibiae and basitarsis black entirely. Gastral tergite blackish brown entirely. Sternite yellowish brown entirely.

Diagnosis. *Lepidotrigona nitidiventris* is the most similar in general coloration to *L. terminata*, both species have a black mesoscutum which surrounded with a thick golden yellow scalelike. On the other hand, *L. nitidiventris* can be recognized by having a wholly black scutellum which 3/4 of it fully covered with a thick golden yellow scalelike. However, there are several individuals that having a scutellum which fully covered with a golden yellow scalelike. *Lepidotrigona nitidiventris* has a larger head ratio compared to *L. terminata* and also possesses a black frons and clypeus which covered with thick brown hairs. The best character to distinguish the two species is the shape of corbicula, which rounded in *L. nitidiventris* while pear shape in *L. terminata*. It is characterized by completely smooth gastral tergite and light to dark brown.

Geniotrigona Moure, 1961

Type species: *Trigona thoracica* Smith, 1857

Head. Large, sparsely covered with short setae. Clypeus and frons separated by epistomal sulcus. Large compound eyes. Antennae geniculate, 10 segmented flagella, uniformly covered with short erecting setae, scape long. The mandibles broader on their basal half, narrower on their apex, possesses two teeth.

Thorax. Mesoscutum punctate and large, covered with long setae at anterior. Scutellum large, convex, usually short, sparsely covered with short setae at posterior margin. **Wings.** Tegulae rounded, highly sclerotized and large. Wing venation weak. Pterostigma quite opaque and large on costal margin of forewings. Total of hamuli on anterior margin of hindwings either 8, 9 or 10. **Legs.** Hind tibiae long, corbicula pear-like shape and obvious, wholly covered with long setae at apical and sparsely covered with slightly short setae at basal. Hind basitarsi short and sparsely covered with short setae.

Abdomen. Triangular shape, first to third gastral tergite usually smooth and shiny. Sternite entirely covered with short setae.

Measurement. Total length 8.12 – 8.65 mm (mean: 8.39 mm). Width of head 3.20 – 3.39 mm (mean: 3.30 mm) and length 2.58 – 2.64 mm (mean: 2.61 mm). Length of tibia 3.20 – 3.30 mm (mean: 3.26 mm), width of tibia 1.15 – 1.26 mm (mean: 1.20 mm).

Coloration. Head black, frons covered with fine brown hairs, clypeus ferruginous covered with yellowish brown hairs. Compound eyes reddish, ocelli blackish and large. Antennal sockets grey, scape black and slightly brown at apical and basal, pedicel and entire flagella blackish brown. Mandible black at basal part and blackish brown on the other part.

Mesoscutum brown to black entirely, covered with blackish brown setae at anterior edge, scutellum brown to black entirely and covered with brown setae. Tegulae brown to blackish, uneven coloration of forewings, wing venation slightly dark brown at basal half while brown to dark brown on the other half and semi-transparent. Hindwings semi-transparent. Hind tibiae and basitarsi fully black. Gastral tergite brown to blackish brown. Sternite brown entirely.

Diagnosis. *Geniotrigona* are largest size of stingless bees among the other in Asia region. The scutellum and propodeum are usually short and possess a very long forewing. The abdomen of *Geniotrigona* is often triangular shape without broadened as certain groups of stingless bee. *Geniotrigona thoracica* is the largest species of stingless bee compared to another species under this genus.

***Geniotrigona thoracica* (Smith, 1857)**

Figure 5 (a-e)

Trigona thoracica Smith 1857: 50: Type (BMNH 17b.1181); Type locality: SINGAPORE.

Trigona ambusta Cockerell 1918: 387: Holotype (BMNH 17b.1131); Type locality: MALAYSIA/SINGAPORE "Sandakan and Singapore".

Geniotrigona indet. Roubik 2006: 130.

Material examined. 10 ex., SELANGOR, Serdang, 20 April 2016, Fahimiee.

Head. Large, width almost twice than length, ratio length to width 0.77 – 0.81 mm (mean: 0.79 mm), sparsely covered with short setae. Clypeus and frons separated by epistomal sulcus. Compound eyes large, ratio width to length 0.39 – 0.44 mm (mean: 0.41 mm) (Figure 5b). Antennae geniculate, 10 segmented flagella, uniformly covered with short erecting setae, scape long, length of pedicel and entire flagella about twice than scape, ratio length of scape to pedicel and entire flagella 0.50 – 0.62 mm (mean: 0.57 mm), length of first and second flagellomeres almost equal, ratio first to second flagellomeres 0.82 – 1.05 mm (mean: 0.94 mm), length of second and third flagellomeres are equal, ratio second to third flagellomeres 0.93 – 1.08 mm (mean: 1.00 mm). The mandibles broader on their basal half, narrower on their apex, possesses two teeth.

Thorax. Mesoscutum punctate and large, covered with long setae at anterior, length and width almost equal, ratio length to width 0.79 – 0.87 mm (mean: 0.83 mm) (Figure 5c). Scutellum large, convex, width almost three times than length, ratio length to width 0.36 – 0.41 mm (mean: 0.38 mm), sparsely covered with short setae at posterior margin. **Wings.** Tegulae rounded, highly sclerotized and large. Wing venation weak, length of forewing almost three times than width, ratio width to length 0.34 – 0.42 mm (mean: 0.37 mm), covered with short and fine setae. Pterostigma quite opaque and large at costal margin of forewing (Figure 5d). Total of hamuli at anterior part of hindwing usually 8, 9 or 10. **Legs.** Hind tibiae very long, corbicula pear shape, covered with long setae at apical edge and slightly short setae at basal (Figure 5e). Basitarsi short, length of tibia almost three times than basitarsus, ratio length of basitarsus to tibia 0.35 – 0.39 mm (mean: 0.37 mm), covered with short setae.

Abdomen. Gastral tergite first to fifth smooth, sixth tergite coarser and covered with short setae. Sternite fully covered with short setae.

Measurement. Total length 8.12 – 8.65 mm (mean: 8.44 mm) (Figure 5a). Width of head 3.20 – 3.39 mm (mean: 3.30 mm) and length 2.58 – 2.64 mm (mean: 2.61 mm). Length 1.20 – 1.26 mm (mean: 1.23 mm) and width of pterostigma 0.24 – 0.37 mm (mean: 0.27 mm). Tibia length 3.20 – 3.30 mm (mean: 3.26 mm), tibia width 1.15 – 1.26 mm (mean: 1.20 mm).

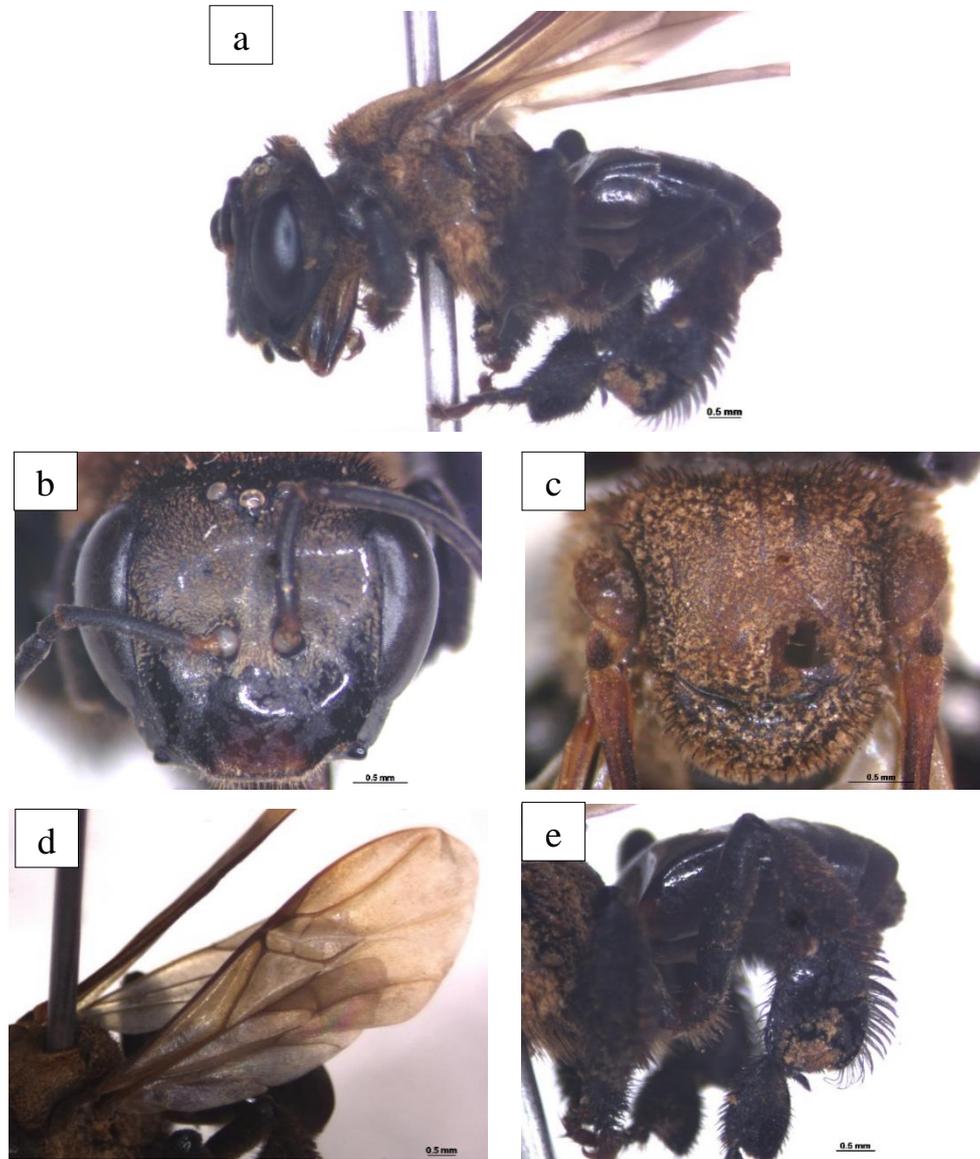


Figure 5 *Geniotrigona thoracica* (Smith, 1857); a, Habitus, Lateral view; b, Frons; c, Mesoscutum; d, Forewing; e, Hind tibia and basitarsus Scale: 0.5 mm.

Coloration. Head black, frons wholly covered with fine brown hairs, clypeus ferruginous fully covered with yellowish brown hairs. Compound eyes reddish, ocelli blackish and large. Antennal socket grey, scape black and slightly brown at basal and apical, pedicel and entire flagella blackish brown. Mandible almost wholly blackish brown but black at basal part. Mesoscutum brown entirely, two vertical black stripes at the middle of mesoscutum, covered with brown setae at anterior part, scutellum brown entirely, covered with brown setae. Tegulae brown, uneven coloration of forewings, wing venation on forewings dark brown but slightly brown at apical and semi-transparent. Hindwings semi-transparent as forewings.

Hind tibiae and basitarsi black entirely. First to fourth gastral tergite blackish brown, fifth and sixth tergite fully brown. Sternite wholly brown.

Diagnosis. *Geniotrigona thoracica* is relatively quite large stingless bee 8.12 – 8.65 mm (mean: 8.44 mm). The width of head in *G. thoracica* is 3.20 – 3.39 mm (mean: 3.30 mm) and the length of head is 2.58 – 2.64 mm (mean: 2.61 mm) which is quite large compared to other species of stingless bees. It is recognized by presence of two vertical black stripes at the middle of completely brown mesoscutum. The forewings are very long 7.93 – 8.59 mm (mean: 8.22 mm). The hind tibiae of this species are entirely black and quite long which is 3.20 – 3.30 mm (mean: 3.26 mm).

***Tetragonula* Moure, 1961**

Type species: *Trigona iridipennis* Smith, 1854

Head. Sparsely covered with short setae at apical part. Clypeus and frons separated by a distinct epistomal sulcus. Compound eyes large. Antennae geniculate, 10 segmented flagella, uniformly covered with short erecting setae, scape long, pedicel and entire flagella about twice than scape, ratio scape to entire flagella and pedicel 0.47 – 0.61 mm (mean: 0.54 mm). The mandibles broader on their basal half, narrower on their apex, possess two teeth.

Thorax. Mesoscutum coarser, possess a smooth vertical bands alternating with hairy bands, covered with setae at anterior part. Scutellum coarser, slightly sharp, cover the entire propodeum. **Wings.** Tegulae rounded, highly sclerotized and jelas. Wing venation weak. Pterostigma opaque on costal margin of forewings. Total of hamuli on anterior margin of hindwing usually 5. **Legs.** Hind tibiae long, corbicula pear shape, covered with short setae at apical and slightly sparse at basal part. Basitarsi long and covered with short setae.

Abdomen. First to third gastral tergite smooth, fourth to sixth tergite coarser, covered with fine setae. Sternite fully covered with setae.

Measurement. Total length 3.16 – 7.35 mm (mean: 5.26 mm). Width of head 1.34 – 3.01 mm (mean: 2.84 mm) and length 0.98 – 2.16 mm (mean: 1.57 mm). Length of tibia 1.22 – 2.18 mm (mean: 1.70 mm), width of tibia 0.34 – 0.82 mm (mean: 0.58 mm).

Coloration. Head black, frons fully covered with fine greyish white to yellowish brown hairs, fine white hairs approached antennal socket and clypeus. Clypeus ferruginous to blackish and covered with white to brownish hairs. Compound eyes red to blackish, ocelli red to blackish and large. Antennal socket grey to blackish, scape brown to greyish, pedicel and entire flagella brown to blackish. Mandible brown but black at basal and slightly black at apical for certain species. Mesoscutum black, covered with yellow to blackish brown setae, scutellum blackish brown to black entirely, covered with yellowish to blackish brown setae. Tegulae brown to dark brown, uniform coloration of forewings and semi-transparent. Hindwings semi-transparent similar as forewings. Hindlegs tibiae blackish brown to wholly black. Basitarsi blackish brown to black. Gastral tergite brown to dark brown. Sternite brown to blackish for certain species.

Diagnosis. *Tetragonula* are relatively medium size stingless bees 3.16 – 7.35 mm (mean: 5.26 mm) with a black vertical smooth bands located at mesoscutum. *Tetragonula* show the highest species richness in Malaysia. The number of that bands are differed among the

species and there are several species which quite difficult to separate due to the intangible bands. However, the total of hamuli on hindwing usually 5 for every species under this genus.

Key to species

1. - Mesoscutum has a vertical smooth bands alternating with distinct hairy bands **2**
 - Mesoscutum does not has a distinct smooth bands **5**
2. - Mesoscutum with a smooth, long and vertical band at the middle **3**
 - Mesoscutum with a five smooth, long and vertical bands **4**
3. - A long band located at the middle of mesoscutum flanked by another two short bands. Mandible brown, slightly black at apical and basal ***T. minangkabau***
 - A long band located at the middle of mesoscutum does not flanked by other bands. Mandible blackish brown and black at basal..... ***T. laeviceps***
4. - Frons with white hairs. Mesoscutum covered with pale yellow setae ***T. fuscobalteata***
 - Frons with yellowish brown hairs. Mesoscutum covered with a blackish brown setae ***T. drescheri***
5. - Antennae blackish brown entirely, scape yellowish brown. Gastral tergite wholly dark brown and slightly blackish in some individuals ***T. geissleri***
 - Antennae blackish brown entirely, scape brown. Gastral tergite first to sixth wholly black and blackish brown in some individuals ***T. testaceitarsis***

***Tetragonula minangkabau* (Sakagami & Inoue, 1985)**

Figure 6 (a-e)

Trigona (Tetragonula) minangkabau Sakagami & Inoue 1985: 175, 176, 177, 178, 179, 180, 181, 184-186*, 187-188: Holotype (MZB, Hymn.0198); paratype (MZB (Hymn.0195-0197); Type Locality: INDONESIA "Lubuk Mintrun nr. Padang, Sumatera Barat, Indonesia, ix 1981 in mass flight, S.F. Sakagami" (1, Holotype); "Lubuk Mintrun" (many s, 25 male, paratype).

Tetragonula indet. Anderson et al. 1982: (pollination); Floral records: *Mangifera indica*; Camargo 1988: 372 (taxonomy); Drumond et al. 1996a: 396, 398, 399 (comparative behaviour); Dollin et al. 1997: (taxonomy); Roubik 2006: 126, 127, 130, 132 (nest).

Material examined. 10 ex., SELANGOR, Bangi, Malaysia Genome Institute, 21 November 2017, Fatimah.

Head. Width almost twice than length, ratio length to width 0.66 – 0.75 mm (mean: 0.70 mm), sparsely covered with short setae at apical. Clypeus and frons separated by epistomal sulcus. Compound eyes large, ratio width to length 0.40 – 0.44 mm mean: 0.42 mm) (Figure 6b). Antennae geniculate, 10 segmented flagella, uniformly covered with short erecting setae, scape long, length of pedicel and entire flagella twice than scape, ratio length of scape to flagella and pedicel 0.48 – 0.61 mm (mean: 0.54 mm), length of first flagellomere almost

equal to second, ratio length of first to second flagellomeres 0.88 – 0.96 mm (mean: 0.91 mm), length of second and third flagellomeres are equal, ratio length of second to third flagellomeres 1.00 – 1.00 mm (mean: 1.00 mm). Mandibles broader on their basal half, narrower on their apex, possesses two teeth.

Thorax. Mesoscutum coarser, possesses three vertical and smooth bands alternating with hairy bands, anteriorly covered with setae, length of mesoscutum almost equal to the width 0.74 – 0.82 mm (mean: 0.78 mm), anterior edge slightly widened than posterior (Figure 6c). Scutellum coarser, slightly sharp, width almost twice than length, ratio length to width 0.37 – 0.44 mm (mean: 0.41 mm), sparsely covered with long setae. **Wings.** Tegulae rounded, highly sclerotized and obvious. Wing venation weak, length of forewing almost three times than width, ratio width to length 0.35 – 0.41 mm (mean: 0.38 mm), finely covered with short setae. Pterostigma very opaque on costal margin of forewings (Figure 6d). Total of hamuli on anterior margin of hindwing usually 5. **Legs.** Hind tibiae long, corbicula pear shape, covered with short setae at apical and sparsely covered with short setae at basal (Figure 6e). Hind basitarsi long, length of tibia almost twice than basitarsi, ratio length of basitarsi to tibia 0.38 – 0.46 mm (mean: 0.42 mm), covered with short setae.

Abdomen. Gastral tergite first to third smooth, tergite fourth to sixth coarser, covered with fine setae. Sternite covered with setae.

Measurement. Total length (mean: 5.04 mm) (Figure 6a). Head width 2.78 – 2.96 mm (mean: 2.84 mm) and length 1.90 – 2.08 mm (mean: 1.99 mm). Pterostigma length 0.64 – 0.70 mm (mean: 0.65 mm) and width 0.17 – 0.20 mm (mean: 0.18 mm). Tibia length 1.70 – 1.87 mm (mean: 1.80 mm) and width 0.65 – 0.76 mm (mean: 0.71 mm).

Coloration. Head black, frons fully covered with grey fine hairs, fine white hairs approaching antennal socket and clypeus. Clypeus ferruginous and covered with fine brown hairs. Compound eyes blackish, ocelli blackish and large. Antennal socket blackish grey, scape ferruginous, pedicel and first flagellomere brown, second to eighth flagellomeres black, ninth to tenth flagellomeres blackish brown. Mandible brown entirely, black at basal and slightly black apical. Mesoscutum black, fully surrounded with blackish brown setae throughout margin, scutellum blackish brown entirely, covered with blackish brown setae. Tegulae brown, uniform coloration of forewings and semi-transparent. Hindwings semi-transparent. Hind tibiae and basitarsi entirely black. Gastral tergite first to sixth entirely brown, dorsal tergite dark brown, gastral tergite entirely blackish brown for certain individuals. Sternite dark brown and blackish in some individuals.

Diagnosis. *Tetragonula minangkabau* resembles *T. laeviceps* from mesoscutum (both possess a black, smooth and vertical band located at the middle) and mandible (two teeth), but *T. minangkabau* possesses a larger size compared to *T. laeviceps* 4.75 – 5.41 mm (mean: 5.04 mm). Both of these species can be distinguished based on the number of smooth band. *Tetragonula minangkabau* possesses a three smooth bands on mesoscutum, the middle band quite long than the other two bands. The abdomen of this species entirely brown, dorsal tergite dark brown but blackish brown in some individuals while entirely dark brown in *T. laeviceps*

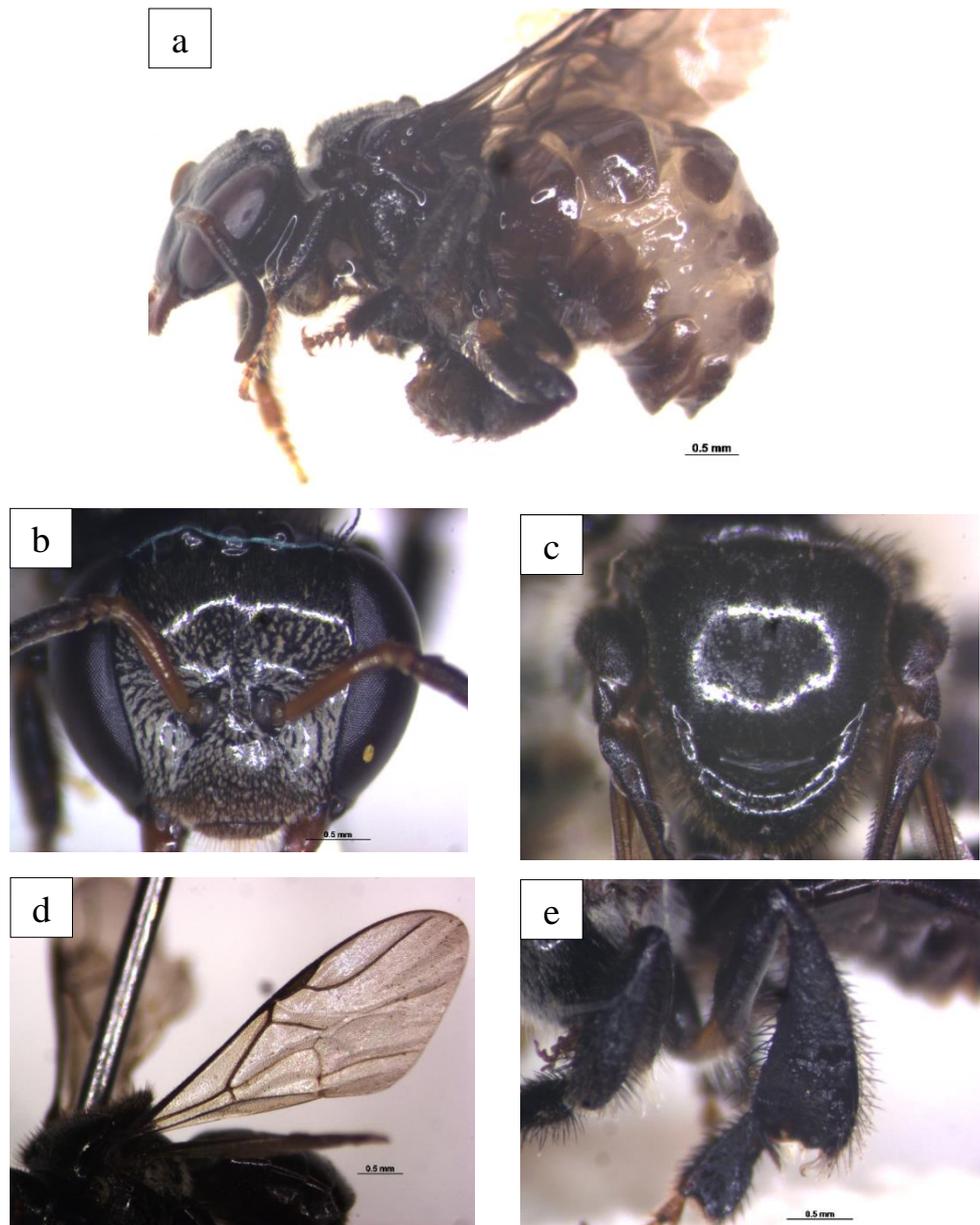


Figure 6 *Tetragonula minangkabau* (Sakagami & Inoue, 1985); a, Habitus, Lateral view; b, Frons; c, Mesoscutum; d, Forewing; e, Hind tibia and basitarsi, Scale: 0.5 mm.

***Tetragonula laeviceps* (Smith, 1857)**

Figure 7 (a-e)

Trigona laeviceps Smith 1857: 51: Holotype (OUMNH). Type Locality: SINGAPORE.

Tetragonula indet. Anderson et al. 1982: (pollination); Floral record: *Mangifera indica*; Camargo 1988: 372 (taxonomy); Drumond et al. 1996a: 396, 398, 399 (comparative behaviour); Dollin et al. 1997: (taxonomy); Roubik 2006: 126, 127, 130, 132 (nest).

Material examined. 8 ex., SELANGOR, Serdang, 20 April 2016, Fahimiee.

Head. Small, width almost twice length, ratio length to width 0.70 – 0.79 mm (mean: 0.74 mm), sparsely covered with long setae. Clypeus and frons separated by epistomal sulcus.

Compound eyes large, ratio width to length 0.38 – 0.44 mm (mean: 0.40 mm) (Figure 7b). Antennae geniculate, 10 segmented flagella, uniformly covered with short erecting setae, scape long, pedicel and entire flagella twice than scape, ratio length of scape to entire flagella n pedicel 0.49 – 0.59 mm (mean: 0.55 mm), length of first flagellomere almost equal to second, ratio length of first to second flagellomeres 0.79 – 0.95 mm (mean: 0.89 mm), length of second flagellomere equal to third, ratio length of second to third flagellomere 0.93 – 1.00 mm (mean: 0.99 mm). Mandibles broader on their basal half, narrower on their apex, possesses two teeth.

Thorax. Mesoscutum finely punctated and small, sparsely surrounded with short setae, length of mesoscutum almost equal to width, ratio length to width (mean: 0.84 mm), anterior widened than posterior (Figure 7c). Scutellum small, extremely convex, width almost three times than length, ratio length to width 0.33 – 0.47 mm (mean: 0.37 mm), sparsely covered with long setae. **Wings.** Tegulae rounded, highly sclerotized and large. Wing venation weak, length of forewing almost three times than width, ratio width to length 0.36 – 0.39 mm (mean: 0.37 mm), covered with short and fine setae. Pterostigma opaque on costal margin of forewings (Figure 7d). Total of hamuli on hindwings 4 in some individuals but usually 5. **Legs.** Hind tibiae short, corbicula pear shape, sparsely covered with long setae at apical but short at basal (Figure 7e). Hind basitarsi short, length of tibia three times than basitarsus, ratio length of basitarsus to tibia 0.24 – 0.42 mm (mean: 0.36 mm), covered with short setae.

Abdomen. Gastral tegite first to third smooth, tergite fourth to sixth fully covered with short setae. Sternite covered with long setae.

Measurement. Total length 4.24 – 4.37 mm (mean: 4.31 mm) (Figure 7a). Head width 1.88 – 2.72 mm (mean: 2.32 mm) and length 1.46 – 2.01 mm (mean: 1.71 mm). Length 0.54 – 0.57 mm (mean: 0.55 mm) and width pterostigma 0.13 – 0.16 mm (mean: 0.15 mm). Tibia width 0.54 – 0.82 mm (mean: 0.63 mm) and length 1.47 – 2.08 mm (mean: 1.70 mm).

Coloration. Head black, sparsely covered with white fine hairs. Clypeus ferruginous and fully covered with fine white hairs. Compound eyes reddish, ocelli blackish and large. Antennal socket grey, scape yellowish brown, pedicel and first flagellomere brown, second to tenth flagellomeres brown and slightly black. Mandible brown and slightly black at basal. Mesoscutum black, fully covered with yellowish setae, scutellum black entirely, covered with yellowish setae at posterior. Tegulae brown, forewings coloration uniform and semi-transparent, wing venation dark brown. Hindwings semi-transparent. Hind tibia entirely black, blackish brown for certain individuals. Basitarsi wholly black and blackish brown for certain individuals. First to sixth gastral tergite fully brown, dark brown at dorsal part and fully dark brown in some individuals. Sternite completely brown.

Diagnosis. *Tetragonula laeviceps* is characterized by small size 4.24 – 4.37 mm (mean: 4.31 mm). *Tetragonula laeviceps* and *T. minangkabau* are the most similar on presence of smooth, vertical and black band in mesoscutum, but *T. laeviceps* possesses only one distinct vertical band in mesoscutum while three bands in *T. minangkabau*. The differences between these two species can be seen on the coloration of abdomen, first to sixth gastral tergite of *T. laeviceps* are completely dark brown while brown in latter species. Both of these species possess two teeth and despite the similarity, the difference occurs on the coloration of mandible, blackish brown and partly black at basal in *T. laeviceps* and usually brown in *T. minangkabau*.

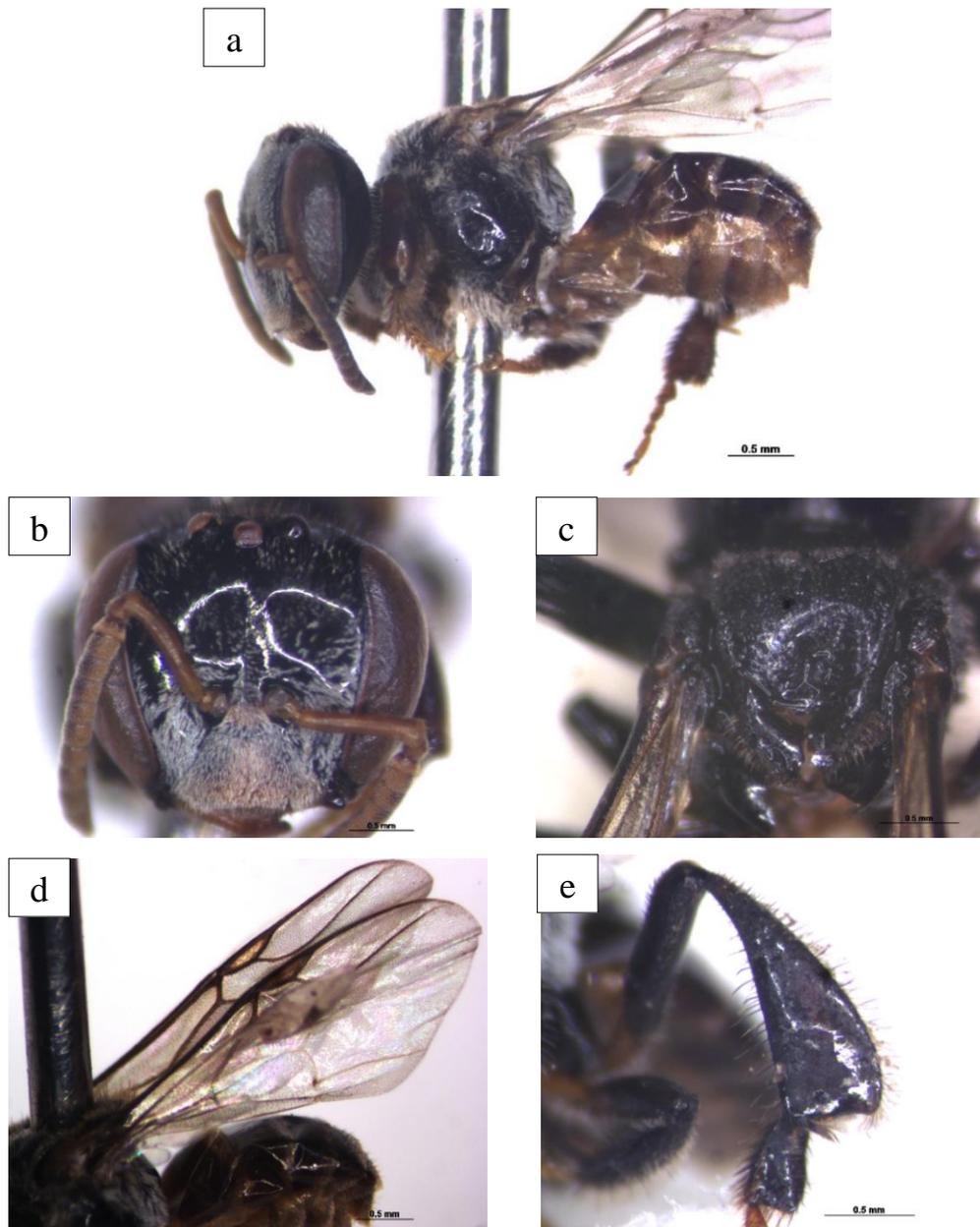


Figure 7 *Tetragonula laeviceps* (Smith, 1857); a, Habitus, Lateral view; b, Frons; c, Mesoscutum; d, Forewing; e, Hind tibia and basitarsus, Scale: 0.5 mm.

***Tetragonula fuscobalteata* (Cameron, 1908)**

Figure 8 (a-e)

Trigona fusco-balteata Cameron 1908: 193, 194: Lectotype (BMNH 17b.1112): Type Locality: MALAYSIA "Medang, Sarawak (Hewitt)".

Trigona atomella Cockerell 1919b: 243-244: Holotype (USNM 29467): examined, "Island of / Penang / Baker", "Type No. / 29467 / U.S.N.M.", "*Trigona / atomella / Ckll TIP*"; 2 paratype (USNM); Type Locality: MALAYSIA "Island of Penang (Baker, 9585)".

Trigona erythrostoma Cameron 1908: 193-194: Syntypes (BMNH 17b.1113, 2 s) (key to species, taxonomy); Type Locality: MALAYSIA "Kuching, Borneo (John Hewitt)".

Trigona pallidistigma Cameron 1908: 193, 195: Syntype (BMNH 17b.1133; Type Locality: MALAYSIA "Sarawak, Borneo (R. Shelford)".

Trigona pfeifferi Friese 1925: 41: Lectotype (AMNH): Type Locality: UNCERTAIN "Campinas (São Paulo), S.-Brasil".

Trigona pygmaea Friese 1933b: 147: Lectotype (ZMHB): determined here "O-Sumatra / Mandau / 7.1933", "*Trigona / pygmaea / Fr. / 1933* Friese det. / n."; paraLectotype (DEI (1), ZMHB (1)) (common name (kloeloet itam ketjid)); Type Locality: INDONESIA "Beringin, in der Wäldern oberhalb Mandau (Sumatra), v. Bengkalis. Im Juli 1933".

Tetragonula indet. Anderson et al. 1982: (pollination); Floral record: *Mangifera indica*; Camargo 1988: 372 (taxonomy); Drumond et al. 1996a: 396, 398, 399 (comparative behaviour); Dollin et al. 1997: (taxonomy); Roubik 2006: 126, 127, 130, 132 (nest).

Material examined. 10 ex., SELANGOR, Serdang, 20 April 2016, Fahimiee.

Head. Small, width almost twice than length, ratio length to width 0.73 – 0.76 mm (mean: 0.74 mm), covered with short setae at apical. Clypeus and frons separated by epistomal sulcus. Compound eyes large, ratio width to length 0.36 – 0.45 mm (mean: 0.42 mm) (Figure 8b). Antennae geniculate, 10 segmented flagella, uniformly covered with erecting short setae, scape long, length of pedicel and entire flagella twice than scape, ratio length of scape to entire flagella and pedicel 0.48 – 0.57 mm (mean: 0.53 mm), length of first and second flagellomeres are equal, ratio length of first to second flagellomeres 0.80 – 1.00 mm (mean: 0.91 mm), length of second and third flagellomeres are equal, ratio length of second to third flagellomeres 0.91 – 1.11 mm (mean: 1.00 mm). Mandibles broader on their basal half, narrower on their apex, possesses two teeth.

Thorax. Mesoscutum slightly coarser, anteriorly covered with setae, length and width almost equal, ratio length to width 0.75 – 0.85 mm (mean: 0.79 mm), anterior broader than posterior (Figure 8c). Scutellum coarser, slightly sharp at posterior edge, width almost twice than length, ratio length to width 0.37 – 0.52 mm (mean: 0.45 mm), covered with long setae.

Wings. Tegulae rounded, highly sclerotized and obvious. Wing venation weak, length of forewing almost three times than width, ratio width to length 0.36 – 0.38 mm (mean: 0.37 mm), uniformly covered with short and fine erecting setae. Pterostigma opaque on costal margin of forewings (Figure 8d). Total of hamuli usually 5. **Legs.** Corbicula pear shape, sparsely covered with long setae at apical and short setae at basal (Figure 8e). Hind basitarsi short, length of tibia almost three times than basitarsus, ratio length of basitarsus to tibia 0.30 – 0.46 mm (mean: 0.36 mm), covered with short setae.

Abdomen. Gastral tergite first to fourth smooth, tergite fifth to sixth slightly coarser. Sternite fully covered with numerous and long setae.

Measurement. Total length 3.16 – 3.33 mm (mean: 3.26 mm) (Figure 8a). Head width 1.34 – 1.48 mm (mean: 1.42 mm) and length 0.98 – 1.09 mm (mean: 1.05 mm). Length 0.44 – 0.48 mm (mean: 0.46 mm) and width of pterostigma 0.10 – 0.13 mm (mean: 0.12 mm). Tibia length 1.2– 1.77 mm (mean: 1.44 mm) and width 0.34 – 0.65 mm (mean: 0.47 mm).

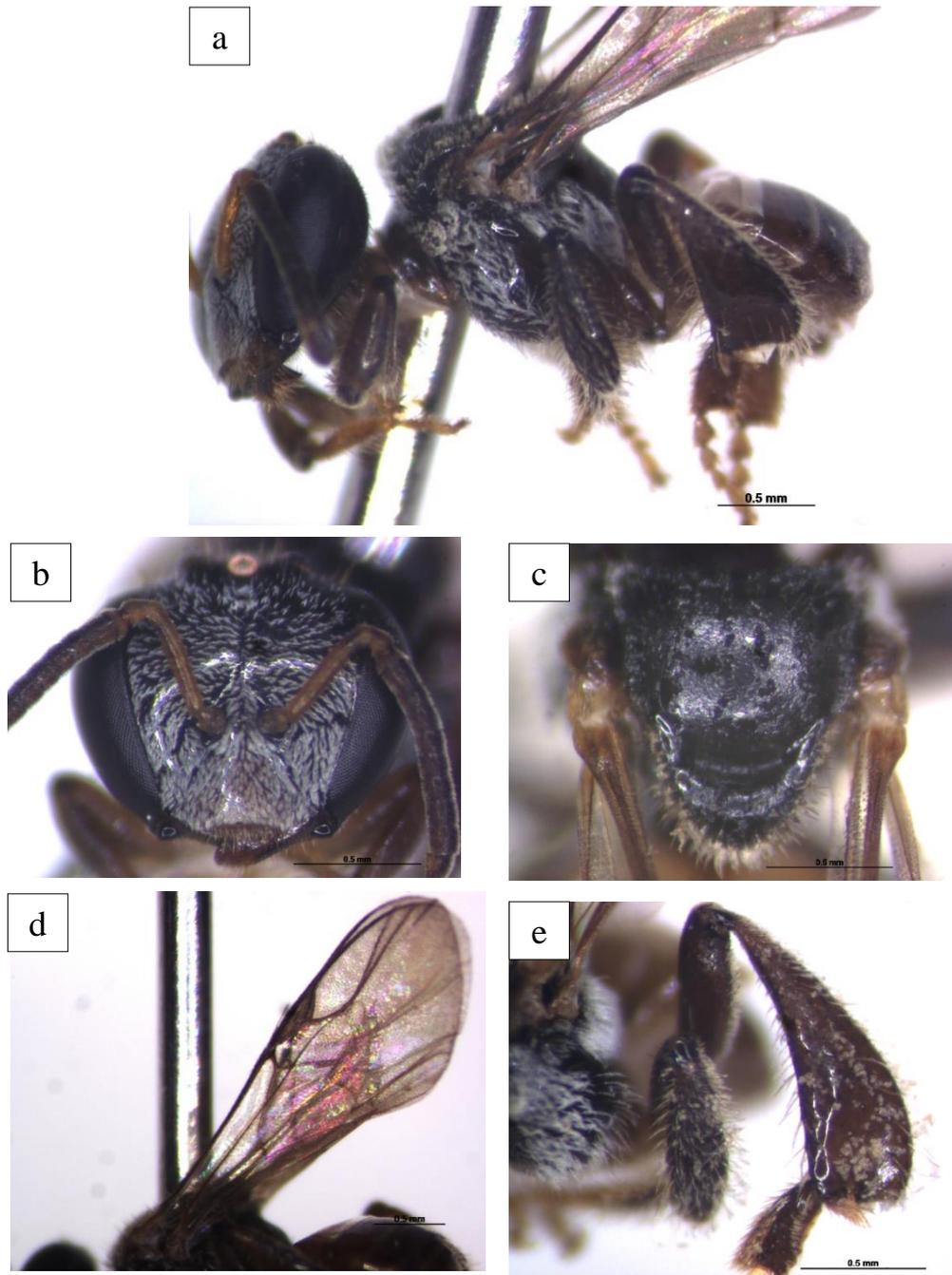


Figure 8 *Tetragonula fuscobalteata* (Cameron, 1908); a, Habitus, Lateral view; b, Frons; c, Mesoscutum; d, Forewing; e, Hind tibia and basitarsus, Scale: 0.5 mm.

Coloration. Head black, frons fully covered with fine white hairs, thickened white hairs approaching antennal sockets and clypeus. Clypeus brown and completely covered with fine white hairs. Compound eyes blackish, ocelli blackish and large. Antennal socket grey, scape brown and slightly yellow at apical, pedicel and first flagellomere dark brown, second to tenth flagellomeres blackish brown. Mandible blackish brown but black at basal. Mesoscutum black, possesses five black smooth bands alternating with thick hairy bands, surrounded with pale yellow setae, scutellum completely black, covered with pale yellow setae. Tegulae dark brown, uniform coloration of forewings and hindwings, semi-transparent.

Tibiae and basitarsi fully dark brown. Gastral tergite brown but dark brown at dorsal. Sternite completely brown.

Diagnosis. *Tetragonula fuscobalteata* 3.16 – 3.33 mm (mean: 3.26 mm) is the smallest species of stingless bee. This black frons species looks similar to *T. drescheri*, but frons of *T. fuscobalteata* covered with white hairs while yellowish brown in *T. drescheri*. Ratio of head size of *T. fuscobalteata* usually smaller than *T. drescheri*. These two species have five black smooth bands alternating with thick hairy bands on black mesoscutum, but in *T. fuscobalteata* the mesoscutum covered with pale yellow setae and blackish brown in *T. drescheri*. The abdomen in both species can be separated by coloration, brown gastral tergite in *T. fuscobalteata* partly dark brown at dorsal while either brown or light brown in *T. drescheri*. For details see diagnosis of *T. drescheri*.

***Tetragonula drescheri* (Schwarz, 1939)**

Figure 9 (a-e)

Trigona (Tetragona) sarawakensis variety *drescheri* Schwarz 1939a: 85, 93, 106-107*: Holotype (AMNH); paratype (AMNH (1); Type Locality: INDONESIA "M. JAVA.South Banjoemas, Koebangkangoeng, 25 meters, July 1935 (F. C. Drescher)" (1 Holotype); "E. JAVA.- Mt. Goemitir, Nov. 3 (R. van der Veen)" (1 paratype).

Tetragonula indet. Anderson et al. 1982: (pollination); Floral record: *Mangifera indica*; Camargo 1988: 372 (taxonomy); Drumond et al. 1996a: 396, 398, 399 (comparative behaviour); Dollin et al. 1997: (taxonomy); Roubik 2006: 126, 127, 130, 132 (nest).

Material examined. 7 ex., SELANGOR, Bangi, Malaysia Genome Institute, 21 November 2017, Fatimah.

Head. Width almost twice than length, ratio length to width 0.74 – 0.77 mm (mean: 0.75 mm), covered with short setae at apical. Clypeus and frons separated by epistomal sulcus. Compound eyes large, ratio width to length 0.41 – 0.43 mm (mean: 0.42 mm) (Figure 9b). Antennae geniculate, 10 segmented flagella, uniformly covered with erecting short setae, scape long, length of pedicel and entire flagella twice than scape, ratio length of scape to entire flagella and pedicel 0.52 – 0.57 mm (mean: 0.54 mm), length of first flagellomere almost equal to second, ratio length of first to second flagellomeres 0.75 – 0.95 mm (mean: 0.88 mm), length of second flagellomere equal to third, ratio second to third flagellomeres 1.00 – 1.05 mm (mean: 1.01 mm). Mandibles broader on their basal half, narrower on their apex, possesses two teeth.

Thorax. Mesoscutum coarser, covered with setae at anterior, length almost equal to width, ratio length to width 0.77 – 0.82 mm (mean: 0.80 mm), anterior slightly broader than posterior (Figure 9c). Scutellum coarser, sharp, width almost twice than length, ratio length to width 0.43 – 0.48 mm (mean: 0.46 mm), covered with short setae. **Wings.** Tegulae rounded, highly sclerotized and obvious. Wing venation weak, length of forewing almost twice than width, ratio width to length 0.40 – 0.41 mm (mean: 0.40 mm), covered with fine and short setae. Pterostigma opaque at costal margin of forewing (Figure 9d). Total of hamuli at anterior of hindwing usually 5. **Legs.** Hind tibiae long, pear shape corbicula, sparsely covered with short setae (Figure 9e). Hind basitarsi short, length of tibia three times than basitarsus, ratio length of basitarsus to tibia 0.35 – 0.37 mm (mean: 0.36 mm), covered with short setae.

Abdomen. First to fourth gastral tergite smooth, fifth and sixth tergite slightly coarser, covered with fine setae. Strenite covered with fine setae.

Measurement. Total length 6.13 – 7.35 mm (mean: 6.66 mm) (Figure 9a). Head width 2.13 – 2.16 mm (mean: 2.14 mm) and length 1.60 – 1.64 mm (mean: 1.62 mm). Length 0.70 – 0.73 mm (mean: 0.72 mm) and width pterostigma 0.18 – 0.21 mm (mean: 0.20 mm). Tibia length 2.06 – 2.18 mm (mean: 2.13 mm) and width 0.72 – 0.78 mm (mean: 0.76 mm).

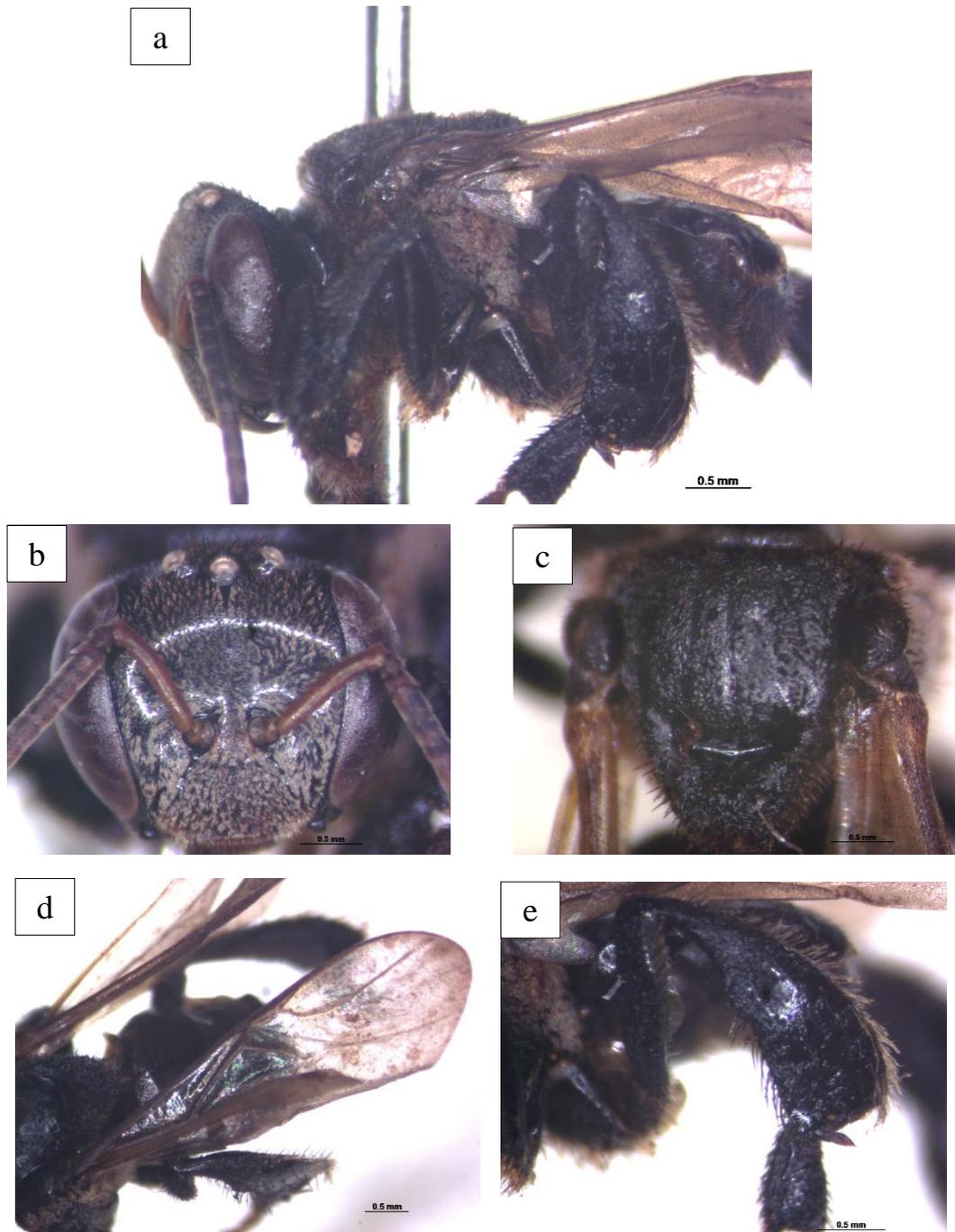


Figure 9 *Tetragonula drescheri* (Schwarz, 1939) a, Habitus, Lateral view; b, Frons; c, Mesoscutum; d, Forewing; e, Hind tibia and basitarsus, Scale: 0.5 mm.

Coloration. Head black, frons wholly covered with fine yellowish brown hairs. Clypeus black and covered with yellowish brown hairs. Compound eyes blackish, ocelli blackish and large. Antennal sockets grey, scape brown, pedicel and first flagellomere ferruginous, second to tenth flagellomeres blackish brown. Mandible brown, slightly black at basal and blackish brown at apical. Mesoscutum black, possesses six vertical hairy bands which blackish brown, alternating with five bands without hairs and surrounded with blackish brown setae. Scutellum entirely blackish brown, covered brown. Tegulae brown, wing venation brown, uniform coloration of forewing and hindwing, semi-transparent. Hind tibiae and basitarsi completely black and slightly reddish in certain individuals. First to sixth gastral tergite brown and light brown in certain individuals, blackish brown at dorsal part. Sternit entirely blackish brown and brown in some individuals.

Diagnosis. *Tetragonula drescheri* has the same coloration of frons (black) as in *T. fuscobalteata*. Both of these species characterized by the coloration of hairs that covered the frons, yellowish brown in *T. drescheri* and white in *T. fuscobalteata*. Ratio of head size in *T. drescheri* usually larger than *T. fuscobalteata*. These two species have a completely black mesoscutum with a presence of five smooth and black bands alternating with thick hairy bands. On the other hand, the setae coloration on mesoscutum are different between these species, blackish brown in *T. drescheri* and pale yellow in *T. fuscobalteata*. The other character to distinguish the two species is the coloration of abdomen, brown gastral tergite in *T. drescheri* but light brown in some individuals while brown gastral tergite in *T. fuscobalteata* with dark brown in the dorsal part.

***Tetragonula geissleri* (Cockerell, 1918)**

Figure 10 (a-e)

Trigona geissleri Cockerell 1918: 385-386, 387: Type Locality: MALAYSIA "Sintang, North Borneo" (male); "Singapore by Baker".

Trigona confusella Cockerell 1919b: 242: Holotype (USNM 40248) (taxonomy, before this known as *T. geissleri* (in Cockerell 1918)); Type Locality: SINGAPORE "Singapore (Baker)".

Tetragonula indet. Anderson et al. 1982: (pollination); Floral record: *Mangifera indica*; Camargo 1988: 372 (taxonomy); Drumond et al. 1996a: 396, 398, 399 (comparative behaviour); Dollin et al. 1997: (taxonomy); Roubik 2006: 126, 127, 130, 132 (nest).

Material examined. 8 ex., SELANGOR, Serdang, 20 April 2016, Fahimiee.

Head. Width almost twice than length, ratio length to width 0.71 – 0.81 mm (mean: 0.76 mm), sparsely covered with short setae. Clypeus and frons separated by epistomal sulcus. Compound eyes large, ratio width to length 0.35 – 0.42 mm (mean: 0.39 mm) (Figure 10b). Antennae geniculate, 10 segmented flagella, uniformly covered with short erecting setae, scape long, length of pedicel and entire flagella twice than scape, ratio length of scape to entire flagella and pedicel 0.48 – 0.59 mm (mean: 0.53 mm), length of first flagellomere almost equal to second, ratio length of first to second flagellomeres 0.78 – 0.93 mm (mean: 0.88 mm), length of second flagellomere equal to third, ratio length of second to third flagellomeres 0.94 – 1.05 mm (mean: 1.00 mm). Mandibles broader on their basal half, narrower on their apex, possesses two teeth.

Thorax. Mesoscutum finely punctated and small, absence of obvious bands on mesoscutum, margin sparsely surrounded by short setae, length of mesoscutum almost equal to width, ratio

length to width 0.83 – 0.90 mm (mean: 0.85 mm), anterior broader than posterior (Figure 10c). Scutellum large, extremely convex, width almost three times than length, ratio length to width 0.34 – 0.46 mm (mean: 0.39 mm), sparsely covered with long setae at posterior margin.

Wings. Tegulae rounded, highly sclerotized and large. Wing venation weak, length of forewing almost three times than width, ratio width to length 0.35 – 0.43 mm (mean: 0.38 mm), covered with fine and short setae. Pterostigma opaque on costal margin of forewing (Figure 10d). Total of hamuli on anterior hindwing usually 5. **Legs.** Hind tibiae short, corbicula pear shape and obvious, sparsely covered with long setae at apical and short setae at basal part (Figure 10e). Hind basitarsi short, length of tibia almost three times than basitarsus, ratio length of basitarsus to tibia 0.34 – 0.38 mm (mean: 0.36 mm), covered with short setae.

Abdomen. First to fourth gastral tergites smooth, fifth to sixth gastral tergites covered with fine and short setae. Sternite fully covered with long setae.

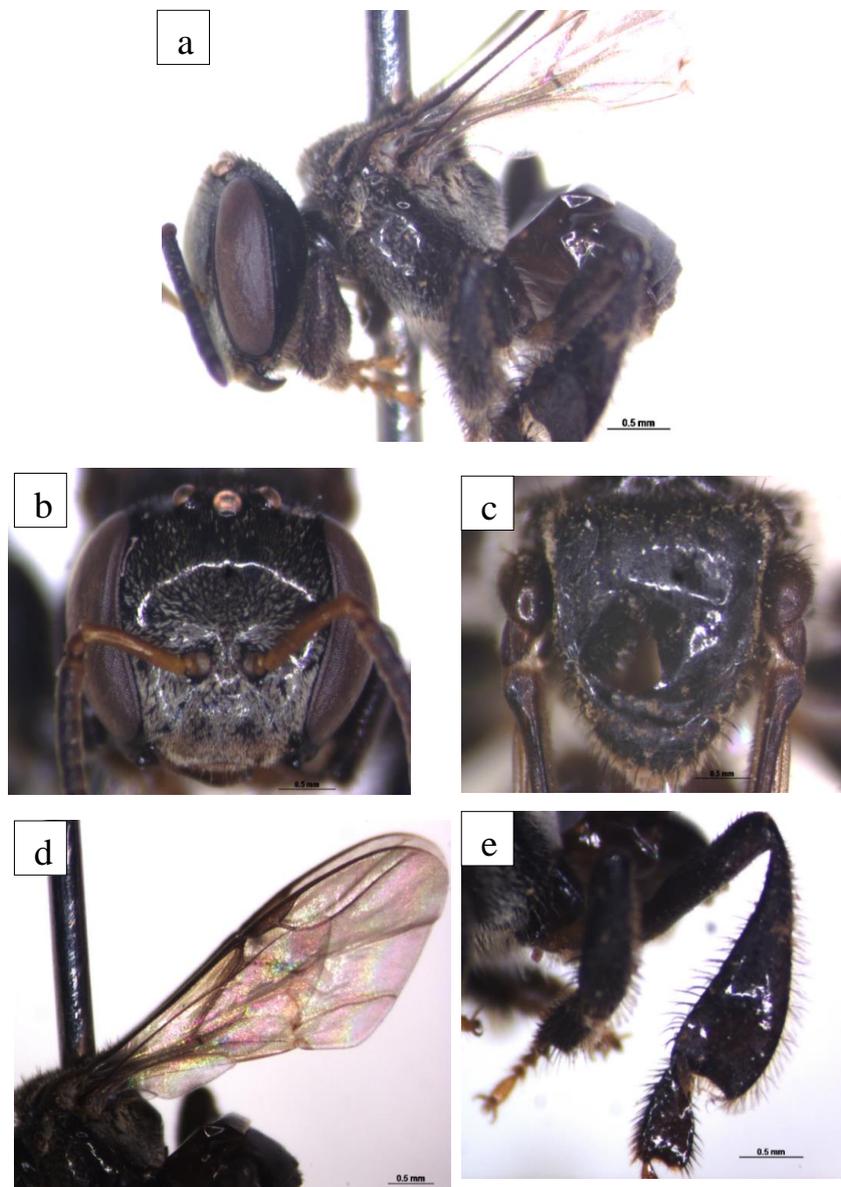


Figure 10 *Tetrasonula geissleri* (Cockerell, 1918); a, Habitus, Lateral view; b, Frons; c, Mesoscutum; d, Forewing; e, Hind tibia and basitarsus, Scale: 0.5 mm.

Measurement. Total length 4.10 – 4.40 mm (mean: 4.17 mm) (Figure 10a). Head width 2.00 – 2.88 mm (mean: 2.56 mm) and length 1.61 – 2.09 mm (mean: 1.93 mm). Length 0.59 – 0.66 mm (mean: 0.63 mm) and width of pterostigma 0.15 – 0.20 mm (0.17 mm). Tibia length 1.60 – 2.00 mm (mean: 1.81 mm), and width 0.60 – 0.82 mm (mean: 0.69 mm).

Coloration. Head black, sparsely covered with yellowish brown hairs, clypeus black and slightly reddish at posterior in some individuals, fully covered with thick brown hairs. Compound eyes reddish, ocelli blackish and large. Antennal sockets grey, scape yellowish brown, pedicel and first flagellomere brown, second to tenth flagellomeres completely blackish brown. Mandible brown and black at basal. Mesoscutum black, wholly covered with blackish brown setae and black in some individuals, scutellum completely black, covered with yellowish setae on posterior margin. Tegulae brown, uniform coloration of forewings and hindwings, semi-transparent. Hind tibiae and basitarsi entirely black, reddish in some individuals. Gastral tergite dark brown and slightly blackish in some individuals.

Diagnosis. *Tetragonula geissleri* looks similar to *T. testaceitarsis* due to the absence of obvious hairy bands on mesoscutum. However, both of these species can be separated by the hair coloration of frons, yellowish brown in *T. geissleri* and white in *T. testaceitarsis*. Antennae of these stingless bees are completely blackish brown but the coloration of scape are different, yellowish brown in *T. geissleri* and brown in latter species. Gastral tergite of *T. geissleri* are dark brown and slightly blackish in some individuals, but *T. testaceitarsis* has a black gastral tergite and blackish brown in some individuals.

***Tetragonula testaceitarsis* (Cameron, 1901)**

Figure 11 (a-e)

Trigona testaceitarsis Cameron 1901: 36: Tip (BMNH 17b.1121) (taxonomy); Type Locality: MALAYSIA "Patani, Malay Peninsula".

Tetragonula indet. Anderson et al. 1982: (pollination); Rekod floral: *Mangifera indica*; Camargo 1988: 372 (taxonomy); Drumond et al. 1996a: 396, 398, 399 (comparative behaviour); Dollin et al. 1997: (taxonomy); Roubik 2006: 126, 127, 130, 132 (nest).

Material examined. 7 ex., SELANGOR, Bangi, Malaysia Genome Institute, 27 September 2017, Fatimah.

Head. Width almost twice than length, ratio length to width 0.71 – 0.74 mm (mean: 0.72 mm), covered with short setae at apical. Clypeus and frons separated by epistomal sulcus. Compound eyes large, ratio width to length 0.41 – 0.44 mm (mean: 0.42 mm) (Figure 11b). Antennae geniculate, 10 segmented flagella, uniformly covered with short erecting setae, scape long, length of pedicel and entire flagella twice than scape, ratio length of scape to entire flagella and pedicel 0.47 – 0.56 mm (mean: 0.53 mm), length of first flagellomere almost equal to second, ratio length of first to second flagellomeres 0.78 – 0.89 mm (mean: 0.84 mm), length of second flagellomere equal to third, ratio length of second to third flagellomeres 1.00 – 1.06 mm (mean: 1.01 mm). Mandibles broader on their basal half, narrower on their apex, possess two teeth.

Thorax. Mesoscutum coarser, absence of obvious hairy bands on mesoscutum, covered with setae on anterior, length almost equal to width, ratio length to width 0.81 – 0.86 mm (mean: 0.83 mm), anterior slightly broader than posterior (Figure 11c). Scutellum coarser, slightly sharp, width almost twice than length, ratio length to width 0.41 – 0.44 mm (mean: 0.42 mm),

covered with long setae. **Wings.** Tegulae rounded, highly sclerotized and obvious. Wing venation weak, length of forewings three times than width, ratio width to length 0.37 – 0.40 mm (mean: 0.39 mm), covered with fine and short setae. Pterostigma opaque on costal margin of forewings (Figure 11d). Total of hamuli on anterior of hindwings usually 5. **Legs.** Hind tibiae long, corbicula pear shape, sparsely covered with long setae at apical and short at basal (Figure 11e). Hind basitarsi long, length of tibia almost twice than basitarsus, ratio length of basitarsus to tibia 0.40 – 0.43 mm (mean: 0.42 mm), covered with short setae.

Abdomen. Gastral tergite first to third smooth, tergite fourth to sixth coarser, covered with fine setae. Sternite covered with setae.

Measurement. Total length 4.30 – 4.90 mm (mean: 4.60 mm) (Figure 11a). Head width 2.92 – 3.01 mm (mean: 2.98 mm) and length 2.13 – 2.16 mm (mean: 2.15 mm). Length 0.60 – 0.65 mm (mean: 0.62 mm) and width of pterostigma 0.13 – 0.17 mm (mean: 0.15 mm). Tibia length 1.63 – 1.70 mm (mean: 1.67 mm), and width 0.65 – 0.71 mm (mean: 0.68 mm).

Coloration. Head black, frons covered with fine and white hairs but yellowish in some individuals, thicken white hairs approaching antennal sockets and clypeus. Clypeus brown and fully covered with white hairs. Compound eyes and ocelli blackish. Antennal sockets blackish grey, scape brown, pedicel and first flagellomere brown, second to tenth flagellomeres blackish brown. Mandible blackish brown and black at basal. Mesoscutum black, margin surrounded with blackish brown setae, scutellum blackish brown, covered with brown setae. Tegulae brown, uniform coloration of forewings and hindwings, semi-transparent. Hind tibiae and basitarsi completely black. Gastral tergite and sternite black and blackish brown in some individuals.

Diagnosis. *Tetragonula testaceitarsis* is the most similar in absence of hairy bands on mesoscutum to *T. geissleri*. Nevertheless, these species have a different coloration of hairs on frons, white in *T. testaceitarsis* while yellowish brown in *T. geissleri*. One of the character to distinguish these two species is scape coloration, brown in *T. testaceitarsis* and yellowish brown in *T. geissleri*. The length of tibia in *T. testaceitarsis* 1.63 – 1.70 mm (mean: 1.67 mm) slightly shorter than *T. geissleri* 1.60 – 2.00 mm (mean: 1.81 mm). The abdomen coloration in *T. testaceitarsis* usually black and blackish brown in certain individuals but dark brown in *T. geissleri*.

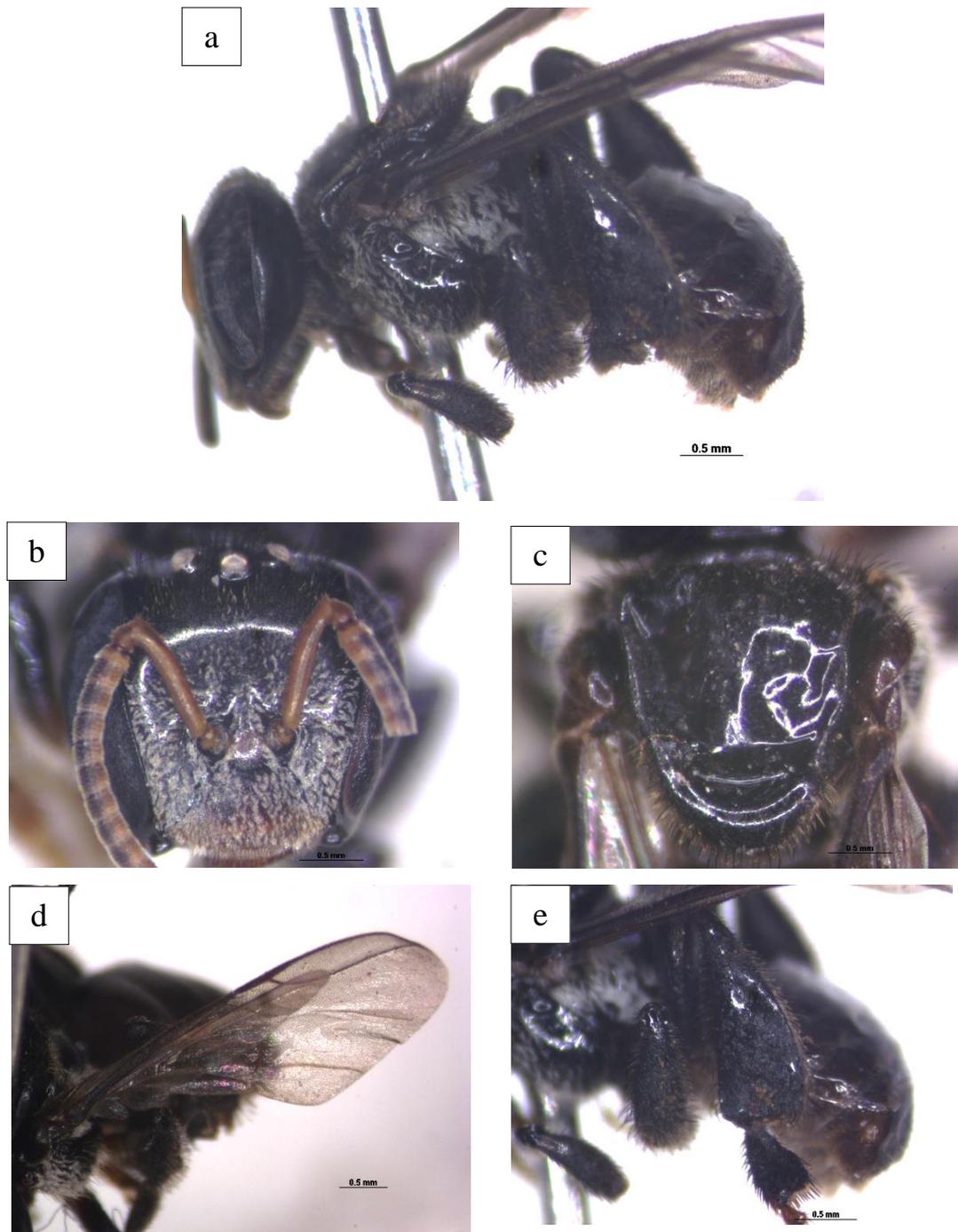


Figure 11 *Tetragonula testaceitarsis* (Cameron, 1901); a, Habitus, Lateral view; b, Frons; c, Mesoscutum; d, Forewing; e, Hind tibia and basitarsus, Scale: 0.5 mm.

Heterotrigona Schwarz, 1939

Type species: *Trigona itama* Cockerell, 1918

Head. Covered with short setae. Clypeus and frons separated by epistomal sulcus. Compound eyes large. Antennae geniculate, 10 segmented flagella, uniformly covered with short erecting setae, scape long, length of pedicel and entire flagella twice than scape, ratio length

of scape to entire flagella and pedicel 0.45 – 0.59 mm (mean: 0.52 mm), length of first and second flagellomeres almost equal, ratio length of first to second flagellomeres 0.73 – 0.95 mm (mean: 0.84 mm), length of second and third flagellomeres are equal, ratio length of second to third flagellomeres 0.80 – 1.00 mm (mean: 0.90 mm). Mandibles broader on their basal half, narrower on their apex, possess one tooth.

Thorax. Mesoscutum quite coarser, covered with long setae at anterior. Scutellum coarser, covered with long setae. **Wings.** Tegulae rounded, highly sclerotized and obvious. Wing venation weak, wings covered with fine and short setae. Pterostigma opaque on costal margin of forewings. Total of hamuli on anterior hindwings 6 but usually 7. **Legs.** Hind tibiae long, corbicula pear shape and obvious, sparsely covered with long setae at apical and short setae at basal. Hind basitarsi long, sparsely covered with short setae.

Abdomen. Gastral tergite first to third smooth, tergite fourth to sixth coarser and covered with fine setae. Sternite fully covered with fine setae.

Measurement. Total length 4.78 – 7.85 mm (mean: 6.32 mm). Head width 2.70 – 2.85 mm (mean: 2.78 mm) and length 1.96 – 2.15 mm (mean: 2.06 mm). Tibia length 2.00 – 2.90 mm (mean: 2.45 mm), and width 0.78 – 1.11 mm (mean: 0.95 mm).

Coloration. Head black, frons fully covered with thick white to yellowish brown hairs. Clypeus black and covered with fine white to yellowish brown hairs. Compound eyes and ocelli blackish. Antennal sockets grey, scape black and brown at basal part while slightly brown at apical, pedicel and entire flagella brown to blackish. Mandible completely black. Mesoscutum and scutellum wholly black. Tegulae black, uniform coloration of forewings, wing venation slightly brown and semi-transparent. Hind tibiae and basitarsi blackish brown to black completely. Gastral tergite and sternite brown to blackish.

Diagnosis. *Heterotrigona* are the only genus of stingless bee that have one tooth on the mandible. However, this tooth cannot be seen clearly due to its small size. *Heterotrigona itama* is commonly found species of stingless bee belongs to this genus and has a high distribution around Malaysia, Borneo, Thailand and Singapore.

Heterotrigona erythrogastra (Cameron, 1902)

Figure 12 (a-e)

Trigona erythrogastra Cameron 1902: 129-130: Holotype (BMNH 17b.1130); 1 paratype (BMNH?); Type Locality: MALAYSIA "Sarawak (R. Shelford)".

Trigona luteiventris Friese 1909("1908"): 354, 358, fig. 15-5: Lectotype (ZMHB): determined here, "Malakka / Perak / 1912", "*Trigona / luteiventris / 1904* Friese det. Fr / n Fr.", "Tip" (red label), "Coll. / Friese"; paraLectotype (ZMHB (1)); additional Type (AMNH) (taxonomy); Type Locality: MALAYSIA/PHILIPPINES "Perak (Malaka)"; "Palawan" (s).

Trigona sandacana Cockerell 1919b: 242-243: Holotype (BMNH 17b.1129; Type Locality: MALAYSIA "Sandakan, Borneo (Baker, 9593)".

Heterotrigona indet. Roubik 2006: 127, 132 (nest).

Material examined. 10 ex., SELANGOR, Bangi, Malaysia Genome Institute, 21 November 2017, Fatimah.

Head. Width almost twice than length, ratio length to width 0.75 – 0.77 mm (mean: 0.75 mm), covered with short setae. Clypeus and frons separated by episomal sulcus. Compound eyes large, ratio width to length 0.38 – 0.41 mm (mean: 0.40 mm) (Figure 12b). Antennae geniculate, 10 segmented flagella, uniformly covered with short erecting setae, scape long, length of pedicel and entire flagella twice than scape, ratio length of scape to entire flagella and pedicel 0.49 – 0.56 mm (mean: 0.53 mm), length of first flagellomere almost equal to second, ratio length of first to second flagellomeres 0.73 – 0.86 mm (mean: 0.81 mm), length of second equal to third flagellomeres, ratio length of second to third flagellomeres 1.00 – 1.00 mm (mean: 1.00 mm). Mandibles broader on their basal half, narrower on their apex, possesses one tooth.

Thorax. Mesoscutum quite coarser, covered with long setae at anterior, length almost equal to width, ratio length to width 0.84 – 0.93 mm (mean: 0.88 mm), anterior edge broader than posterior (Figure 12c). Scutellum coarser, convex, width almost three times than length, ratio length to width 0.36 – 0.43 mm (mean: 0.39 mm), covered with long setae. **Wings.** Tegulae rounded, highly sclerotized and obvious. Wing venation weak, length of forewings almost three times than width, ratio width to length 0.35 – 0.37 mm (mean: 0.36 mm), wings covered with fine and short setae. Pterostigma opaque on costal margin of forewings (Figure 12d). Total of hamuli on anterior hindwings usually 7. **Legs.** Hind tibiae quite long, corbicula pear shape and obvious, covered with long setae at apical and short setae at basal (Figure 12e). Hind basitarsi long, length of tibia almost three times than basitarsus, ratio length of basitarsus to tibia 0.36 – 0.40 mm (mean: 0.38 mm), sparsely covered with short setae.

Abdomen. Gastral tergite first to third smooth, tergite fourth to sixth coarser and covered with fine setae. Sternite fully covered with fine setae.

Measurement. Total length 6.69 – 7.85 mm (mean: 7.36) (Rajah 12a). Head width 2.78 – 2.85 mm (mean: 2.81 mm) and length 2.09 – 2.15 mm (mean: 2.12 mm). Length 0.98 – 1.03 mm (mean: 1.01 mm) and width pterostigma 0.22 – 0.25 mm (mean: 0.24 mm). Tibia length 2.76 – 2.90 mm (mean: 2.84 mm), and width 1.05 – 1.11 mm (mean: 1.08 mm).

Coloration. Head black, frons fully covered with thick yellowish brown hairs. Clypeus black and covered with fine yellowish brown hairs. Compound eyes and ocelli blackish. Antennal sockets grey, scape black and brown at basal part while slightly brown at apical, pedicel to ninth flagellomere black and slightly brown at apical, tenth flagellomere brown. Mandible completely black. Mesoscutum and scutellum wholly black. Tegulae black, uniform coloration of forewings and hindwings, wing venation brown and semi-transparent. Hind tibiae black entirely. Hind basitarsi black but blackish brown in some individuals. Gastral tergite and sternite completely brown.

Diagnosis. *Heterotrigona erythrogastra* possesses a similar appearance to *H. itama*, but both can be differentiated through the coloration of gastral tergite and sternite, light brown in *H. erythrogastra* while blackish brown in latter species. Besides, *H. erythrogastra* has a ratio of head size which quite similar to *H. itama* but these species possess a distinct coloration of frons and clypeus. Frons and clypeus of *H. erythrogastra* completely black and covered with a thick yellowish brown hairs while in *H. itama* the frons and clypeus also completely black but fully covered with thick white hairs. Wing venation of *H. erythrogastra* is brown compared to dark brown in *H. itama*.

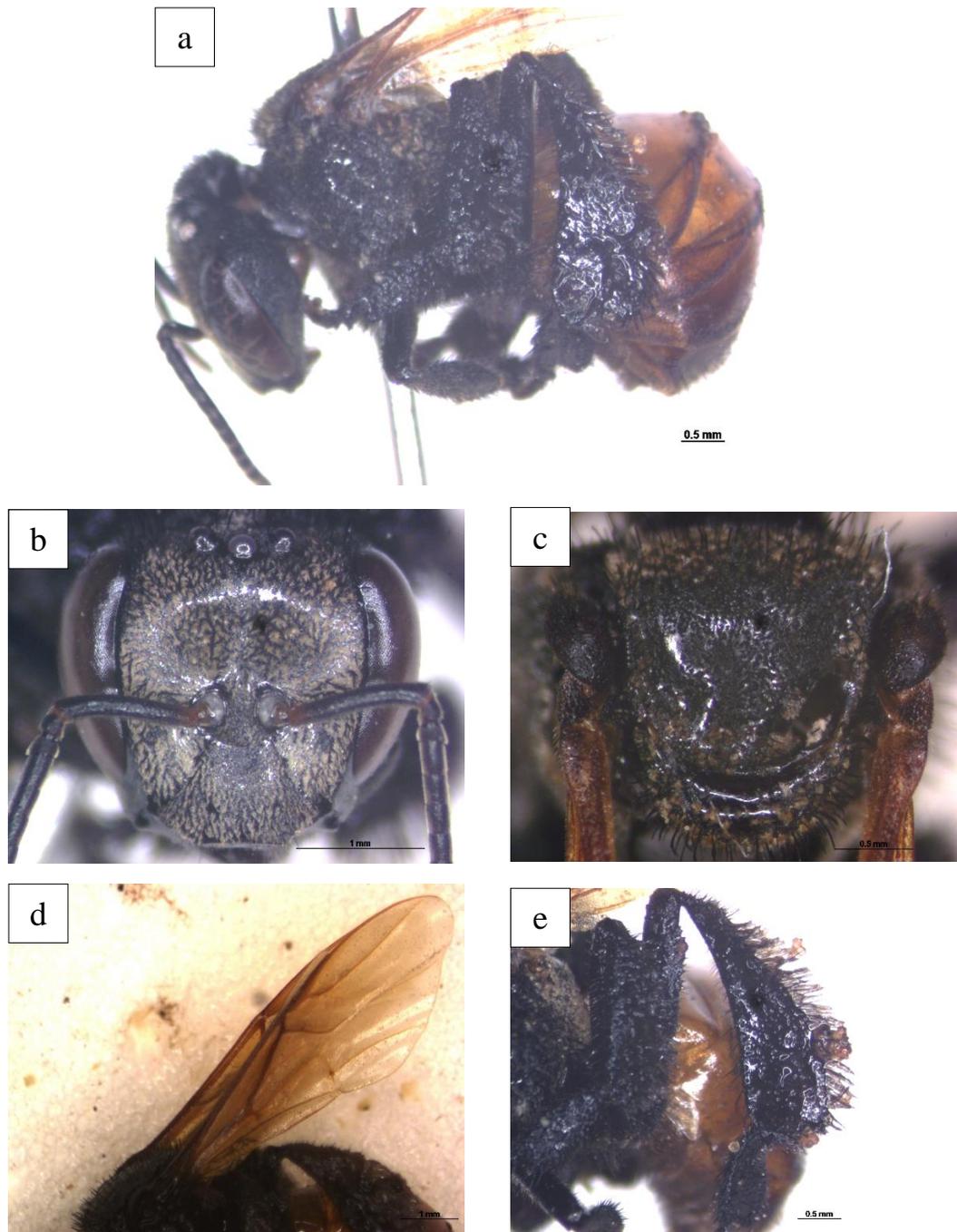


Figure 12 *Heterotrigona erythrogastra* (Cameron, 1902); a, Habitus, Lateral view; b, Frons; c, Mesoscutum; d, Forewing; e, Hind tibia and basitarsus, Scale: 0.5 mm and 1.0 mm.

***Heterotrigona itama* (Cockerell, 1918)**

Figure 13 (a-e)

Trigona itama Cockerell 1918: 387: Holotype (USNM 29471): Type Locality: SINGAPORE.

Trigona breviceps Cockerell 1919b: 244: Holotype (BMNH 17b.1123): examined, "Type" "Sandakan / Borneo / Baker", "*Trigona / breviceps / Ckl* TIP", "B.M. TIP / HYM. / 17B.1123", "9591"; Type Locality: MALAYSIA "Sandakan, Borneo (Baker, 9591)".

Heterotrigona indet. Roubik 2006: 127, 132 (nest).

Material examined. 10 ex., KELANTAN, Bachok, 7 February 2016, Nik Abdul Rahman.

Head. Width almost twice than length, ratio length to width 0.70 – 0.75 mm (mean: 0.73 mm), covered with short setae. Clypeus and frons separated by episomal sulcus. Compound eyes large, ratio width to length 0.40 – 0.43 mm (mean: 0.41 mm) (Figure 13b). Antennae geniculate, 10 segmented flagella, uniformly covered with short erecting setae, scape long, length of pedicel and entire flagella twice than scape, ratio length of scape to entire flagella and pedicel 0.45 – 0.59 mm (mean: 0.54 mm), length of first flagellomere almost equal to second, ratio length of first to second flagellomeres 0.77 – 0.95 mm (mean: 0.88 mm), length of second equal to third flagellomeres, ratio length of second to third flagellomeres 0.80 – 1.00 mm (mean: 0.96 mm). Mandibles broader on their basal half, narrower on their apex, possesses one tooth.

Thorax. Mesoscutum coarser, covered with long setae at anterior, length almost equal to width, ratio length to width 0.83 – 0.90 mm (mean: 0.87 mm), anterior edge broader than posterior (Figure 13c). Scutellum coarser, extremely convex, width almost three times than length, ratio length to width 0.33 – 0.37 mm (mean: 0.36 mm), covered with long setae. **Wings.** Tegulae rounded, highly sclerotized and obvious. Wing venation weak, length of forewings almost three times than width, ratio width to length 0.35 – 0.38 mm (mean: 0.36 mm), wings covered with fine and short setae. Pterostigma opaque on costal margin of forewings (Figure 13d). Total of hamuli on anterior hindwings 6 in some individuals but usually 7. **Legs.** Hind tibiae long, corbicula pear shape and obvious, sparsely covered with long setae at apical and short setae at basal (Figure 13e). Hind basitarsi long, length of tibia almost twice than basitarsus, ratio length of basitarsus to tibia 0.38 – 0.45 mm (mean: 0.41 mm), sparsely covered with short setae.

Abdomen. Gastral tergite first to third smooth, tergite fourth coarser, tergite fifth to sixth coarser and covered with fine setae. Sternite fully covered with fine setae.

Measurement. Total length 4.78 – 5.87 mm (mean: 5.58 mm) (Figure 13a). Head width 2.70 – 2.85 mm (mean: 2.78 mm) and length 1.96 – 2.06 mm (mean: 2.02 mm). Length 0.85 – 0.90 mm (mean: 0.88 mm) and width pterostigma 0.20 – 0.25 mm (mean: 0.22 mm). Tibia length 2.00 – 2.20 mm (mean: 2.12 mm), and width 0.78 – 0.91 mm (mean: 0.86 mm).

Coloration. Head black, frons fully covered with fine white hairs, slightly thick white hairs approaching clypeus. Clypeus black and covered with white hairs. Compound eyes and ocelli blackish. Antennal sockets grey, scape black and brown at basal part, pedicel and entire flagella completely black. Mandible entirely black. Mesoscutum and scutellum wholly black. Tegulae black, uniform coloration of forewings and hindwings, wing venation dark brown and semi-transparent. Hind tibiae and basitarsi black entirely. Gastral tergite and sternite completely blackish brown.

Diagnosis. *Heterotrigona itama* is the most similar to *H. erythrogastra*, but the coloration of gastral tergite for both species are different, blackish brown in *H. itama* while light brown in latter species. Coloration of hairs on frons of *H. itama* also different from *H. erythrogastra*, white in this species while yellowish brown in *H. erythrogastra*. The body size of *H. itama* 4.78 – 5.87 mm (mean: 5.58 mm) usually smaller than *H. erythrogastra* 6.69 – 7.85 mm (mean: 7.36).

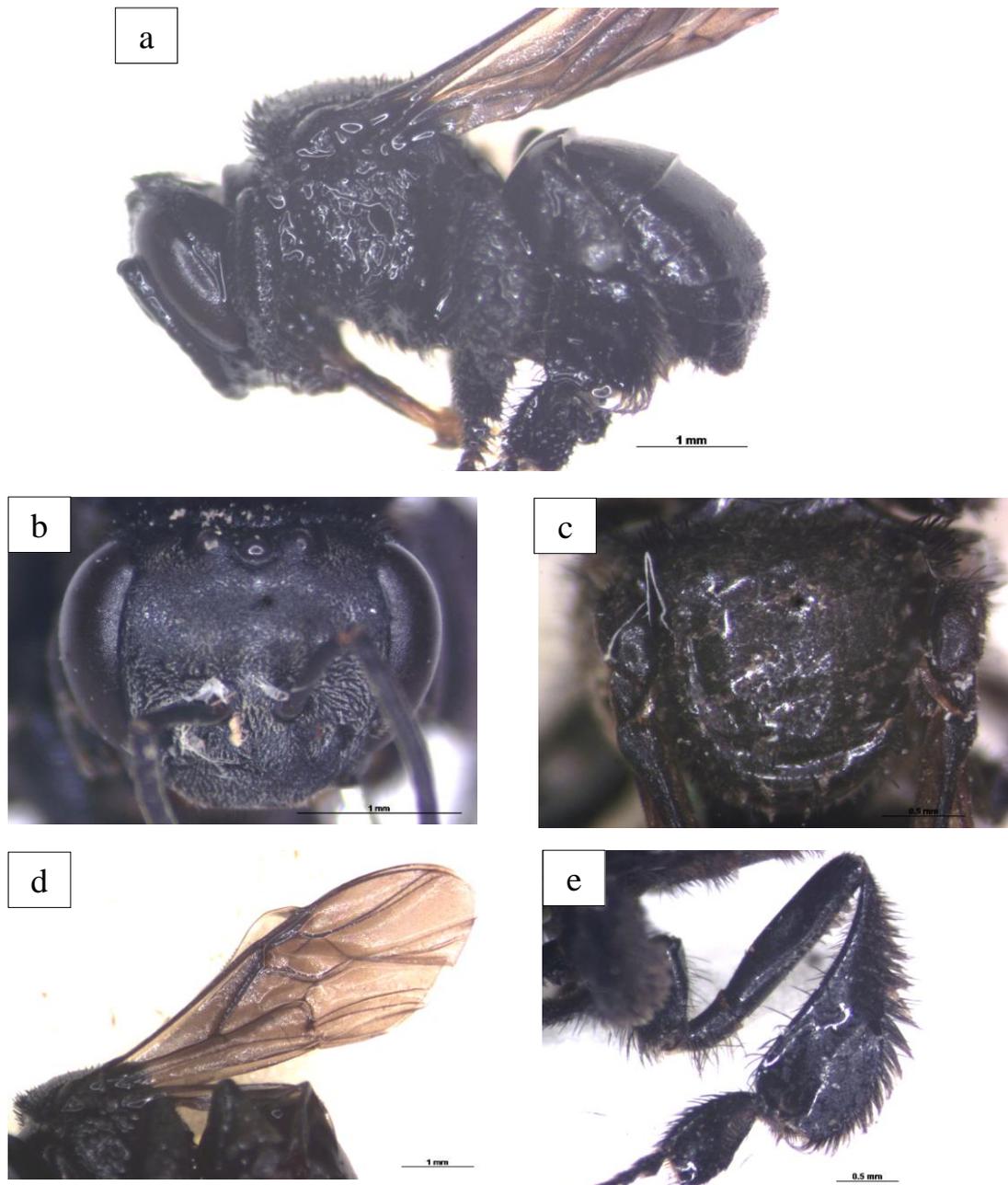


Figure 13 *Heterotrigona itama* (Cockerell, 1918); a, Habitus, Lateral view; b, Frons; c, Mesoscutum; d, Forewing; e, Hind tibia and basitarsus, Scale: 0.5 mm and 1.0 mm.

Lophotrigona Moure, 1961

Type species: *Trigona Canifrons* Smith, 1857

Head. Covered with short setae. Clypeus and frons separated by episomal sulcus. Compound eyes large. Antennae geniculate, 10 segmented flagella, uniformly covered with short erecting setae, scape long, length of pedicel and entire flagella twice than scape, ratio length of scape to entire flagella and pedicel 0.52 – 0.63 mm (mean: 0.56 mm). Mandibles broader on their basal half, narrower on their apex, possesses two teeth.

Thorax. Mesoscutum coarser, covered with setae at anterior, anterior edge broader than posterior. Scutellum coarser, extremely convex, sparsely covered with long setae. **Wings.** Tegulae rounded, highly sclerotized and obvious. Wing venation weak, wings covered with fine and short setae. Pterostigma opaque on costal margin of forewings. Total of hamuli on anterior hindwings 6 in some individuals but usually 7. **Legs.** Hind tibiae long, corbicula pear shape and obvious, covered with long setae at apical and short setae at basal. Hind basitarsi short, sparsely covered with short setae.

Abdomen. Gastral tergite first to second smooth, tergite third to sixth covered with fine setae. Sternite fully covered with fine setae.

Measurement. Total length 6.25 – 8.30 mm (mean: 7.12 mm). Head width 2.85 – 3.15 mm (mean: 3.03 mm) and length 1.90 – 2.07 mm (mean: 1.95 mm). Tibia length 2.50 – 2.84 mm (mean: 2.68 mm) and width 0.95 – 1.06 mm (mean: 1.01 mm).

Coloration. Head black, frons covered with thick mosses-like white hairs, a very thick white hairs and slightly brownish at antennal sockets. Clypeus black and slightly brown at posterior, covered with brownish hairs. Compound eyes and ocelli blackish. Antennal sockets grey, scape black and slightly brown at basal and apical, pedicel and entire flagella completely black. Mandible brown and black at basal. Mesoscutum and scutellum wholly black. Tegulae dark brown, uniform coloration of forewings and hindwings, wing venation dark brown and semi-transparent. Hind tibiae and basitarsi entirely black, blackish brown in some individuals. Gastral tergite and sternite completely blackish brown.

Diagnosis. *Lophotrigona* are large sized 6.25 – 8.30 mm (mean: 7.12 mm) Meliponinae, one of the genera that consist only one species (monotype) other than genus *Odontotrigona*. *Lophotrigona canifrons* is the only known species with the characters of this genus. A mosses-like hairs that covering the frons is peculiar character to distinguish *Lophotrigona* from other genera of stingless bees. The antennae coloration of this genus can easily identified due to entirely black flagella, black scape and slightly blackish brown at basal and apical of scape.

***Lophotrigona canifrons* (Smith, 1857)**

Figure 14 (a-e)

Trigona canifrons Smith 1857: 51: Sintip (OUMNH, 1); additional type (BMNH 17b.1183) (taxonomy); Type Locality: MALAYSIA "Borneo (Sarawak)".

Trigona busara Cockerell 1918: 387: Holotype (USNM 29496): examined, "Singapore / Coll. Baker", "9072", Type No. / 29496 / U.S.N.M.", "*Trigona / busara / Ckll TIP*"; Type Locality: MALAYSIA "Sandakan".

Lophotrigona Moure, 1961: 205.

Material examined. 5 ex., SELANGOR, Serdang, 20 April 2016, Fahimiee. 2 ex., SELANGOR, Bangi, Malaysia Genome Institute, 27 September 2017, Fatimah. 3 ex., SELANGOR, Bangi, Malaysia Genome Institute, 21 November 2017, Fatimah.

Head. Width almost twice than length, ratio length to width 0.61 – 0.67 mm (mean: 0.64 mm), covered with short setae. Clypeus and frons separated by episomal sulcus. Compound eyes large, ratio width to length 0.38 – 0.41 mm (mean: 0.40 mm) (Figure 14b). Antennae geniculate, 10 segmented flagella, uniformly covered with short erecting setae, scape long,

length of pedicel and entire flagella twice than scape, ratio length of scape to entire flagella and pedicel 0.52 – 0.63 mm (mean: 0.56 mm), length of first flagellomere almost equal to second, ratio length of first to second flagellomeres 0.64 – 0.92 mm (mean: 0.83 mm), length of second equal to third flagellomeres, ratio length of second to third flagellomeres 0.96 – 1.04 mm (mean: 1.00 mm). Mandibles broader on their basal half, narrower on their apex, possesses two teeth.

Thorax. Mesoscutum coarser, covered with setae at anterior, length almost twice than width, ratio length to width 0.69 – 0.76 mm (mean: 0.73 mm), anterior edge broader than posterior (Figure 14c). Scutellum coarser, extremely convex, width twice than length, ratio length to width 0.46 – 0.53 mm (mean: 0.50 mm), sparsely covered with long setae. **Wings.** Tegulae rounded, highly sclerotized and obvious. Wing venation weak, length of forewings almost three times than width, ratio width to length 0.35 – 0.39 mm (mean: 0.37 mm), wings covered with fine and short setae. Pterostigma opaque on costal margin of forewings (Figure 14d). Total of hamuli on anterior hindwings 6 in some individuals but usually 7. **Legs.** Hind tibiae long, corbicula pear shape and obvious, covered with long setae at apical and short setae at basal (Figure 14e). Hind basitarsi short, length of tibia almost twice than basitarsus, ratio length of basitarsus to tibia 0.34 – 0.43 mm (mean: 0.38 mm), sparsely covered with short setae.

Abdomen. Gastral tergite first and second smooth, tergite third to sixth covered with fine setae. Sternite fully covered with fine setae.

Measurement. Total length 6.25 – 8.30 mm (mean: 7.12 mm) (Figure 14a). Head width 2.85 – 3.15 mm (mean: 3.03 mm) and length 1.90 – 2.07 mm (mean: 1.95 mm). Length 0.85 – 0.99 mm (mean: 0.91 mm) and width of pterostigma 0.18 – 0.22 mm (mean: 0.21 mm). Tibia length 2.50 – 2.84 mm (mean: 2.68 mm), tibia width 0.95 – 1.06 mm (mean: 1.01 mm).

Coloration. Head black, frons covered with thick and white hairs at anterior, a very thick and slightly brownish at antennal sockets. Clypeus black, slightly brown at posterior and fully covered with brownish hairs. Compound eyes and ocelli blackish. Antennal sockets grey, scape black and slightly blackish brown at basal and apical, pedicel and entire flagella completely black. Mandible brown and black at basal. Mesoscutum and scutellum black. Tegulae dark brown, uniform coloration of forewings and hindwings, semi-transparent, wing venation of forewings dark brown. Hind tibiae and basitarsi completely black, blackish brown in some individuals. Gastral tergite and sternite blackish brown.

Diagnosis. *Lophotrigona canifrons* can be recognized by the presence of white mosses-like hairs that covering a black frons. On the other hand, this species often has a black clypeus and slightly brown at posterior edge which covered with brownish hairs. This species can be distinguished from other species of stingless bees by the coloration of antennae, it has a completely black flagella and black scape but slightly brownish at apical and basal.

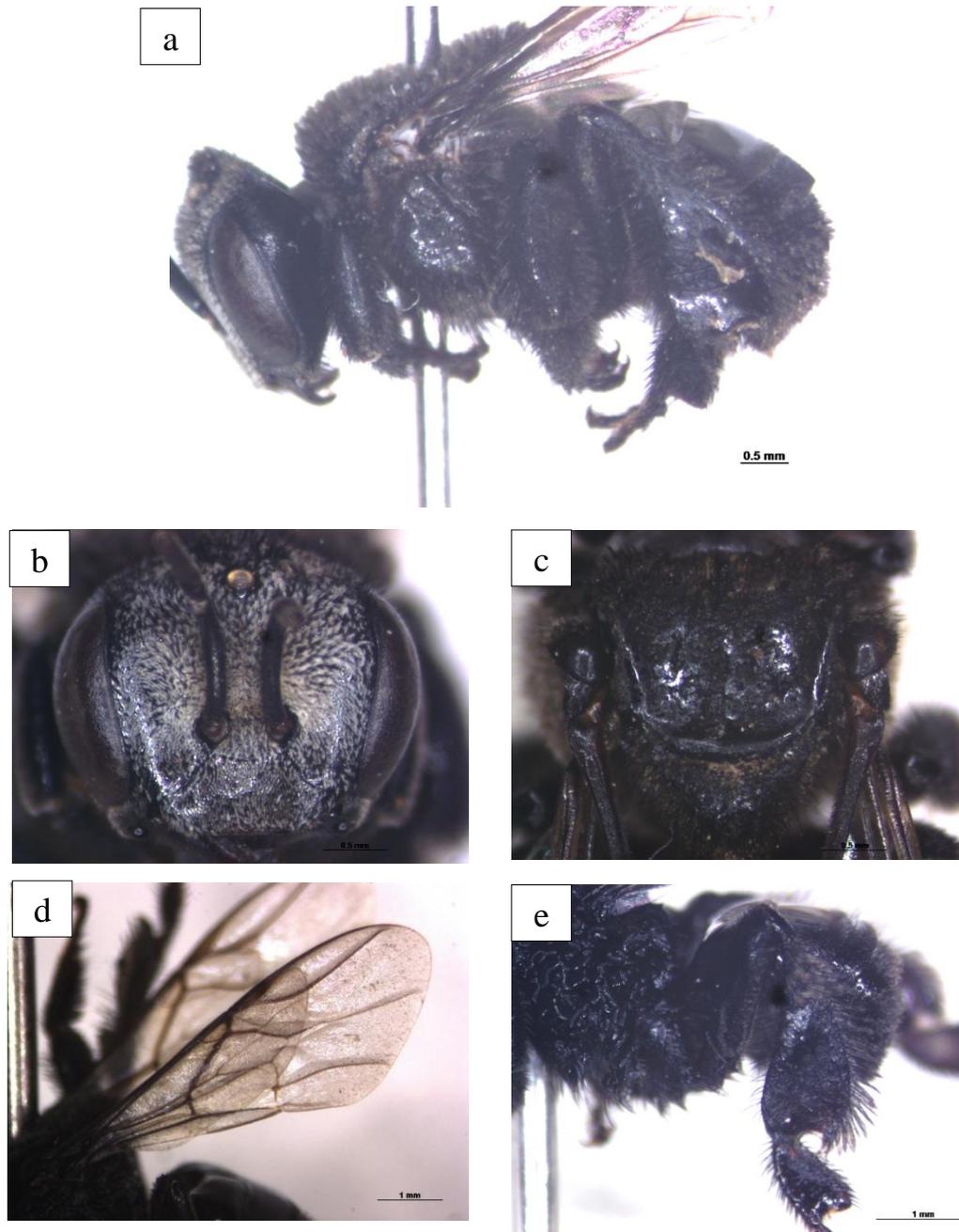


Figure 14 *Lophotrigona canifrons* (Smith, 1857); a, Habitus, Lateral view; b, Frons; c, Mesoscutum; d, Forewing; e, Hind tibia and basitarsus, Scale: 0.5 mm and 1.0 mm.

Homotrigona Moure, 1961

Type species: *Trigona fimbriata* Smith, 1857

Head. Covered with quite long setae. Clypeus and frons separated by obvious episomal sulcus. Compound eyes large. Antennae geniculate, 10 segmented flagella, uniformly covered with short erecting setae, scape long. Mandibles broader on their basal half, narrower on their apex, possesses two teeth.

Thorax. Mesoscutum coarser and immaculate in some species, margin surrounded with setae, anterior edge broader than posterior. Scutellum coarser, convex, covered with long

setae. **Wings.** Tegulae rounded, highly sclerotized and obvious. Wing venation weak, wings covered with fine and short setae. Pterostigma slightly opaque on costal margin of forewings. Total of hamuli on anterior hindwings either 7 or 8. **Legs.** Hind tibiae long and broadened, corbicula pear shape and obvious, covered with long setae. Hind basitarsi short, covered with short setae.

Abdomen. Gastral tergite first to third smooth, tergite fourth to sixth usually coarser and covered with long setae.

Measurement. Total length 8.10 – 8.29 mm (mean: 8.24 mm). Width 3.00 – 3.29 mm (mean: 3.16 mm) and length of head 2.10 – 2.25 mm (mean: 2.16 mm). Tibia length 3.34 – 3.68 mm (mean: 3.54 mm) and width 1.40 – 1.59 mm (mean: 1.48 mm).

Coloration. Head and frons ferruginous to blackish and clypeus brown. Compound eyes and ocelli blackish. Antennal sockets grey, scape ferruginous to blackish, pedicel and entire flagella brown except tenth flagellomere ferruginous to blackish. Mandible brown to ferruginous, black at basal. Mesoscutum and scutellum reddish brown to blackish. Tegulae ferruginous to blackish, uneven coloration of forewings and slightly brownish at basal, semi-transparent at apex. Hindwings semi-transparent as forewings. Hind tibiae and basitarsi dark brown to black entirely. Gastral tergite and sternite brown to blackish.

Diagnosis. *Homotrigona* are relatively large sized 8.10 – 8.29 mm (mean: 8.24 mm) of stingless bee other than *Geniotrigona*. It can be recognized by uniform coloration of whole body including head, thorax and abdomen which is ferruginous. Compared to *Geniotrigona*, this genus has an immaculate mesoscutum, absence of any bands or stripes.

Homotrigona fimbriata (Smith, 1857)

Figure 15 (a-e)

Trigona fimbriata Smith 1857: 52: Type (BMNH 17b.1182) (taxonomy); Type Locality: SINGAPORE.

Melipona castanea Bingham 1903: vi: Type (BMNH 17b.1128) (taxonomy); Type Locality: THAILAND "Bukit Besar, Nawngchik. 1500 to 2500 feet".

Trigona flavistigma Cameron 1902: 130: Holotype (BMNH 17b.1097) (taxonomy); Type Locality: MALAYSIA "Kuching, Sarawak" (male).

Trigona versicolor Friese 1909("1908"): 358, 359, fig. 15-1: Lectotype (ZMHB): determined here, "Tandjong / SO.-Borneo / coll. Speyer", "Trigona / versicolor / 1904 Friese det. / n. Fr.", "Tip"; Type Locality: MALAYSIA "Malaka (Perak); "SO-Borneo (Tandjong)" (2 s).

Homotrigona indet. Roubik 2006: 130 (nest).

Material examined. 5 ex., SELANGOR, Serdang, 20 April 2016, Fahimiee.

Head. Covered with quite long setae. Clypeus and frons separated by obvious episomal sulcus. Compound eyes large, ratio width to length 0.41 – 0.44 mm (mean: 0.42 mm) (Figure 15b). Antennae geniculate, 10 segmented flagella, uniformly covered with short erecting setae, scape long, length of pedicel and entire flagella twice than scape, ratio length of scape to entire flagella and pedicel 0.53 – 0.58 mm (mean: 0.56 mm), length of first flagellomere equal to second, ratio length of first to second flagellomeres 0.83 – 1.42 mm (mean: 1.08 mm), length of second equal to third flagellomeres, ratio length of second to third

flagellomeres 0.90 – 1.04 mm (mean: 1.00 mm). Mandibles broader on their basal half, narrower on their apex, possesses two teeth.

Thorax. Mesoscutum coarser, immaculate, margin surrounded with setae, length almost equal to width, ratio length to width 0.80 – 0.86 mm (mean: 0.83 mm), anterior slightly broader posterior (Figure 15c). Scutellum coarser, convex, width almost twice than length, ratio length to width 0.39 – 0.44 mm (mean: 0.42 mm), covered with long setae. **Wings.** Tegulae rounded, highly sclerotized and obvious. Wing venation weak, forewings extremely long and broadened, length of forewing almost three times than width, ratio length of forewing to width 0.35 – 0.38 mm (mean: 0.36 mm), covered with fine and short setae. Pterostigma slightly opaque on costal margin of forewings (Figure 15d). Total of hamuli on anterior of hindwings either 7 or 8. **Legs.** Hind tibiae very long and slightly broadened, corbicula pear shape and obvious, covered with long setae (Figure 15e). Hind basitarsi short, length of tibia three times than basitarsus, ratio length of basitarsus to tibia 0.31 – 0.36 mm (mean: 0.33 mm), covered with short setae.

Abdomen. Gastral tergite first to third smooth, tergite fourth to fifth covered with short setae, tergite sixth sparsely covered with long setae.

Measurement. Total length 8.10 – 8.29 mm (mean: 8.24 mm) (Figure 15a). Width 3.00 – 3.29 mm (mean: 3.16 mm) and length of head 2.10 – 2.25 mm (mean: 2.16 mm). Length 1.00 – 1.44 mm (mean: 1.10 mm) and width of pterostigma 0.22 – 0.39 mm (0.27 mm). Tibia length 3.34 – 3.68 mm (mean: 3.54 mm) and width 1.40 – 1.59 mm (mean: 1.48 mm).

Coloration. Head and frons ferruginous to blackish and clypeus brown. Compound eyes and ocelli blackish. Antennal sockets grey, scape ferruginous, pedicel and entire flagella brown except tenth flagellomere ferruginous. Mandible ferruginous, black at basal. Mesoscutum and scutellum reddish brown to blackish. Tegulae ferruginous, uneven coloration of forewings and slightly brownish at basal, semi-transparent at apex. Hindwings semi-transparent as forewings. Hind tibiae, slightly brownish in some individuals. Hind basitarsi black entirely. Gastral tergite first ferruginous, tergite second 3/4 ferruginous at anterior and 1/4 black at posterior, tergite third 1/2 ferruginous and black on another half, tergite fourth to sixth black completely. Sternite blackish brown.

Diagnosis. *Homotrigona fimbriata* is relatively large sized 8.10 – 8.29 mm (mean: 8.24 mm), possesses quite broad head 3.00 – 3.29 mm (mean: 3.16 mm) and longer 2.10 – 2.25 mm (mean: 2.16 mm). This species has a very uniform coloration of body including head, frons, mesoscutum, scutellum and first gastral tergite which is ferruginous. Mesoscutum of *H. fimbriata* is immaculate unlike in some species of stingless bees that possess stripes or bands on mesoscutum. The length of hind tibia of this species quite long than other species 3.34 – 3.68 mm (mean: 3.54 mm).

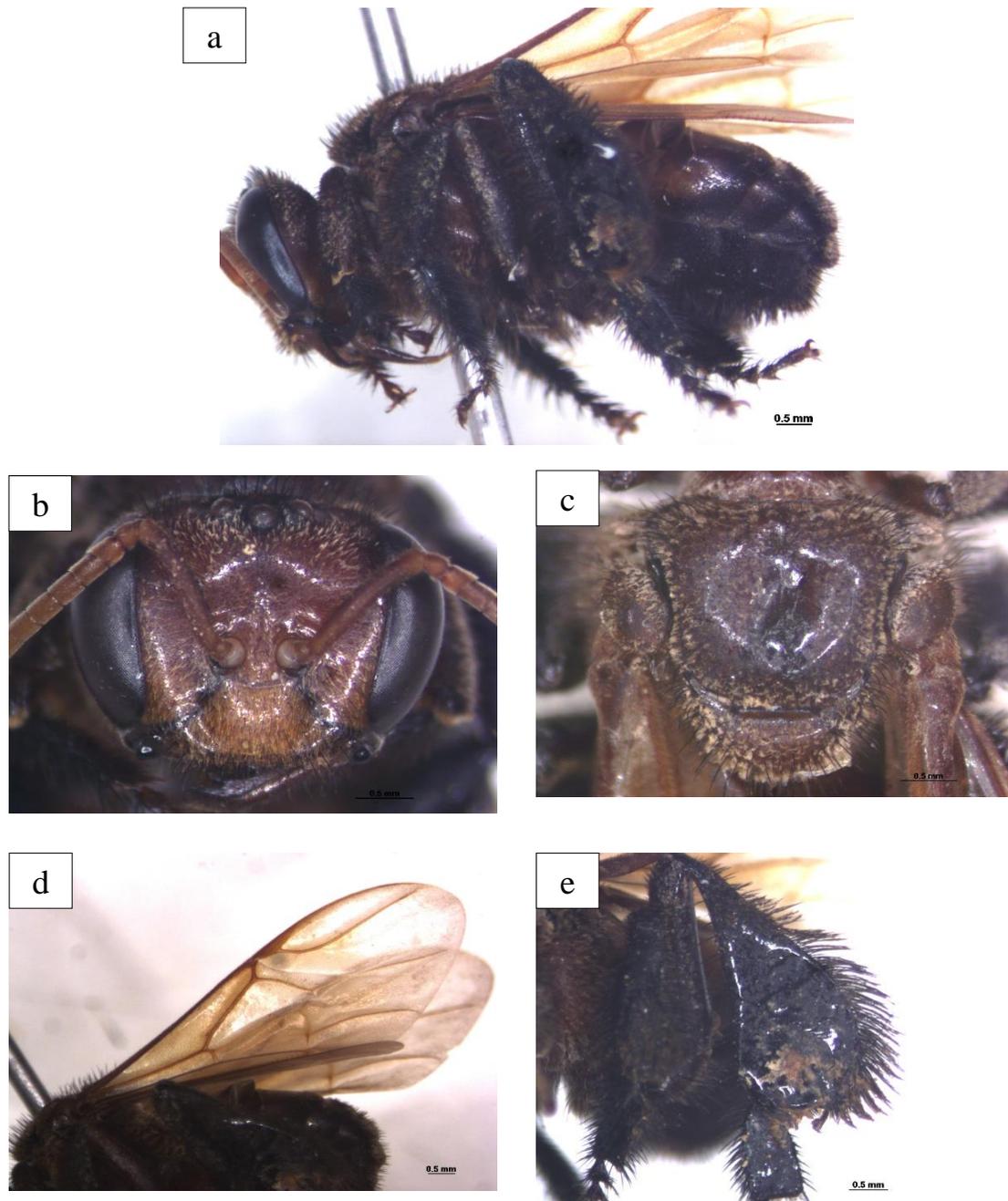


Figure 15 *Homotrigona fimbriata* (Smith, 1857); a, Habitus, Lateral view; b, Frons; c, Mesoscutum; d, Forewing; e, Hind tibia and basitarsus, Scale: 0.5 mm.

Tetragonilla Moure, 1961

Type species: *Trigona atripes* Smith, 1857

Head. Small, sparsely covered with short setae. Clypeus and frons separated by obvious episomal sulcus. Compound eyes large. Antennae geniculate, 10 segmented flagella, uniformly covered with short erecting setae, scape long, length of pedicel and entire flagella twice than scape, ratio length of scape to pedicel and entire flagella 0.48 – 0.60 mm (mean: 0.54 mm). Mandibles broader on their basal half, narrower on their apex, possesses two teeth.

Thorax. Mesoscutum finely punctated and large, covered with long setae at anterior. Scutellum large, extremely convex, covered with short setae and long setae in some species at

posterior edge. **Wings.** Tegulae rounded, highly sclerotized and large. Wing venation weak and unclear, wings covered with fine and short setae. Pterostigma slightly opaque on costal margin of forewings. Total of hamuli on anterior hindwings either 6 or 7. **Legs.** Hind tibiae long, corbicula pear shape and obvious, sparsely covered with long setae at apical and short setae at basal. Hind basitarsi short, covered with short setae.

Abdomen. Gastral tergite first to third smooth. Sternite fully covered with short setae.

Measurement. Total length 4.85 – 6.80 mm (mean: 5.83 mm). Head width 2.30 – 2.86 mm (mean: 2.58 mm) and length 1.66 – 1.99 mm (mean: 1.83 mm). Tibia length 2.50 – 2.92 mm (mean: 2.71 mm), and width 0.88 – 1.06 mm (mean: 0.97 mm).

Coloration. Head black, frons fully covered with white to greyish hairs, clypeus brown to reddish and covered with greyish white hairs. Compound eyes and ocelli blackish red. Antennal sockets grey, scape yellowish brown to brown, pedicel and entire flagella brown to blackish brown. Mandible ferruginous to blackish. Mesoscutum black, fully covered with black setae at anterior edge, scutellum black entirely and covered with yellow to blackish setae. Tegulae brown to blackish brown, uneven coloration of forewings, 1/2 on basal half blackish brown and 1/2 on apical semi-transparent. Hindwings blackish brown as forewings. Hind tibiae and basitarsi black entirely, blackish brown in some species. Gastral tergite blackish brown. Sternite yellowish brown to brown entirely.

Diagnosis. *Tetragonilla* resemble *Tetrigona* from uneven coloration of forewings (both possess blackish brown of 1/2 on basal and another 1/2 is semi-transparent). However, *Tetragonilla* can be separated by having a weak contrast of forewings coloration compared to *Tetrigona*. Furthermore, the sternite of this genus covered with brown to yellowish brown setae.

***Tetragonilla collina* (Smith, 1857)**

Figure 16 (a-e)

Trigona collina Smith 1857: 51-52: Type (OUMNH (= collection of Wilson Saunders)) (taxonomy); Type Locality: MALAYSIA "Malacca (Mount Ophir)".

Trigona cambodiensis Cockerell 1926a: 224: Holotype (USNM 29470): examined (nest, taxonomy); Type Locality: CAMBODIA "Angkov (=Angkor) Wat, Cambodia, Jan. 11, 1926 (H.M. Smith)" (4 s).

Tetragonilla indet. Camargo 1988: 371, 373 (distribution); INDIA; MYANMAR.

Material examined. 7 ex., SELANGOR, Serdang, 20 April 2016, Fahimiee.

Head. Small, width almost twice than length, ratio length to width 0.63 – 0.76 mm (mean: 0.71 mm), sparsely covered with short setae. Clypeus and frons separated by obvious episomal sulcus. Compound eyes large, ratio width to length 0.39 – 0.41 mm (mean: 0.40 mm) (Figure 16b). Antennae geniculate, 10 segmented flagella, uniformly covered with short erecting setae, scape long, length of pedicel and entire flagella twice than scape, ratio length of scape to entire flagella and pedicel 0.50 – 0.59 mm (mean: 0.55 mm), length of first flagellomere equal to second, ratio length of first to second flagellomeres 0.93 – 1.06 mm (mean: 1.01 mm), length of second equal to third flagellomeres, ratio length of second to third flagellomeres 0.94 – 1.07 mm (mean: 0.99 mm). Mandibles broader on their basal half, narrower on their apex, possesses two teeth.

Thorax. Mesoscutum finely punctuated and large, covered with long setae at anterior, length almost equal to width, ratio length to width 0.84 – 0.91 mm (mean: 0.88 mm) (Figure 16c). Scutellum coarser, extremely convex, width twice than length, ratio length to width 0.50 – 0.55 mm (mean: 0.53 mm), covered with short setae at posterior edge. **Wings.** Tegulae rounded, highly sclerotized and obvious. Wing venation weak and unclear, length of forewing almost twice than width, ratio length of forewing to width 0.37 – 0.44 mm (mean: 0.41 mm), covered with fine and short setae. Pterostigma slightly opaque on costal margin of forewings (Figure 16d). Total of hamuli on anterior of hindwings usually 6. **Legs.** Hind tibiae long, corbicula pear shape and obvious, covered with long setae at apical and short setae at basal (Figure 16e). Hind basitarsi short, length of tibia almost three times than basitarsus, ratio length of basitarsus to tibia 0.34 – 0.38 mm (mean: 0.36 mm), covered with short setae.

Abdomen. Gastral tergite first and second smooth, tergite third coarser and fully covered with fine and short setae, tergite fourth to sixth coarser and covered with long setae. Sternite completely covered with short setae.

Measurement. Total length 4.85 – 5.80 mm (mean: 5.22 mm) (Figure 16a). Head width 2.30 – 2.63 mm (mean: 2.39 mm) and length 1.66 – 1.74 mm (mean: 1.70 mm). Length 0.85 – 0.94 mm (mean: 0.89 mm) and width of pterostigma 0.18 – 0.22 mm (mean: 0.21 mm). Tibia length 2.50 – 2.61 mm (mean: 2.55 mm), tibia width 0.88 – 0.93 mm (mean: 0.90 mm).

Coloration. Head black, frons fully covered with grey hairs, clypeus brown and covered with grey hairs. Compound eyes and ocelli blackish. Antennal sockets grey, scape yellowish brown, pedicel and entire flagella blackish brown. Mandible brown, black at basal. Mesoscutum black and immaculate, covered with black setae at anterior edge, scutellum entirely black and covered with black setae. Tegulae blackish brown, uneven coloration of forewings, 1/2 on basal blackish brown and 1/2 on apical semi-transparent. Hindwings blackish brown as forewings. Hind tibiae and basitarsi black entirely. Gastral tergite first to sixth wholly blackish brown. Sternite yellowish brown.

Diagnosis. *Tetragonilla collina* resembles to *T. fuscibasis* (both possess black mesoscutum and covered with a black setae). Nonetheless, *T. collina* has an immaculate mesoscutum while *T. fuscibasis* has a yellow spots on mesoscutum. These species have a different coloration of forewings, blackish brown of 1/2 on basal and semi-transparent of 1/2 on apical. In contrast, *T. fuscibasis* has a brown forewing of 1/2 on basal. This species has a blackish brown tegulae unlike in latter species which has a brown tegulae.

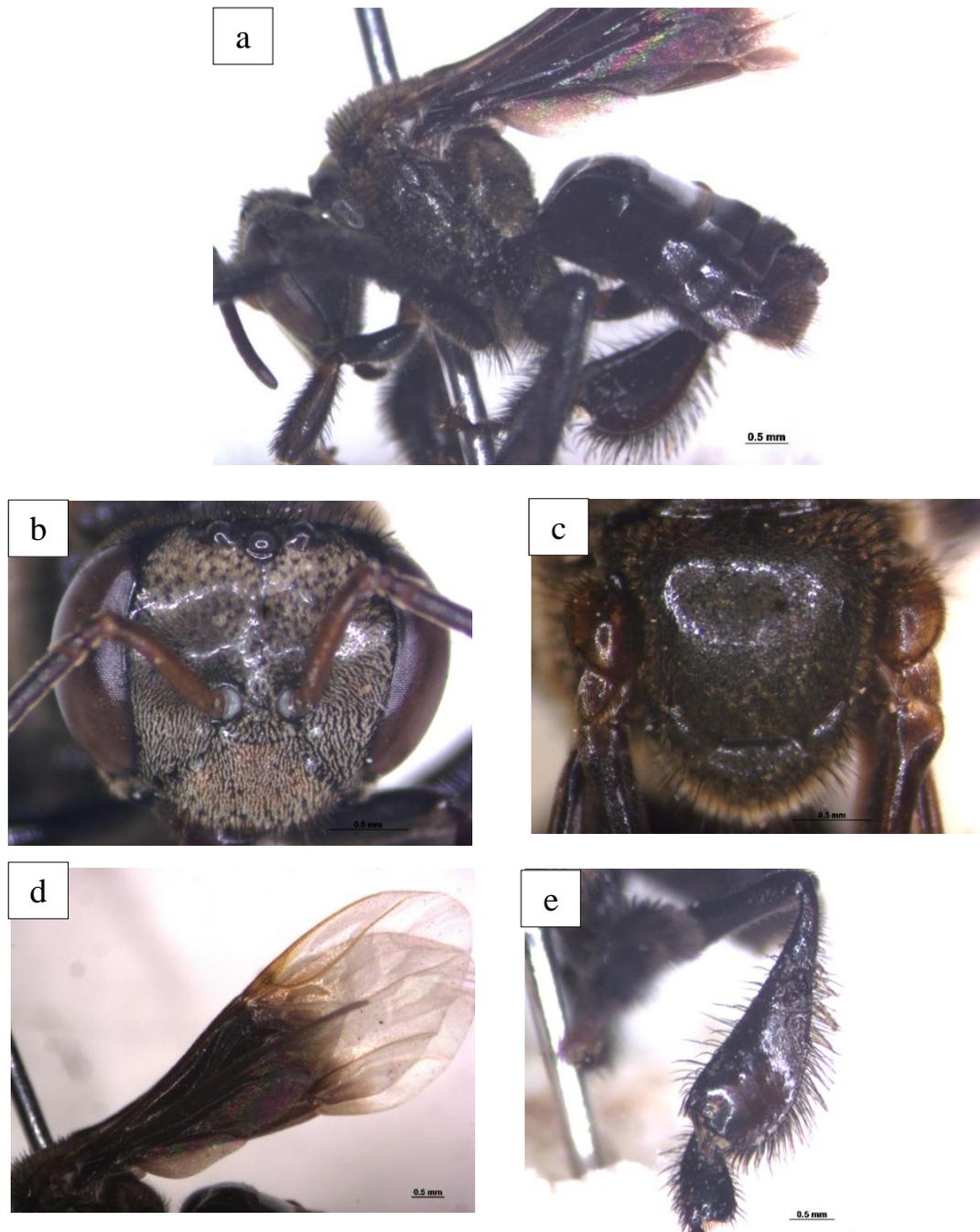


Figure 16 *Tetragonilla collina* (Smith, 1857); a, Habitus, Lateral view; b, Frons; c, Mesoscutum; d, Forewing; e, Hind tibia and basitarsus, Scale: 0.5 mm.

***Tetragonilla fuscibasis* (Cockerell, 1920)**

Figure 17 (a-e)

Trigona fuscibasis Cockerell 1920a: 115-116: Holotype (BMNH 17b.1082) (taxonomy);

Type Locality: MALAYSIA "Sandakan, Borneo (Baker, 9964)"

Tetragonilla indet. Camargo 1988: 371, 373 (distribution); INDIA; MYANMAR.

Material examined. 9 ex., SELANGOR, Serdang, 20 April 2016, Fahimiee.

Head. Small, width almost twice than length, ratio length to width 0.64 – 0.73 mm (mean: 0.69 mm), sparsely covered with long setae. Clypeus and frons separated by episomal sulcus. Compound eyes large, ratio width to length 0.37 – 0.43 mm (mean: 0.40 mm) (Figure 17b). Antennae geniculate, 10 segmented flagella, uniformly covered with short erecting setae, scape long, length of pedicel and entire flagella twice than scape, ratio length of scape to entire flagella and pedicel 0.48 – 0.60 mm (mean: 0.54 mm), length of first flagellomere almost equal to second, ratio length of first to second flagellomeres 0.78 – 1.11 mm (mean: 0.91 mm), length of second equal to third flagellomeres, ratio length of second to third flagellomeres 0.95 – 1.10 mm (mean: 1.01 mm). Mandibles broader on their basal half, narrower on their apex, possesses two teeth.

Thorax. Mesoscutum finely punctuated, sparsely covered with long setae at margin, presence of indentation on anterior, length almost equal to width, ratio length to width 0.85 – 0.94 mm (mean: 0.88 mm), anterior broader than posterior (Figure 17c). Scutellum coarser, extremely convex, width twice than length, ratio length to width 0.46 – 0.53 mm (mean: 0.51 mm), sparsely covered with long setae. **Wings.** Tegulae rounded, highly sclerotized and obvious. Wing venation weak and unclear, length of forewing almost three times than width, ratio length of forewing to width 0.34 – 0.41 mm (mean: 0.38 mm), covered with fine and short setae. Pterostigma slightly opaque on costal margin of forewings (Figure 17d). Total of hamuli on anterior of hindwings either 6 or 7. **Legs.** Hind tibiae long, corbicula pear shape and obvious, sparsely covered with long setae at apical and short setae at basal (Figure 17e). Hind basitarsi short, length of tibia three times than basitarsus, ratio length of basitarsus to tibia 0.31 – 0.40 mm (mean: 0.35 mm), sparsely covered with short setae.

Abdomen. Gastral tergite first to third smooth, tergite fourth to sixth fully covered with short setae. Sternite wholly covered with fine setae.

Measurement. Total length 5.69 – 6.80 mm (mean: 6.34 mm) (Figure 17a). Head width 2.62 – 2.86 mm (mean: 2.74 mm) and length 1.78 – 1.99 mm (mean: 1.88 mm). Length 0.85 – 0.95 mm (mean: 0.91 mm) and width of pterostigma 0.19 – 0.23 mm (0.22 mm). Tibia length 2.70 – 2.92 mm (mean: 2.82 mm), tibia width 0.98 – 1.06 mm (mean: 1.02 mm).

Coloration. Head black, fully covered with white hairs, clypeus ferruginous and covered with white hairs. Compound eyes and ocelli blackish. Antennal sockets grey, scape brown, pedicel ferruginous, first flagellomere brown, second to entire flagella blackish brown. Mandible ferruginous. Mesoscutum black and possesses black indentation on mesoscutum, covered with black setae, scutellum entirely black and covered with yellowish setae at posterior edge. Tegulae brown, uneven coloration of forewings, 1/2 on basal brown and 1/2 on apical semi-transparent. Hindwings brown as forewings. Hind tibiae brown, black in some individuals. Hind basitarsi black entirely, reddish in some individuals. Gastral tergite first to third wholly black, tergite fourth to sixth blackish brown. Sternite fully brown.

Diagnosis. *Tetragonilla fuscibasis* and *T. collina* are the most similar on mesoscutum coloration, both have a black mesoscutum which covered with a black setae. Nevertheless, *T. fuscibasis* possesses a black indentation on mesoscutum unlike *T. collina*. This peculiar characteristic easily to distinguish *T. fuscibasis* from other species of stingless bees. Forewings coloration in both species are different, brown 1/2 on basal and semi-transparent 1/2 on apical in *T. fuscibasis* while blackish brown 1/2 on basal in *T. collina*.

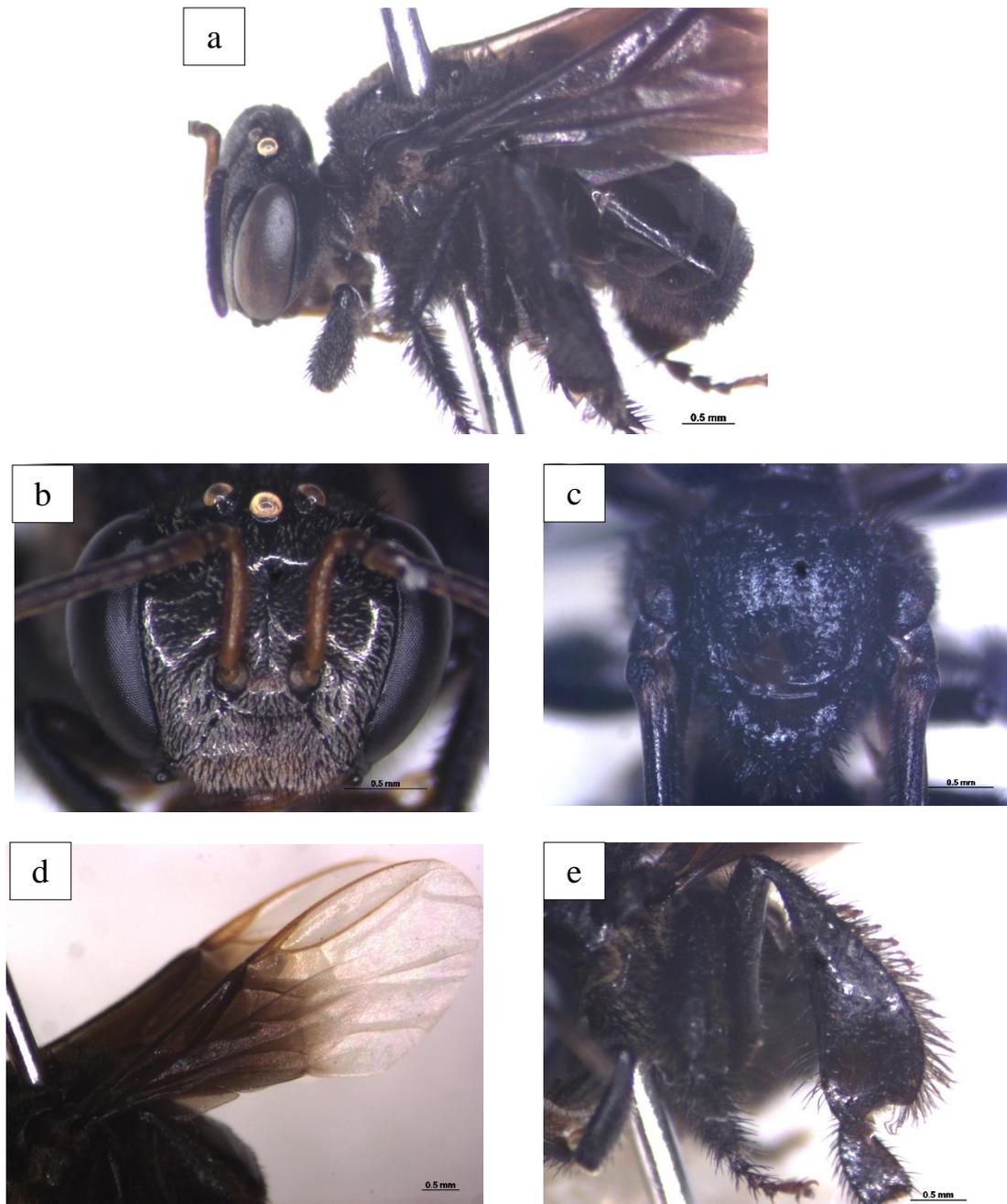


Figure 17 *Tetragnolla fuscibasis* (Cockerell, 1920); a, Habitus, Lateral view; b, Frons; c, Mesoscutum; d, Forewing; e, Hind tibia and basitarsus, Scale: 0.5 mm.

Tetrigona Moure, 1961

Type species: *Trigona apicalis* Smith, 1857

Head. Covered with long setae at apical. Clypeus and frons separated by episomal sulcus. Compound eyes large. Antennae geniculate, 10 segmented flagella, uniformly covered with short erecting setae, scape long, length of pedicel and entire flagella twice than scape, ratio length of scape to pedicel and entire flagella 0.51 – 0.70 mm (mean: 0.61 mm). Mandibles broader on their basal half, narrower on their apex, possess two teeth.

Thorax. Mesoscutum punctated and coarser, covered with long setae at anterior, anterior broader than posterior. Scutellum coarser, convex, covered with long setae. **Wings.** Tegulae rounded, highly sclerotized and large. Wing venation weak and unclear, wings covered with fine and short setae. Pterostigma slightly opaque on costal margin of forewings. Total of hamuli on anterior hindwings either 6, 7 or 8. **Legs.** Hind tibiae long, corbicula pear shape and obvious, covered with long setae at apical and short setae at basal. Hind basitarsi long, covered with short setae.

Abdomen. Gastral tergite usually smooth, covered with fine setae. Sternite fully covered with fine setae.

Measurement. Total length 5.53 – 7.75 mm (mean: 6.64 mm). Head width 2.48 – 3.02 mm (mean: 2.75 mm) and length 1.85 – 2.20 mm (mean: 2.03 mm). Tibia length 2.30 – 3.00 mm (mean: 2.65 mm), tibia width 0.90 – 1.08 mm (mean: 0.99 mm).

Coloration. Head black, frons fully covered with fine yellowish white to brown hairs, yellowish white to brown hairs approaching antennal sockets and clypeus. Clypeus ferruginous and wholly covered with yellowish white to brown hairs. Compound eyes and ocelli blackish. Antennal sockets grey to blackish, scape ferruginous to brown at apical, pedicel and entire flagella brown to blackish brown. Mandible brown to reddish, black at basal. Mesoscutum blackish brown to black, fully covered with blackish brown to black setae at anterior edge, scutellum entirely black, covered with brown to blackish setae. Tegulae brown to blackish brown, uneven coloration of forewings, 1/2 on basal blackish brown and 1/2 semi-transparent on apical. Hindwings blackish brown. Hind tibiae and basitarsi black and blackish brown in some species. Gastral tergite and sternite brown to blackish brown.

Diagnosis. *Tetrigona* are more similar to *Tetragonilla*. Both of these genera possess uneven coloration of forewings unlike in other genera. However, *Tetrigona* has a strong contrast of coloration than *Tetragonilla*. *Tetrigona* 5.53 – 7.75 mm (mean: 6.64 mm) usually have a larger body size compared to *Tetragonilla* 4.85 – 6.80 mm (mean: 5.83 mm). Furthermore, this genus also has a sternite which covered with a blackish brown to black setae unlike the latter.

***Tetrigona* Moure, 1961**

Key to species

1. - Head black, frons fully covered with fine white to yellowish hairs, thicken yellowish white hairs approaching antennal sockets and clypeus. Clypeus ferruginous and fully covered with fine yellowish white hairs. *T. apicalis*
 - Head black, frons fully covered with fine yellowish brown hairs, fine and black hairs approaching antennal sockets and clypeus. Clypeus ferruginous and fully covered with fine yellowish brown hairs.....**2**
2. - Possesses a red mark between antennal sockets. Tegulae blackish brown..... *T. melanoleuca*
 - Possesses a black mark between antennal sockets. Tegulae brown..... *T. binghami*

Tetrigona apicalis* (Smith, 1857)*Figure 18 (a-e)**

Trigona apicalis Smith 1857: 51: Holotype (OUMNH); Tip (BMNH 17b.1188) (taxonomy); Type Locality: MALAYSIA "Borneo (Sarawak)".

Trigona hemileuca Cockerell 1929b: 140: Holotype (BMNH 17b.1098); Type Locality: THAILAND "Siam: Nan, Dec. 31 and Jan. 31 (Cockerell)" (); CAMBODIA, Ban Maa Hia; Mekami river.

Trigona sericea Friese 1933a: 45-46: Lectotype (ZMHB): determined here, "Borneo / Sanggau / 247-32", "*Trigona / sericea / 1925* Friese det. / Fr."; paraLectotypes (ZMHB (5), DEI (4)) (taxonomy); Type Locality: MALAYSIA/INDONESIA "Meliiau (Borneo) 4. Juni 1932"; "Sanggau (Borneo) 24. Juli 1932" (several s).

Tetrigona Moure, 1961: 215.

Material examined. 4 ex., SELANGOR, Bangi, Malaysia Genome Institute, 27 September 2017, Fatimah.

Head. Width almost twice than length, ratio length to width 0.69 – 0.73 mm (mean: 0.70 mm), covered with long setae at apical. Clypeus and frons separated by episomal sulcus. Compound eyes large, ratio width to length 0.42 – 0.46 mm (mean: 0.43 mm) (Figure 18b). Antennae geniculate, 10 segmented flagella, uniformly covered with short erecting setae, scape long, length of pedicel and entire flagella twice than scape, ratio length of scape to pedicel and entire flagella 0.53 – 0.59 mm (mean: 0.56 mm), first flagellomere almost equal to second, ratio length of first to second flagellomeres 0.65 – 0.83 mm (mean: 0.76 mm), length of second and third flagellomeres are equal, ratio length of second to third flagellomeres 1.00 – 1.00 mm (mean: 1.00 mm). Mandibles broader on their basal half, narrower on their apex, possesses two teeth.

Thorax. Mesoscutum coarser, covered with setae at anterior, length almost equal to width, ratio length to width 0.75 – 0.83 mm (mean: 0.79 mm), anterior broader than posterior (Figure 18c). Scutellum coarser, convex, width almost twice than length, ratio length to width 0.40 – 0.45 mm (mean: 0.43 mm), covered with long setae. **Wings.** Tegulae rounded, highly sclerotized and large. Wing venation weak and unclear, length of forewings almost three times than width, ratio width to length 0.37 – 0.40 mm (mean: 0.38 mm), wings covered with fine and short setae. Pterostigma slightly opaque on costal margin of forewings (Figure 18d). Total of hamuli on anterior hindwings usually 7. **Legs.** Hind tibiae long, corbicula pear shape and obvious, covered with long setae at apical and short setae at basal (Figure 18e). Hind basitarsi long, length of tibia almost twice than basitarsus, ratio length of basitarsus to tibia 0.38 – 0.42 mm (mean: 0.40 mm), covered with short setae.

Abdomen. Gastral tergite first and second usually smooth, tergite third to fifth coarser, tergite sixth coarsest, covered with fine setae. Sternite fully covered with fine setae.

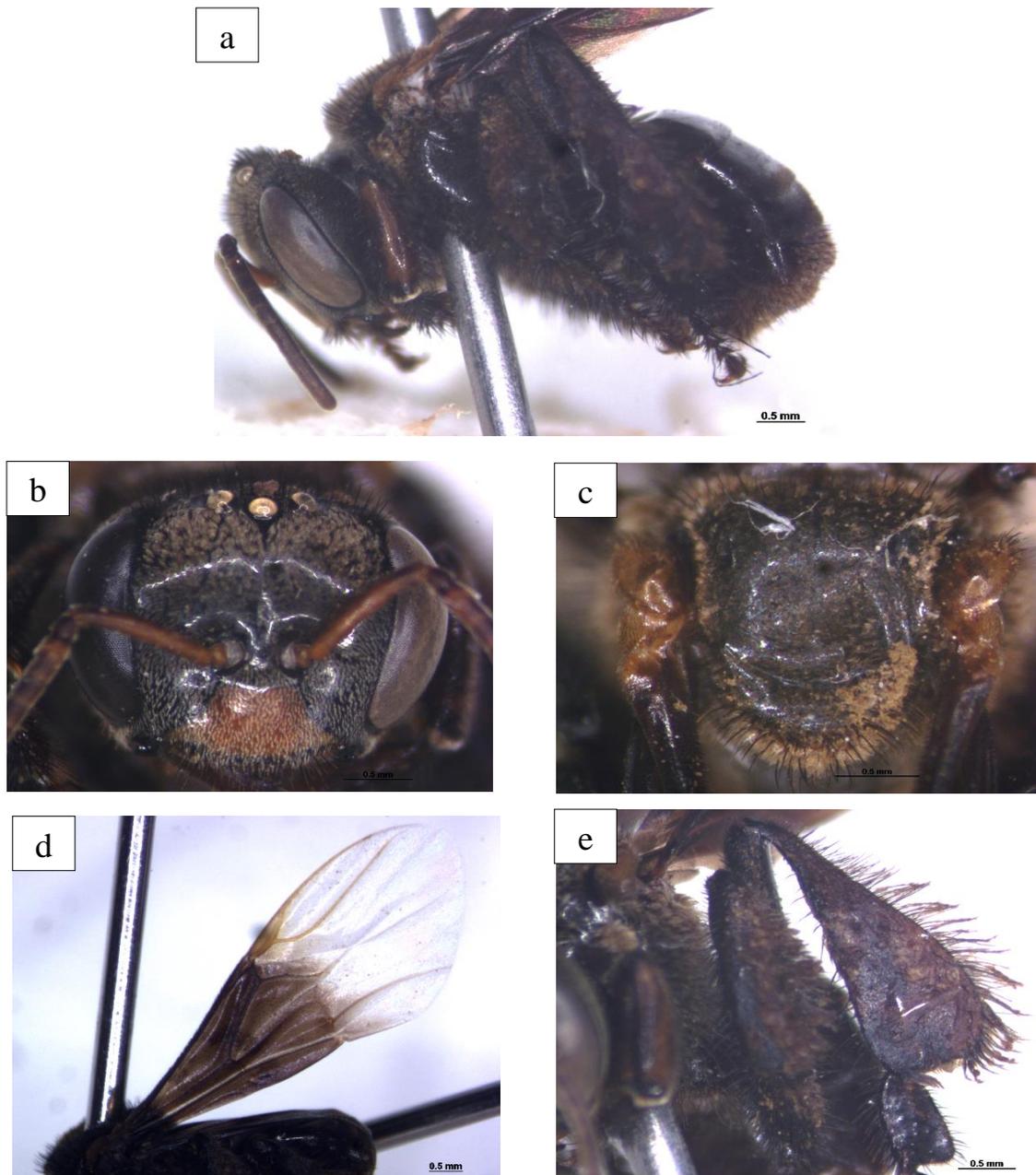


Figure 18 *Tetrigona apicalis* (Smith, 1857); a, Habitus, Lateral view; b, Frons; c, Mesoscutum; d, Forewing; e, Hind tibia and basitarsus, Scale: 0.5 mm.

Measurement. Total length 6.82 – 7.30 mm (mean: 7.01 mm) (Figure 18a). Head width 2.61 – 3.02 mm (mean: 2.74 mm) and length 1.81 – 2.20 mm (mean: 1.94 mm). Length 0.91 – 0.96 mm (mean: 0.94 mm) and width of pterostigma 0.22 – 0.26 mm (mean: 0.24 mm). Tibia length 2.76 – 2.89 mm (mean: 2.86 mm), tibia width 1.02 – 1.07 mm (mean: 1.04 mm).

Coloration. Head black, frons fully covered with fine yellowish white hairs, yellowish hairs approaching antennal sockets and clypeus. Clypeus ferruginous and wholly covered with yellowish white hairs. Compound eyes and ocelli blackish. Antennal sockets grey, scape ferruginous at apical, pedicel and first flagellomere ferruginous, second to tenth flagellomeres blackish brown. Mandible brown, black at basal. Mesoscutum black, fully covered with black setae at anterior edge, scutellum entirely black, covered with black setae. Tegulae brown, uneven coloration of forewings, 1/2 on basal blackish brown and 1/2 semi-transparent on

apical. Hindwings blackish brown. Hind tibiae and basitarsi black and slightly brown in some individuals. Gastral tergite first to fifth blackish brown, tergite sixth brown. Sternite blackish brown.

Diagnosis. *Tetrigona apicalis* looks similar to *T. binghami* on frons coloration (black) but these species have a different color of clypeus, red in *T. apicalis* and brown in *T. binghami*. The frons of *T. apicalis* fully covered with yellowish white setae while yellowish brown in *T. binghami*. Despite the fact that both of these species have uneven coloration of forewings, the differences can be seen on coloration of forewing which is blackish brown of 1/2 on basal and 1/2 semi-transparent on apical in *T. apicalis*. Meanwhile, *T. binghami* has a dark brown of 3/4 on forewing basal. The mesoscutum of *T. apicalis* entirely black and fully covered with a black setae at anterior edge while mesoscutum of *T. binghami* covered with blackish brown setae.

***Tetrigona melonaleuca* (Cockerell, 1929)**

Figure 19 (a-e)

Trigona melanoleuca Cockerell 1929b: 140-141: Holotype (BMNH 17b.1119). Possible to become a junior synonym *vidua*. Type Locality: THAILAND "Siam: Nan, Jan. 13, 1928 (Alice Mackie)".

Tetrigona Moure, 1961: 215.

Spesimen diperiksa. 2 ex., SELANGOR, Serdang, 20 April 2016, Fahimiee.

Head. Width almost twice than length, ratio length to width 0.69 – 0.78 mm (mean: 0.73 mm), sparsely covered with short setae. Clypeus and frons separated by epistomal sulcus. Compound eyes large, ratio width to length 0.36 – 0.38 mm (mean: 0.37 mm) (Figure 19b). Antennae geniculate, 10 segmented flagella, uniformly covered with short erecting setae, scape long, length of pedicel and entire flagella almost twice than scape, ratio length of scape to pedicel and entire flagella 0.63 – 0.70 mm (mean: 0.66 mm), length of second flagellomer almost twice than first, ratio length of first to second flagellomeres 0.72 – 0.77 mm (mean: 0.75 mm), length of second flagellomere equal to third, ratio length of second to third flagellomeres 1.00 – 1.05 mm (mean: 1.02 mm). Mandibles broader on their basal half, narrower on their apex, possesses two teeth.

Thorax. Mesoscutum punctate and small, looks like square shape, sparsely covered with short setae, length almost equal to width, ratio length to width 0.78 – 0.79 mm (mean: 0.79 mm) (Figure 19c). Scutellum large, extremely convex, width twice than length, ratio length to width 0.47 – 0.49 mm (mean: 0.48 mm), sparsely covered with long setae at posterior edge.

Wings. Tegulae rounded, highly sclerotized and large. Wing venation weak and unclear, length of forewing almost twice than width, ratio width to length 0.38 – 0.41 mm (mean: 0.40 mm), covered with short and fine setae. Pterostigma slightly opaque on costal margin of forewing (Figure 19d). Total of hamuli on anterior of hindwings usually 6. **Legs.** Hind tibiae long, corbicula pear shape and obvious, covered with long setae at apical and short setae at basal (Figure 19e). Hind basitarsi short, length of tibia three times than basitarsus, ratio length of basitarsus to tibia 0.31 – 0.40 mm (mean: 0.35 mm), covered with short setae.

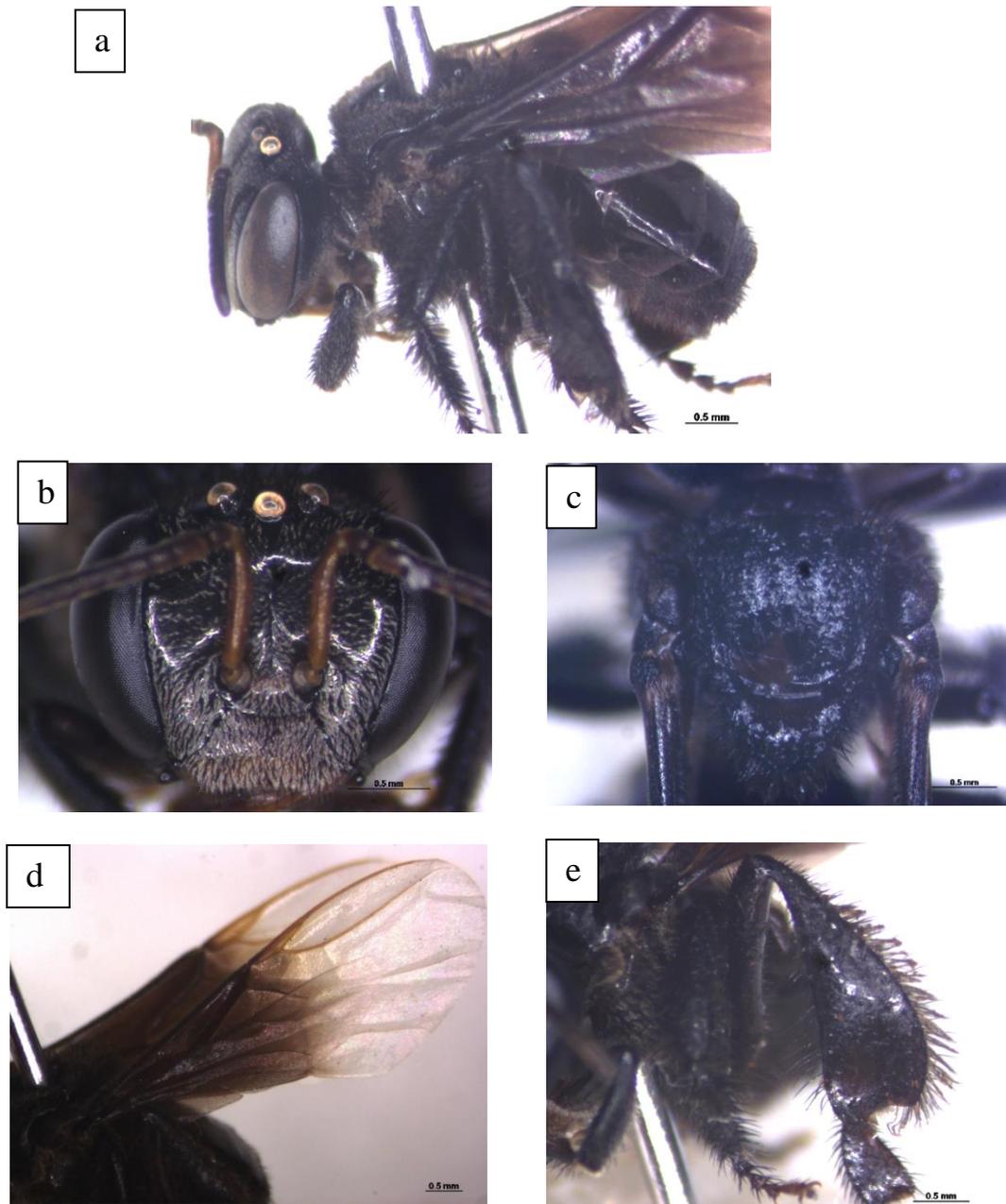


Figure 19 *Tetrigona melanoleuca* (Cockerell, 1929); a, Habitus, Lateral view; b, Frons; c, Mesoscutum; d, Forewing; e, Hind tibia and basitarsus, Scale: 0.5 mm.

Abdomen. Gastral tergite first smooth, tergite second smooth but slightly coarser at posterior, tergite third to sixth coarsest and fully covered with fine and short setae. Sternite covered with long setae.

Measurement. Total length 5.53 – 6.00 mm (mean: 5.77 mm) (Figure 19a). Head width 2.50 – 2.62 mm (mean: 2.56 mm) and length 1.85 – 1.90 mm (mean: 1.88 mm). Length 0.81 – 1.22 mm (mean: 1.00 mm) and width of pterostigma 0.21 – 0.30 mm (mean: 0.26 mm). Tibia length 2.30 – 2.59 mm (mean: 2.45 mm), tibia width 0.95 – 1.00 mm (mean: 0.98 mm).

Coloration. Head black, frons fully covered with fine and white hairs, ferruginous between antennal sockets. Clypeus ferruginous and wholly covered with white hairs. Compound eyes

and ocelli blackish. Antennal sockets grey, scape ferruginous and slightly yellow at apical, pedicel brown, first flagellomere yellowish brown, second to tenth flagellomeres blackish brown. Mandible ferruginous, black at basal. Mesoscutum blackish brown, fully covered with black setae, scutellum entirely black, covered with black setae and slightly yellowish at posterior edge. Tegulae blackish brown, uneven coloration of forewings, 3/4 on basal blackish brown and 1/4 semi-transparent on apical. Hindwings blackish brown. Hind tibiae and basitarsi blackish brown. Gastral tergite first and second ferruginous, tergite third to sixth blackish brown. Sternite completely brown.

Diagnosis. *Tetrigona melonaleuca* possesses a similar coloration of clypeus to *T. apicalis*. These two species can be separated by coloration between antennal sockets, red in *T. melonaleuca* and black in *T. apicalis*. This species has a relatively small sized compared to the other species in genus *Tetrigona* 5.53 – 6.00 mm (mean: 5.77 mm).

***Tetrigona binghami* (Schwarz, 1937)**

Figure 20 (a-e)

Trigona apicalis variety *binghami* Schwarz 1937: 288, 300, 301, 303-304*, 328, plate 2, 5, 7: Holotype (BMNH 17b.1142); paratype (AMNH, BMNH, USNM); Type Locality: MYANMAR "Tenasserim: Dawnat Range, Jan., 1891 (Col. C.T. Bingham)" (1).

Tetrigona Moure, 1961: 215.

Material examined. 10 ex., SELANGOR, Bangi, Malaysia Genome Institute, 27 September 2017, Fatimah.

Head. Width almost twice than length, ratio length to width 0.66 – 0.69 mm (mean: 0.68 mm), sparsely covered with short setae at apical. Clypeus and frons separated by epistomal sulcus. Compound eyes large, ratio width to length 0.38 – 0.45 mm (mean: 0.42 mm) (Figure 20b). Antennae geniculate, 10 segmented flagella, uniformly covered with short erecting setae, scape long, length of pedicel and entire flagella twice than scape, ratio length of scape to pedicel and entire flagella 0.51 – 0.58 mm (mean: 0.55 mm), length of second flagellomere almost equal to first, ratio length of first to second flagellomeres 0.74 – 0.96 mm (mean: 0.87 mm), length of second flagellomere equal to third, ratio length of second to third flagellomeres 1.00 – 1.04 mm (mean: 1.01 mm). Mandibles broader on their basal half, narrower on their apex, possesses two teeth.

Thorax. Mesoscutum coarser, covered with setae at anterior, length almost equal to width, ratio length to width 0.75 – 0.86 mm (mean: 0.81 mm), anterior slightly broader than posterior (Figure 20c). Scutellum coarser, slightly sharp, width almost twice than length, ratio length to width 0.35 – 0.46 mm (mean: 0.41 mm), covered with long setae. **Wings.** Tegulae rounded, highly sclerotized and large. Wing venation weak and unclear, length of forewing three times than width, ratio width to length 0.36 – 0.40 mm (mean: 0.38 mm), covered with short and fine setae. Pterostigma slightly opaque on costal margin of forewing (Figure 20d). Total of hamuli on anterior of hindwings either 6 or 8, but usually 7. **Legs.** Hind tibiae long, corbicula pear shape and obvious, covered with long setae at apical and short setae at basal (Figure 20e). Hind basitarsi short, length of tibia three times than basitarsus, ratio length of basitarsus to tibia 0.33 – 0.40 mm (mean: 0.35 mm), covered with short setae.

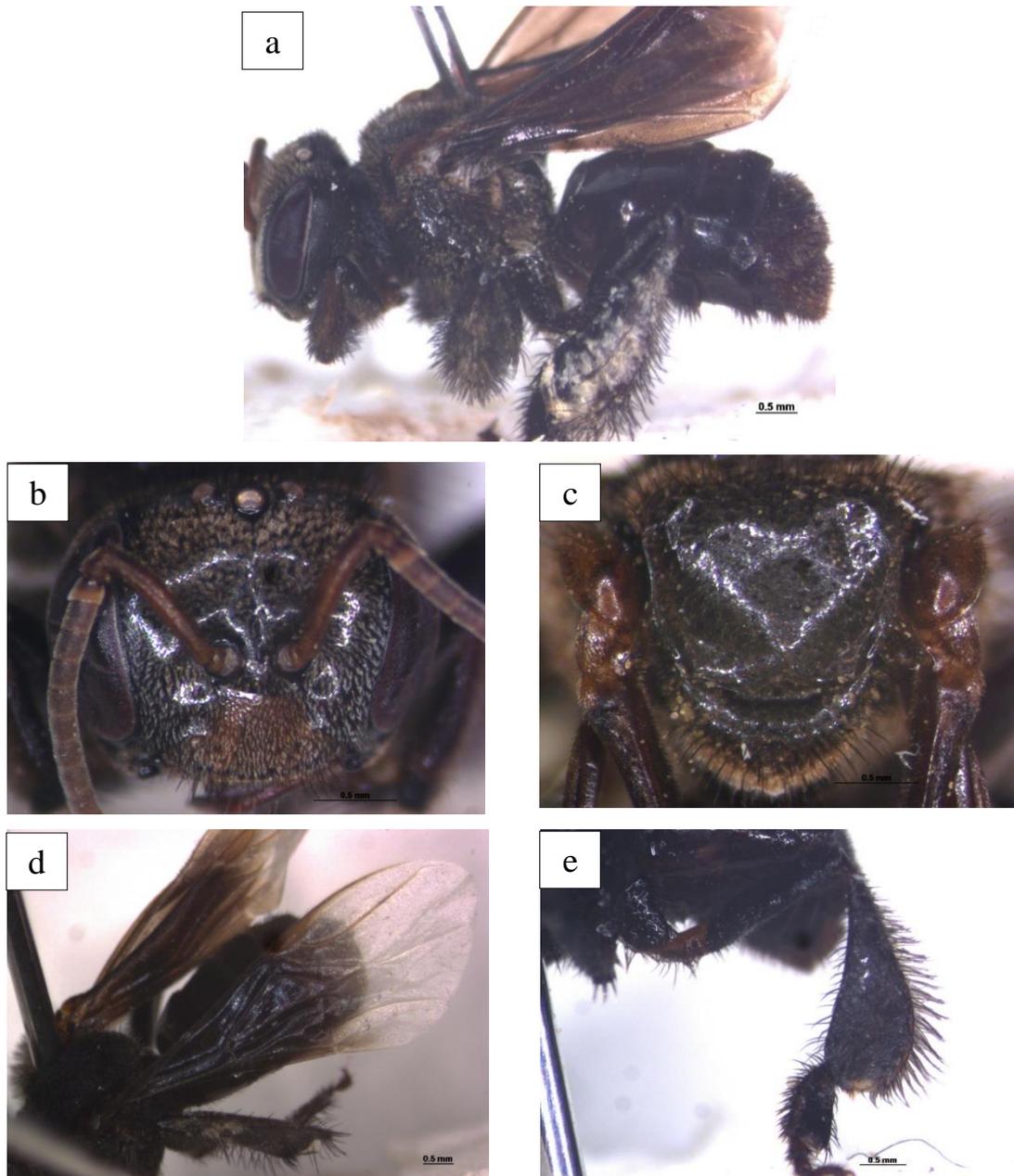


Figure 20 *Tetrigona binghami* (Schwarz, 1937); a, Habitus, Lateral view; b, Frons; c, Mesoscutum; d, Forewing; e, Hind tibia and basitarsus, Scale: 0.5 mm.

Abdomen. Gastral tergite first to third smooth, tergite fourth coarser, tergite fifth to sixth coarsest, fully covered with fine setae. Sternite covered with fine setae.

Measurement. Total length 6.61 – 7.75 mm (mean: 7.01 mm) (Figure 20a). Head width 2.48 – 2.77 mm (mean: 2.66 mm) and length 1.70 – 1.87 mm (mean: 1.80 mm). Length 0.73 – 0.88 mm (mean: 0.80 mm) and width of pterostigma 0.18 – 0.25 mm (mean: 0.21 mm). Tibia length 2.50 – 3.00 mm (mean: 2.83 mm), tibia width 0.90 – 1.08 mm (mean: 1.02 mm).

Coloration. Head black, frons fully covered with fine and yellowish brown hairs, fine and black hairs approaching antennal sockets and clypeus. Clypeus ferruginous and wholly covered with yellowish brown hairs. Compound eyes and ocelli blackish. Antennal sockets

blackish grey, scape ferruginous and slightly brown at apical, pedicel brown, first flagellomere brown, second to tenth flagellomeres brown and blackish brown in some individuals. Mandible brown, black at basal. Mesoscutum black, fully covered with blackish brown setae, scutellum entirely blackish brown, covered with blackish brown setae. Tegulae brown, uneven coloration of forewings, 3/4 on basal dark brown and 1/4 semi-transparent on apical. Hindwings dark brown. Hind tibiae and basitarsi blackish brown. Gastral tergite first to fourth blackish brown, tergite fifth and sixth brown. Sternite completely blackish brown.

Diagnosis. *Tetrigona binghami* characterize by brown clypeus, and similar to this species is *T. apicalis* that has red clypeus, but *T. binghami* has frons that covered with yellowish brown setae while in *T. apicalis* covered with yellowish white setae. Although both species have uneven coloration of forewings but can be distinguished because *T. binghami* has a dark brown of 3/4 on basal and semi-transparent of 1/4 on apical part while in *T. apicalis*, 1/2 on basal part is blackish brown. On the other hand, the black mesoscutum of *T. binghami* covered with blackish brown setae while black setae in *T. apicalis*.

CONCLUSION

In overall, a total of 19 species of stingless bee (Apidae: Meliponini) from 8 genera was examined and revised in this study. Genus *Geniotrigona* is known as a largest size of stingless bee. There are two species of stingless bees possess a larger body size than the other which are *Geniotrigona thoracica* (mean body size: 8.44 mm) and *Homotrigona fimbriata* (mean body size: 8.24 mm). Meanwhile, *Tetragonula fuscobalteata* possesses a smallest size of stingless bee (mean body size: 3.26 mm). On the other hand, genus *Lepidotrigona* have a peculiar characteristic which made them discernible by the presence of yellow scale-like on mesoscutum. Besides, *Tetragonula* can be recognized based on bands on mesoscutum, and the differentiation can be made whether it is obviously seen or not in each species. *Tetragonula* is the most abundant genus and recorded most species of stingless bee which being described in this study. Last but not least, 8 out of 14 genera of stingless bees which being recorded in Malaysia were successfully redescibe in this study.

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