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Distribution of Stingless Bee (*Trigona* spp.) from Meliponiculture in South Sumatra Province, Indonesia

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Abstract

This study aims to determine species distribution by observing the stingless bees cultivated by the community in South Sumatra Province using meliponiculture. By visiting boxes and studying the entrance and characteristics of stingless bee hives at each research location, bee samples were obtained in six districts or cities where beekeepers exist. The study was conducted from January 2023 to May 2023. The type of bee species was identified in each culture box, the diameter of the entrance was measured, and the diameters of the honey pot and brood cell pot were measured. A descriptive analysis was performed to gain an overview of each entrance and nest. Based on the identification results, eight different varieties of stingless bees were discovered. Each research site had an unequal distribution of the eight varieties of bees. Lepidotrigona terminata, Heterotrigona itama, Lophotrigona canifrons, Geniotrigona thoracica, Tetrigona apicalis, Tetragonula testaceitarsis, Tetragonula fuscobalateata, and Tetragonula laeviceps are examples of stingless bees. Variations in the size of identified stingless bees affect the size of the hive, brood cell, honey pot, and entrance. The nest, brood cells, honey pot, and entrance grow in proportion to the size of the stingless bee. Differences in the form and size of the entrance can also distinguish between species.

Keywords: *diversity, meliponini, entrance, nest characteristic*

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Introduction

Stingless bees are a potential resource in integrated agricultural operations, including agroforestry, both inside and outside the forest, because they help boost crop quality, quantity, and diversification in addition to maintaining the environment. Stingless bee make up roughly 50% of the pollinators for flowers in the Indo-Malayan and Australian regions. Like honey bee, they reside in colonies and produce honey. These bees are crucial for pollination of thousands of different plant species and play important roles in human culture (Chuttong et al., 2020; Sanchez-Famoso et al., 2022; Bueno et al., 2023).

Stingless bees are one of the pollinator insects that play many roles in pollination and have several advantages over other pollinators, including the ability to visit flowers many times, work in all seasons, visit many flowers at once, and visit only flowers with mature pollen or stigmas that are ready to be fertilized (Basari et al., 2021; Atmowidi et al., 2022).

Stingless bees are more likely than stinged bees to visit cultivated plants. According to Schrader et al. (2017), pollinators are more complicated in plantations bordered by woody plant habitats. Woody habitats boost the number and diversity of nectar and pollen sources. Bee abundance grows as floral resources become more readily available. Woody habitats, forest fragments, and many floral resources, must be maintained and restored to increase pollination services in a mosaic of small-scale rice farming landscapes (Toni et al., 2018).

The South Sumatra Provincial Government is working hard to plan green economic growth for regional advancement. The South Sumatra Province Government continues its efforts to plan for green economic growth to progress in its region. The goal must be to achieve equal growth, foster social, economic, and environmental resilience, maintain healthy and productive ecosystems, provide environmental services, and reduce greenhouse gas emissions. There are at least seven strategies for green economic growth, as listed in the South Sumatra Governor's Decree Number 21/2017 on the Green Economic Growth Master Plan of the Southern Sumatra Province (Pemprov Sumsel, 2017). Firstly, land-use planning. Secondly, we need to enhance the ability of a society, which encompasses five primary sources of livelihood: financial, human, physical, natural, and social resources. Thirdly, by enhancing the productivity of specific commodities and leveraging the advantages of a specific land area, we can prevent further expansion. Fourth, repair the value chain. Developing the connectivity of farm business roads, inter-center production routes, and distribution lines is the fifth step. Sixth, do the restoration. The seventh step involves establishing reward systems for environmental services and implementing innovative funding strategies for sustainable commodities.

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Trigona spp. (meliponiculture) is a method of increasing the productivity of excess commodities by intensifying the use of land through the enrichment of plants as a source of feed. This approach has the overall impact of improving income and environmental quality. Meliponiculture, a method of enhancing the productivity of bee commodities by expanding land use and enriching plants as a food source, has a favorable influence on raising revenue and improving environmental quality (Carvalho-Zilse & Nunes-Silva, 2012).

Meliponiculture refers to stingless beekeeping. This practice, typically performed by communities characterized by local wisdom, is performed according to area knowledge and custom. Meliponiculture is derived from the name of a stingless bee family, Meliponini. Currently, meliponiculture is gaining traction in several countries. Many people started raising stingless bees during the 2000s after learning about the benefits of honey and how to raise them (Buchori et al., 2022). However, there is no information or statistics on the distribution of stingless bee species maintained by breeders to support the South Sumatra policy of developing meliponiculture. So this research aims to find out the distribution of species by observing the stingless bees cultivated by the community in South Sumatra Province using meliponiculture.

Methods

The study was conducted in numerous meliponiculture settings in South Sumatra Province from January 2023 to May 2023. The existence of forest farmer groups cultivating stingless bees, as well as the characteristics of the meliponiculture pattern, were taken into account in the location selection, including: a) meliponiculture in Gunung Megang District and Rambang Niru District, Muara Enim Regency, with location characteristics in the form of rubber and oil palm plantations with annual crops; b) meliponiculture in Rambutan District, Banyuasin Regency, with location characteristics in the form of a lowland area with tidal swamp plants; c) meliponiculture in Batumarta District, East OKU Regency, with location characteristics in the form of rubber plantations around settlements; d) meliponiculture in Rambang Kapak Tengah District, Prabumulih City, with location characteristics of ex-transmigration areas; e) meliponiculture in East Baturaja District, OKU Regency, with location characteristics of plantation crops and bush plants; and f) meliponiculture in Gandus sub-district, Palembang City, with location characteristics around community settlements. The spatial research location is shown in Figure 1.

Materials and tools Bees' identification tally sheet, honey bee, food source plant types, key book for determining bee types, vials, 70% alcohol, camera, stationery, road plank, laptop, calculator, questionnaire, and label paper were all used. Plants that are food sources for bees and samples of *Trigona* spp. Worker bees were used.

Data collection At this step, research was conducted using a qualitative and quantitative survey method. Observations of food supply plants and bee sample collection were carried out in the meliponiculture location, which served as the research site. The existence of active and producing stingless bee breeders determines the site of meliponiculture. Five samples of meliponiculture practitioners were collected at each meliponiculture location.

Determine the various stingless bee species The study involves survey methods that involve visiting the culture box at each research location. Samples of stingless bees were collected at the beekeeping site, which served as the study's research location. bee samples are collected by inserting vials right into the nest funnel at each setup and tapping it until the worker bees fly out. If each sample has been taken individually, the vials are closed, and 70% alcohol is added.

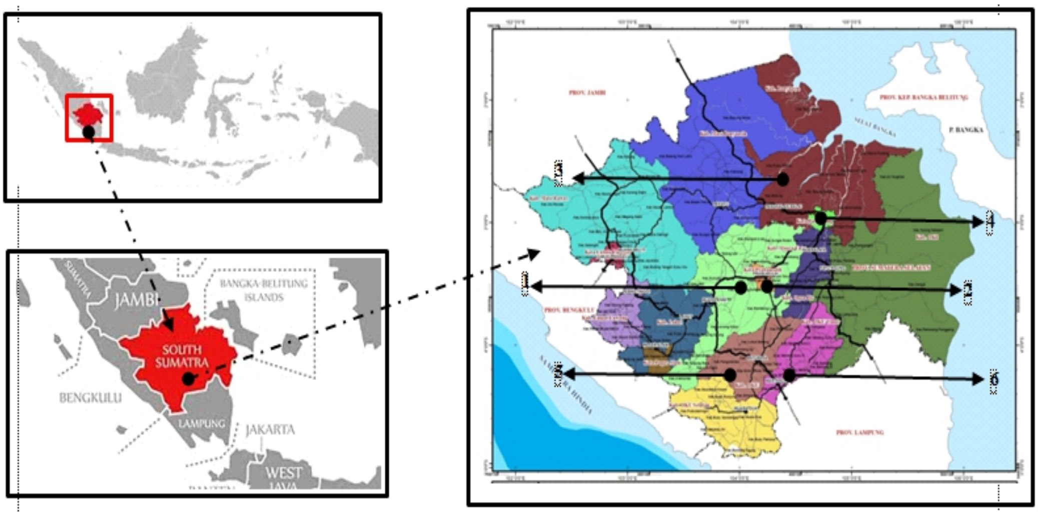

Figure 1 Research locations in South Sumatra Province (S1°S4° and E102°E106°). Image caption: 1. Muara Enim District, 2. Prabumulih City, 3. Palembang City, 4. Banyuasin District, 5. Ogan Komering Ulu District, 6. East Ogan Komering Ulu District.

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Following labeling, the samples are removed for identification. The worker bee samples' complete body, head, thorax, abdomen, and wings were then captured on camera with a high-resolution device. An identification key is utilized to ascertain the characteristics observed, which include the species of bee and morphological descriptions of the bee. The key book for determining stingless bee species is the reference book "Key to Workers of Indo-Malayan Stingless Bees" (Smith, 2012).

Identify entrances and nests Entrances and stingless bee nests were identified by visiting five cultivations boxes at each research location. At each stop, the diameter of the entrance funnel and the diameter of the honey and egg cell pot were measured. In order to get an overview of each entrance funnel and nest, a descriptive analysis was made.

Results and Discussion

Distribution of stingless bees *Trigona* spp. have various names and pronunciations depending on where they are found. The common names for stingless bees include *kelulut* (Malay), *galo-galo* (Minang), *gegalo* (South Sumatra), *teuweul* (Sunda), *klanceng* (Java), *emuk* (Sulawesi), and others (Buchori et al., 2022). Stingless bees in the world have more than 600 species. Stingless bee distribution is separated into three regions: Neotropical, Afrotropical, and Indo-Malay/Australasian (Sakagami et al., 1990). Stingless bees have been discovered in Indonesia in 46 species across 10 genera. Sumatra is home to 23 different species of stingless bees (Sakagami et al., 1990). Some morphological characters that can be observed in stingless bees to differentiate between types are tibia, basitarsus, malar space, mandible, head, clypeus, propodeum, mesoscutum, mesoscutellum, antenna, eyes, gena, forewing, wing venation, hamuli, and color body (head, clypeus, thorax, abdomen, tegula, wings) (Rasmussen et al., 2017).

The research results show that eight stingless bees were found in South Sumatra. A list of the types of bees found in South Sumatra and their comparison with types of bee found on the island of Java and Sumatra as a whole is shown in Table 1.

According to the findings, there were 5 genera consisting of 8 species of stingless bees in South Sumatra. The eight species of stingless bees found in South Sumatra are as follows: *Lepidotrigona terminate* Smith, *Heterotrigona itama* Cockerell, *Lophotrigona canifrons* Smith, *Geniotrigona thoracica* Smith, *Tetrigona apicalis* Smith, *Tetragonula testaceitarsis* Cameron, *Tetragonula*

Table 1 Comparison of the distribution of stingless bee species between South Sumatra, Java, and Sumatra (Sakagami et al., 1990) and South Kalimantan (Purwanto et al., 2022)

No	Stingless bee species	JW	SM	SS	KS
1	*Geniotrigona thoracica*	-	+	+	+
2	*Heterotrigona itama*	+	+	+	+
3	*Homotrigona fimbriata*	-	+	-	-
4	*Lepidotrigona nitidiventris*	+	+	-	-
5	*Lepidotrigona terminata*	-	+	+	+
6	*Lepidotrigona trochanterica*	-	+	-	-
7	*Lepidotrigona ventralis*	-	+	-	-
8	*Lophotrigona canifrons*	-	+	+	+
9	*Lisotrigona scintillans*	-	+	-	-
10	*Tetragonula atripes*	-	+	-	-
11	*Tetragonula biroi*	-	-	-	+
12	*Tetragonula colina*	-	+	-	-
13	*Tetragonula drescheri*	+	+	-	+
14	*Tetragonula fuscibasis*	-	+	-	-
15	*Tetragonula fuscobalteata*	+	+	+	+
16	*Tetragonula melina*	-	+	-	-
17	*Tetragonula reepeni*	-	+	-	-
18	*Tetragonula laeviceps*	+	+	+	+
19	*Tetragonula melanocephala*	-	-	-	+
20	*Tetragonula minangkabau*	-	+	-	-
21	*Tetragonula minangkabau f. darek*	-	+	-	-
22	*Tetragonula testaceitarsis*	-	-	+	-
23	*Tetrigona apicalis*	+	+	+	+
24	*Trigonella moorei*	-	+	-	-
25	*Trigonella lieftincki*	-	+	-	-
26	*Pariotrigona pendleburyi*	-	+	-	-
	Total	6	23	8	10

Note: JW = Java, SM = Sumatra, SS = South Sumatra, KS = South Kalimantan, + = found, - = not found.

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fuscobalateata Cameron, and *Tetragonula laeviceps* Smith. The distribution of stingless bees at meliponiculture sites in South Sumatra can be seen at Table 2.

To differentiate between species, several morphological characters that can be observed in stingless bees are: tibia, basitarsus, malar space, mandible, head, clypeus, propodeum, mesoscutum, mesoscutellum, antenna, eyes, gena, forewings, wing venation, hamuli, and body-color (head, clypeus, thorax, abdomen, tegula, wings) (Michener, 2007). All species of stingless bees gathered from the worker group are then photographed to allow identification and description of the stingless bees obtained as follows:

***Geniotrigona thoracica* Smith** Beekeepers call it *kelulut kijang*, the largest of the stingless bees identified at the research site, with an average worker bee size of 7.58 mm from five species. Visual qualities include: The head of *G. thoracica* is yellowish brown, while the thorax is yellowish

Table 2 Location of stingless bee sample collection and species of bees found

Location	Coordinat	Species
1. Muara Enim District		
Sumaja Makmur Village	E103°57′5.622″	*Tetrigona apicalis* (Smith, 1857)
Subdistrict Gunung Megang	S3°32′5.622″	*Tetragonula fuscobalteata* (Cameron, 1908)
		Tetragonula laeviceps (Smith, 1857)
Aur Duri Village	E103°56′50.395″	*Tetrigona apicalis* (Smith, 1857)
Subdistrict Rambang Niru	S3°38′56.504″	*Tetragonula fuscobalteata* (Cameron, 1908)
		Tetragonula laeviceps (Smith, 1857)
		Heterotrigona itama (Cockerell, 1918)
Tebat Agung Village	E104°3′46.558″	*Tetragonula fuscobalteata* (Cameron, 1908)
Subdistrict Rambang Niru	S3°27′21.242″	*Tetragonula laeviceps* (Smith, 1857)
Banuayu Village	E104°2′32.036″	*Tetragonula fuscobalteata* (Cameron, 1908)
Subdistrict Rambang Niru	S3°24′39.28″	*Tetragonula laeviceps* (Smith, 1857)
Marga Mulya Village	E104°4′20.363″	*Tetragonula laeviceps* (Smith, 1857)
Subdistrict Rambang	S3°37′25.608″	
2. OKU District		
Tanjung Baru Village	E104°13′19″	*Lepidotrigona terminata* (Smith, 1878)
Subdistrict Baturaja Timur	S4°9′5″	*Heterotrigona itama* (Cockerell, 1918)
		Geniotrigona thoracica (Smith, 1857)
		Lophotrigona canifrons (Smith, 1857)
Lekis Rejo Village	E104°16′50.365″	*Geniotrigona thoracica* (Smith, 1857)
Subdistrict Lubuk Raja	S4°6′21.743″	*Heterotrigona itama* (Cockerell, 1918)
3. OKU Timur District		
Sukaraja Village	E104°22′46″	*Geniotrigona thoracica* (Smith, 1857)
Subdistrict Buay Madang	S4°7′29″	*Heterotrigona itama* (Cockerell, 1918)
Batumarta X Village	E104°21′33.079″	*Lepidotrigona terminata* (Smith, 1878)
Subdistrict Madang SK III	S4°6′50.834″	*Geniotrigona thoracica* (Smith, 1857)
		Heterotrigona itama (Cockerell, 1918)
4. Prabumulih City		
Patih Galung Village	E104°9′23″	*Tetrigona apicalis* (Smith, 1857)
Subdistrict Prabumulih Barat	S3°27′31″	*Tetragonula fuscobalteata* (Cameron, 1908)
		Tetragonula laeviceps (Smith, 1857)
		Lepidotrigona terminata (Smith, 1878)
		Heterotrigona itama (Cockerell, 1918)
		Geniotrigona thoracica (Smith, 1857)
		Tetragonula testaceitarsis (Cameron, 1901)
		Lophotrigona canifrons (Smith, 1857)
Karya Mulya Village	E104°9′56.907″	*Tetrigona apicalis* (Smith, 1857)
Subdistrict Rambang Kapak	S3°31′35.32″	*Tetragonula fuscobalteata* (Cameron, 1908)
Tengah		*Tetragonula laeviceps* (Smith, 1857)
5. Banyuasin District		
Talang Lembak Village	E104°55′19″	*Geniotrigona thoracica* (Smith, 1857)
Subdistrict Rambutan	S3°7′48″	*Heterotrigona itama* (Cockerell, 1918)
Sungai Gerong Village	E104°51′35.938″	*Geniotrigona thoracica* (Smith, 1857)
Subdistrict Banyuasin I	S2°58′42.326″	*Heterotrigona itama* (Cockerell, 1918)
Kenten Laut Village	E104°48′21.626″	*Geniotrigona thoracica* (Smith, 1857)
Subdistrict Talang Kelapa	S2°51′25.594″	*Heterotrigona itama* (Cockerell, 1918)
6. Palembang City		
Pulokerto Village	E104°44′46″	*Geniotrigona thoracica* (Smith, 1857)
Subdistrict Gandus	S2°55′15″	*Heterotrigona itama* (Cockerell, 1918)

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black and coated in thick yellowish-brown hair. The abdomen is black and covered in delicate feathers. Forewing coloration varies; wing venation is dark brown but somewhat brown apically and semitransparent at the tip (Figure 2).

According to Samsudin et al. (2018), that *G. thoracica* is a stingless bee that is relatively large, measuring 8.12–8.65 mm (average: 8.44 mm). The difference in size of a worker bee is a form of morphological adaptation to different environmental conditions Temperature or environmental conditions would cause living creatures to morphologically adapt as a form of adaptation of flying activity and feed them to the environment (Soraye et al., 2020).

***Heterotrigona itama* Cockerell** Because of its mostly black coloring, it is also known as *kelulut beruang*. *H. itama* is an aggressive species that attacks when threatened. *H. itama* worker bees had an average size of 5.17 mm. Visual traits include a primarily black head color. On the front, the thorax is black, tougher, and covered with long, silvery-white hairs. The fur on the abdomen is evenly black throughout. The hue of the forewings is consistent, and the wing venation is dark brown and semitransparent (Figure 3.). *H. itama* is a sort of stingless bee most commonly found in forests, is aggressive, and has a body size of 6.15 mm (Jalil & Shuib, 2012).

***Lepidotrigona terminate* Smith** Beekeeper in South Sumatra often call it *kelulut kuning*, which has an average size of 4.15 mm. The worker bee Lepidotrigona terminata has a black head and thorax. The mesonotum is covered with short thick, yellowish hairs. The scutellum is short, reaching only the metanotum. The color of the forewings is uniform and semi-transparent. Eight hamuli per hind wing. The posterior border of the hind tibia is simple (unbranched). Fore and middle tibia and basitarsi are black. The hind legs are black (Figure 4).

The morphology of this bee is also dominated by black and yellow, on the thorax and abdomen. The body length of this bee is 5.05 mm, mandible length is 0.73 mm and width is 0.22 mm. The eyes are brownish black. Clypeus is black and covered in off-white or silver hair. The ocellar is blackish with a few fine hairs. Scape and antennae are black or brownish-black with yellow hairs at the margins of the flagellomer. The base of the scape is brownish yellow while the antenna tip is reddish brown (Suprianto, 2020).

***Lophotrigona canifrons* Smith** *L. canifrons* is often called *kelulut sri gunting*, because its bite is quite hard. Visual characteristics: worker bees with an average size of 6.15 mm are predominantly black; the head and body are predominantly black. The thorax is black, rougher, and covered with long hairs at the front. On the head, there is a small white part. There are two strong teeth on the jaw. The forewing color is uniform and semi-transparent, and the forewing venation is dark brown (Figure 5). *L. canifrons* exhibits a substantial size range of 6.25–8.30 mm, with an average of 7.12 mm (Samsudin et al., 2018).

***Tetragonula fuscobalateata* Cameron** Beekeepers refer to this stingless bee as *kelulut posco*, and worker bees have an average size of 2.35 mm. Visual features include six golden

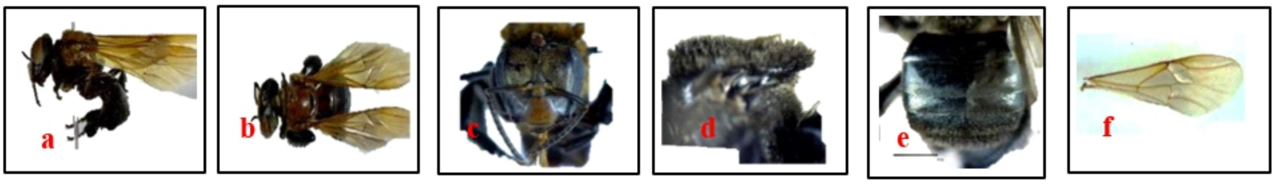

Figure 2 *Geniotrigona thoracica.* a) whole body side view, b) whole body view above, c) head, d) thoracic section, e) abdomen, f) wing cross section.

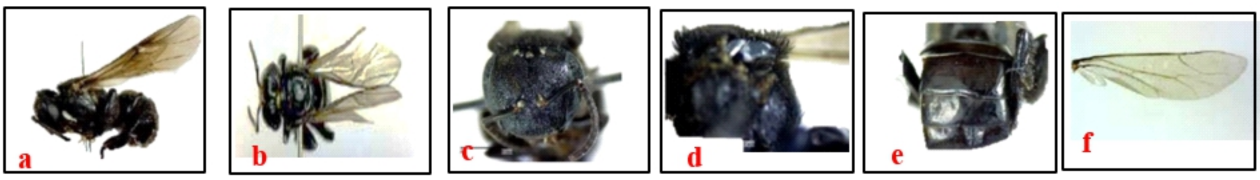

Figure 3 *Heterotrigona itama*. a) whole body side view, b) whole body view above, c) head, d) thoracic section, e) abdomen, f) wing cross section.

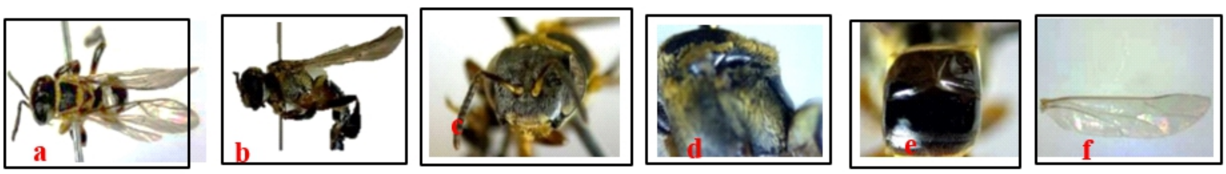

Figure 4 *Lepidotrigona terminata*. a) whole body side view, b) whole body view above, c) head, d) thoracic section, e) abdomen, f) wing cross section.

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longitudinal bands on the thorax, particularly the mesonotum. Body color is bicolor. The thorax is black, with a yellowish and brownish abdomen. The wings are uniform and semi-transparent (Figure 6).

T. fuscobalateata is a stingless bee that belongs to the Tetragonula genus, just like *Tetragonula laeviceps*. The trigona type in the Tetragonula genera has easily detectable traits, such as a tiny body size compared to the Heterotrigona genera; this type of trigona is 4 mm. This small body size makes this type easy to breed because this type does not require a large space for nesting and can survive in food-poor areas (Astiani & Indrayani, 2022).

Tetragonula laeviceps **Smith** Beekeepers refer to it as *kelulut nasi*. Visual characteristics: worker bees are petite, with an average size of 3.65 mm and a primarily black body color. The head and thorax are completely black. It has two reddish-red antennas. The color of the abdomen is brown. The forewings are semi-transparent and homogeneous in color (Figure 7).

T. laeviceps body is predominantly glossy black, the mesoscutum is black and completely covered with yellowish setae posteriorly. Number of hamuli 5 per hind wing. In nature, these bees have morphometric sizes that vary from one region to another. These bees can also be found in almost all habitats or locations ranging from dead tree trunks, bamboo, and building houses with a distance of about 15 m from the ground. The nest structure consists of a nest entrance in a tube surrounded by a blackish resin. The entrance funnel is in the form of an inner and outer tube as a way for the bees to enter and leave the hive internally (Chinh et al., 2005; Purwanto et al., 2022).

Tetragonula testaceitarsis **Cameron** *T. testaceitarsis*, with an average size of 4.47 mm for worker bees, is called *kelulut matahari* by beeepers due to the form of the nest funnel resembling the sun. The head and thorax are completely black. The abdomen is a dark brown color. The wings are semi-transparent and uniformly pigmented (Figure 8).

T. testaceitarsis is the most comparable to *T. geissleri* without mesoscutum hairy bands. *T. testaceitarsis*, on the other hand, has white hair fronts, whereas *T. geissleri* has fawn hair fronts. The color of the scape, brown in T. *testaceitarsis* and yellowish brown in *T. geissleri*, is one of the characteristics that distinguish these two species. The length of the tibia in *T. testaceitarsis* is 1.63–1.70 mm (average: 1.67 mm), slightly shorter than *T. geissleri* 1.60–2.00 mm (average: 1.81 mm). The abdominal coloration of T. *testaceitarsis* is usually black and blackish brown in certain individuals but is dark brown in individuals of *T. geissleri* (Samsudin et al., 2018).

Tetrigona apicalis **Smith** Worker bees with an average size of 5.25 mm are also known as *kelulut damar*, because they nest a lot in hollow resin trees. The body and thorax are predominantly black. There is a marked difference in wing coloration, being blackish-brown at the base and semi-transparent apically. On the hind wings there are 7 hamuli. The posterior border of the tibia is unbranched (Figure 9). There are black hairs on the body. The scutellum is short, reaching only the metanotum (Purwanto et al., 2022).

Based on overall identification results, the *Tetragonula* genus is the most prevalent type in South Sumatra meliponiculture locales. According to cultivators, this is because the *Tetragonula* genera have many prolific species

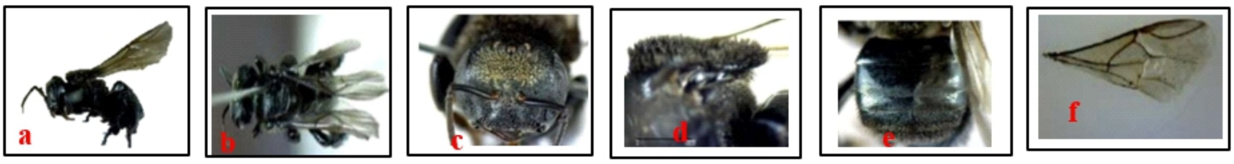

Figure 5 *Lophotrigona canifrons*. a) whole body side view, b) whole body view above, c) head, d) thoracic section, e) abdomen, f) wing cross section.

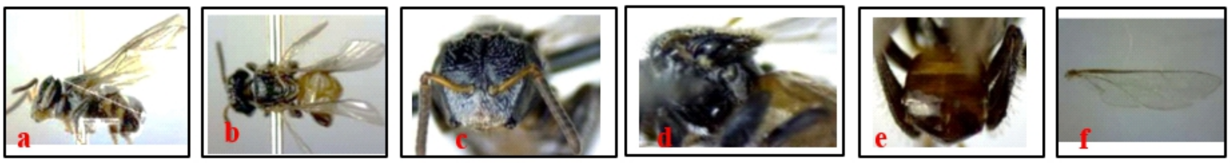

Figure 6 *Tetragonula fuscobalateata*. a) whole body side view, b) whole body view above, c) head, d) thoracic section, e) abdomen, f) wing cross section.

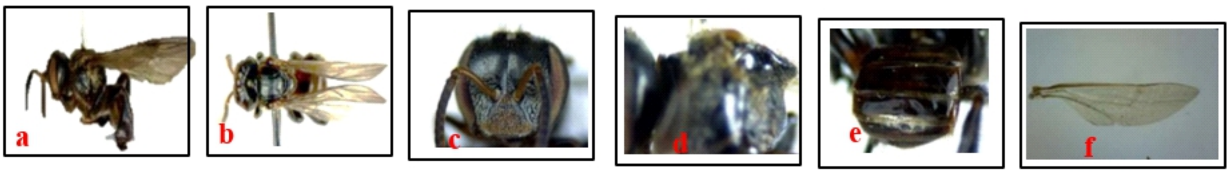

Figure 7 *Lophotrigona canifrons*. a) whole body side view, b) whole body view above, c) head, d) thoracic section, e) abdomen, f) wing cross section.

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that are found more frequently in nature. This species survives better than others despite its modest size. The scarcity of food sources is a key impediment to breeding stingless bees. When there is a famine, most bred bees will move quickly, not the *kelulut* type from the *Tetragonula* genus.

The trigona species in the *Tetragonula* genus has easily detectable traits, such as a tiny body size compared to the *Heterotrigona* genus; this type of trigona is 4 mm. Because this species does not require a large amount of nesting space and can survive in food-poor areas, its small body size makes it easier to reproduce (Astiani & Indrayani, 2022). *T. laeviceps* type is a kelulut with a regular body size but is exceptionally tough compared to other varieties of *kelulut* and can survive in low-nutrient environments and even at high temperatures (Sanjaya et al., 2019).

Nest and entrance characteristics Variations in the size of identified stingless bees affect the size of the hive, brood cells, honey pot, and entrance. Differences in the form and size of the in-and-out funnels can also distinguish between stingless bee species. Apart from the wider shape of the nest, the entrance to this nest has a dark brown color and reaches 20 mm, as in the *H. itama* type. *H. itama* has several entrances because this form of trigona can easily adapt to diverse nesting media (Sanjaya et al., 2019). Hence, this type of trigona must modify the building of the nest door to the requirements of different nesting media.

All eight species identified have different in-out-funnel forms and nest morphologies. Figure 10 depicts the differences in funnels entering and departing the stingless bee nest, whereas Figure 11 depicts the differences in nest shape. Table 3 shows a comparison of the size and parameters of the nest and the entry funnel.

The bee *Trigona* sp. lives in colonies by building nests in wooden or bamboo tree trunks, pillars, and crevices in rocks

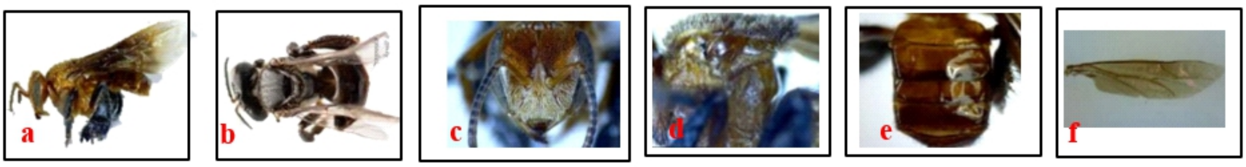

Figure 8 *Tetragonula testaceitarsis*. a) whole body side view, b) whole body view above, c) head, d) thoracic section, e) abdomen, f) wing cross section.

Figure 9 *Tetrigona apicalis*. a) whole body side view, b) whole body view above, c) head, d) thoracic section, e) abdomen, f) wing cross section.

Figure 10 Various forms of stingless bee entrance in South Sumatra. a) *Geniotrigona thoracica*, b) *Heterotrigona itama*, c) *Lepidotrigona terminata*, d) *Tetragonula apicalis*, e) *Tetragonula fuscobalteata*, f) *Tetragonula testaceitarsis*, g) *Tetragonula laeviceps*, h) *Lophotrigona canifrons*.

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Figure 11 Various forms of stingless bee nests in South Sumatra. a) *Geniotrigona thoracica*, b) *Heterotrigona itama*, c) *Lepidotrigona terminata*, d) *Tetragonula apicalis*, e) *Tetragonula fuscobalteata*, f) *Tetragonula testaceitarsis*, g) *Tetragonula laeviceps*, h) *Lophotrigona canifrons.*

Table 3 Comparison of the size and characteristic of the nest and entrance of the stingless bees at South Sumatera

Stingless bee species	Entrance size (mm)	Honey pot size (mm)	Brood cell size (mm)	Entrance characteristics	Nest characteristics
Geniotrigona thoracica	27.7	23.2	3.6	In the shape of a single cylindrical hole surrounded by a thick covering	It has an irregular circular shape and comprises an entry route, a pot for storing larvae, a pot for storing honey and pollen, and trails that look like roots and branches.
Heterotrigona itama	15.9	18.9	2.2	The entrance is shaped like an elephant's trunk, with a delicate texture and narrow size, and there is propolis on the outside.	Round in shape, with an entry route, a pot for keeping larvae, a pot for storing honey and pollen, and resin and propolis-based trails that resemble roots and branches.
Lepidotrigona terminata	16.1	13.3	1.8	The trumpet shape is bone white, 3–4 cm long, and has a smooth and thin feel.	It has a spherical form and comprises an entry route, a pot for keeping larvae, a pot for storing honey and pollen, and trails that look like reddish-brown roots and branches.
Lophotrigona canifrons	17.4	16.2	2.4	It has a delicate, thin feel and is extended like a white pipe.	The nest comprises pyramid-shaped egg cells in the center, encircled by a big honey pot, and neatly placed in the pattern of a merged hexagon.
Tetragonula laeviceps	12.3	7.0	1.2	It is blackish brown and is stretched downwards with a velvety and branching texture.	The nest comprises a pot of honey and pollen, as well as egg cells placed vertically or linked to the nest wall. The honey pot is blackish-brown.
Tetragonula testaceitarsis	19.4	6.4	3.4	Colored holes that are reddish yellow or black and resemble the sun	The nest comprises a honey and pollen pot and an egg cell pot. Honey and pollen pots are built at the bottom of the nest, while egg cells are built at the top.
Tetrigona apicalis	30.2	7.2	3.5	Shaped like an elephant's trunk, 5–6 cm long, yellowish gray with a soft texture	The nest comprises a pot of honey and pollen, as well as egg cells placed vertically or linked to the nest wall. The egg cells are brownish-yellow in hue.

and soil (Iqbal et al., 2016). The entrance serves as a marking for the nest and a point of admission and escape for bees. Similarly, the *Trigona* sp. beehive is built on stones comprising a resin, earth, and mud mixture that protects the nest from shocks (Michener, 2007). *Trigona* sp.'s nest comprises various tree sap exudates/resins, a mixture of wood dust, and small stones that protect against predator attacks.

Syafrizal et al. (2020) mention that each basic nest construction material is unique to each *Trigona* sp. bee, with color and aroma determined by the species of plant from which the resin is extracted. The size of the entrance to the beehive is determined by the size of the bee's body. The larger the bee's body size, the larger the entrance to the beehive.

Conclusion

There are eight species of stingless bees that were discovered in South Sumatera Province, namely *L. terminata, H. itama, L. canifrons, G. thoracica, T. apicalis, T. testaceitarsis, T. fuscobalateata*, and *T. laeviceps*. The stingless bee *H. itama* was present in all meliponiculture places because growers believed it was a prolific stingless bee with high honey production. Variations in the size of identified stingless bees affected the size of the hive, brood cell, honey pot, and entrance. Differences in the types of stingless bees were also reflected in the entry funnel, as well as the characteristics of the nest, which includes a honey pot, pollen pot, brood cell pot, and their arrangement.

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