

The diversity of honey bee and entrance characteristics of stingless bees nests at a meliponiculture in Batu Gadang, West Sumatra.

Melda Yunita Sari¹, Henny Herwina^{1*}, Suat Cheng Tan³, Mairawita Mairawita¹, Muhammad Nazri Janra¹, and Jasmi Jasmi²

¹Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Andalas. Limau Manis, Padang 25163, West Sumatra, Indonesia.

²STIKES Indonesia, Jl. Khatib Sulaiman No. 17, Padang, 25173, West Sumatra, Indonesia.

³School of Health Science, Health Campus, Universiti Sains Malaysia, 16150 Kubang Kerian, Kelantan, Malaysia

Abstract. Honey bees, consist of true honey bee bees and stingless bees, are common in Indonesia. This study aimed to do the inventory on honey bee species as well as to study the entrance characteristics of stingless bee nests that exist at the meliponiculture in Batu Gadang, Padang Pariaman Regency, West Sumatra. Specimen sampling had been directly conducted at bee colonies, while the entrances of stingless bee nests were measured and described for their characteristics. As result, this study recorded one true honey bee *Apis cerana* and five stingless bee species from total 37 colonies surveyed. *Heterotrigona itama* became the most abundant stingless bee with 23 colonies, followed by *Lepidotrigona terminata* (in four colonies), *Geniotrigona thoracica* (in three colonies). Two *Tetragonula* members, *laeviceps* and *fuscolbaeata* were observed from one colony each. The entrances of stingless bee are characterized with 2 to 30 cm length, 1 to 5 mm, and 19 to 187 cm height from ground surface.

1 Introduction

One of the most dominant pollinating insects is the bee. Honey bees are insects from the order Hymenoptera with vast distribution, feeding on nectar and pollen from flowering plants [1]. Bees play crucial role as pollinator that help maintaining ecosystem sustainability and increasing agricultural productivity. Honey bees are divided into stinging honey bees and stingless honey bees. Aside from its anatomical differences, true honey bees such as *Apis mellifera* uses its sting with subsequent lethal consequence, whereas stingless bees use biting or spraying acidic liquid when threatened. Stingless honey bees had greater diversity compared to true *honey* bees, with 556 described species. These bees are known to store food in the form of honey, which can be cultivated by humans [2].

In Indonesia, there are 46 species of stingless bee from nine genera distributed across the archipelago [2]. Several species from genus *Apis* that were introduced from Australia also

* Corresponding author: hennyherwina@sci.unand.ac.id

exist in Indonesia, including *A. andreniformis*, *A. dorsata*, *A. cerana*, *A. koschevnikovi*, *A. nigrocincta*, and *A. mellifera*. As a tropical country, Indonesia has the highest diversity of stingless bees in the world [1]. Honey from bees has long been utilized by people for its benefits, particularly as a traditional remedy for diseases such as influenza, burned-skin infections cough or for its economic value [3].

In Batu Gadang, Padang Pariaman Regency of West Sumatra Province, bee cultivation groups have been established for over the past three years. Unfortunately, information regarding the diversity of honey bees and other pertinent aspects such as nest entrance characteristics are limited. The lack of information on stingless bees and their cultivation may hinder effective nest management and conservation efforts. Therefore, this study was conducted to document the species present, describe their nest entrance characteristics, and provide baseline information to support improved management and conservation of stingless bees.

2 Material and methods

2.1 Study sites and Sampling Method

This research had been conducted in meliponiculture in Batu Gadang, Padang Pariaman Regerency, West Sumatra (-0.4459811, 100.0672087) (Figure 1). Field survey spanned from April – Jun 2021, using direct sampling. Method to collect bee specimens from the colonies found in this area. Meanwhile the entrances of stingless bee nests were directly surveyed, measured, and described.

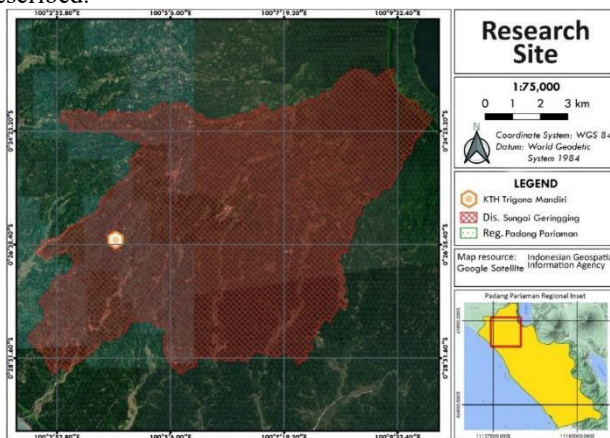


Fig. 1. Study site at meliponicultures in Batu Gadang, Padang Pariaman Regerency, West Sumatra

2.2 Data Analysis

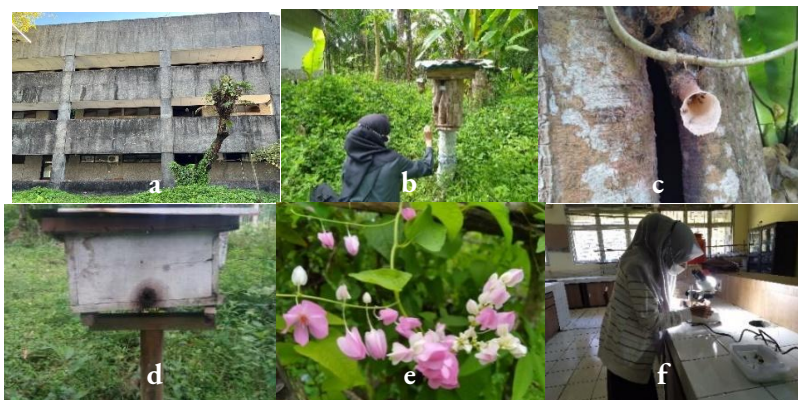


Fig. 2. Honey bee survey and identification. (a) Laboratory identification at the Animal Taxonomy Lab, Andalas University; (b) worker bees were collected at the colony entrance; (c) nest entrance for the colony; (d) measurement of nest entrance colour, texture, length, diameter, and height; (e) *Antigonon leptopus* flora surrounding the colony; (f) morphological observation of specimens under a microscope for species identification.

The identification process was performed at the Laboratory of Animal Taxonomy, Biology Department, Faculty of Mathematics and Natural Sciences, Andalas University (Figure 2a). To identify honey bee species, several workers bees were collected at the colony entrance (Figure 2b and c) and stored in vials containing 70% ethanol. The survey method was used to locate and measure the characters of entrance of stingless bees. Observation was then made onto the nest entrance which included its colour (brown, light brown, or black), and texture (soft or hard) (Figure 2d). Measurement of the nest entrance included its length, diameter and height above the ground. It was found that the surrounding area of the farm was populated with *Antigonon leptopus* flora (Figure 2e). Bee specimens were observed for their morphological characters using microscope (Figure 2f) which then used for identification purpose. The specimen was then mounted and photographed. Identification process guided with proper reference for West Sumatra [4]. The data of nest entrance measurements and observation were then descriptively and thoroughly discussed.

3 Result and discussions

There were four genera and five species of stingless honey bee, in addition to one true honey bee species recorded in Batu Gadang (Table 1). *Heterotrigona itama* was the commonest among all, found at 23 colonies. Other stingless bees, *Lepidotrigona terminata* was observed from four colonies, *Geniotrigona thoracica* from three colonies, while both *Tetragonula laeviceps* and *Tetragonula fuscobalteata* from only one colony each. *Heterotrigona itama* and *Geniotrigona thoracica* were the only stingless bee species colonized artificial nests, whereas the other three were found nesting in natural nesting sites. These five were 28% of total West Sumatra stingless bees ever recorded [5]. The only honey bee species found was *Apis cerana* and it was found from four colonies.

Table 1. Detail on honey bee in Meliponiculture Batu Gadang Padang Pariaman

No	Species	Number of Colony per Site		Total
		Artificial Nest	Natural Nest	

Stingless Bee				
1	<i>Heterotrigona itama</i> (Cockerell, 1918)	23	-	23
2	<i>Lepidotrigona terminata</i> (Smith, 1878)	-	4	4
3	<i>Geniotrigona thoracica</i> (Smith, 1854)	3	-	3
4	<i>Tetragonula fuscobalteata</i> (Cameron, 1908)	-	1	1
5	<i>Tetragonula laeviceps</i> (Smith, 1857)	-	1	1
True Honey Bee				
6	<i>Apis cerana</i> (Fabricius, 1793)	2	2	4

Table 1 indicates that *H. itama* as the most abundant honey bee species cultivated in Batu Gadang as it was observed from 23 colonies that all artificial. This is due to their nesting preference in artificial nests increase effectiveness for further colony development (i.e., splitting) and improve the community meliponiculture scope. It is prioritized for breeding in meliponiculture as having high adaptability, productivity, as well as prone to inhabit various nesting places [5]. In this study, *H. itama* was observed to have total body length ranging from 6.5 to 9 mm. Morphologically, the specimen has a black body with hairy tomentum on the mesopleura, and each side appears silvery (Figure 3a); it resembles a black fly at first glance. Its nest entrance shapes like elephant trunk or trumpet [6].

The second most common honey bee in Batu Gadang was *L. terminata*. It is favourable among breeders due to its high productivity, despite having relatively small body. *L. terminata* in this study had body length 6.5 to 9 mm. Its head black, thorax with yellow patch (Figure 3b). It is easily recognized by the arrangement of hairs forming a yellow or white ring on the outside of mesoscutum and semicircular yellow hairs on the compound eyes and ocelli black [7].

The next most common honey bee in Batu Gadang was the stinging honey bee *A. cerana*. This true honey bee has been a priority stinging honey bee species in Batu Gadang, as it has great production capacity for honey. In this study, *A. cerana* measured to have 11 - 12 mm body length, which may be different with the body size of its population in other locations [8]. Specimen in this study appeared to be black in color, head and thorax covered with yellow hairs, abdomen yellow with a blackish patch (Figure 3c).

Stingless bee *G. thoracica* was the fourth favourable honey bee in Batu Gadang as it has considerable honey production, similar to what reported in many previous studies [9], which becomes main reason its popularity in meliponiculture industry. Specimens of *G. thoracica* in this study appeared to have smooth and shiny abdomen tinted with dark brown. Total body length, including wings, 11-12 mm (Figure 3d).

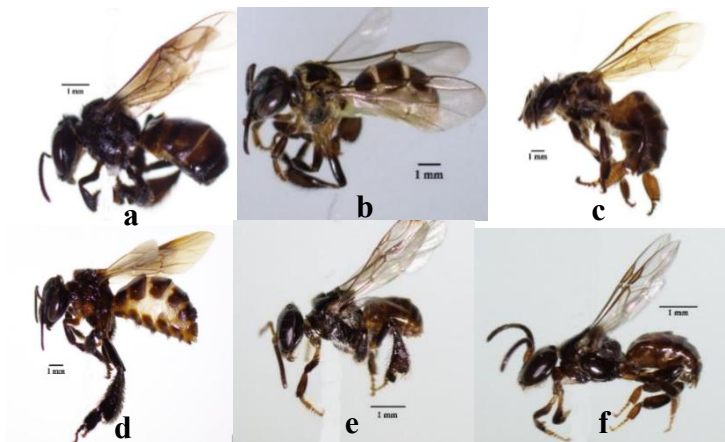


Fig. 3. Morphology of forager honey bees in Batu Gadang. a. *Heterotrigona itama*, b. *Lepidotrigona terminata*, c. *Apis cerana* d. *Geniotrigona thoracica*, e. *Tetragonula fuscobalteata*, f. *Tetragonula laeviceps*

Two species of *Tetragonula* were recorded in this research, *T. fuscobalteata* and *T. laeviceps*; *T. fuscobalteata* was the smallest species among other recorded species with average body length 4.5-5 mm (Figure 3e). Its workers with blackish brown body, mesoscutum consists of 6 longitudinal hairs, each separated by 5 conspicuous glabrous, clypeus pale, anterior hind limbs with silvery gray fringe hairs, abdomen pale, teeth dark brown [10].

T. laeviceps with 5-5.5 mm body length. Body black and hairy with brown compound eyes (Figure 3f). Thorax black with hairy mesoscutum and indistinct hair band pattern, mesoscutellum protrudes backwards until propodeum (first segment of the abdomen). Propodeum black, smooth, and shiny. Wings transparent wings, legs black and hairy (plumose). Posterior basitarsus oval with fine hair (sericeous) [11]. This species is common in West Sumatra, yet its small body and less honey production make it less favourable choice for breeding [12].



Fig. 4. Nest entrance of stingless bee colony in Batu Gadang; a. *Heterotrigona itama*, b. *Geniotrigona thoracica*, c. *Lepidotrigona terminata*, d. *Tetragonula laeviceps*, e. *Tetragonula fuscobalteata*

The nest entrance in a stingless bee colony facilitates the in-and-out movements of hive members, as well as become its unique character. Its shape varies from funnel-shaped, irregularly rounded, to stump (without protrusion). Nest entrance has always sticky edge structure; it also serves as hive marker. The nest entrance is composed of various tree sap, resins, a mixture of sawdust, and small stones; all combined to provide defence against predators. The variability of composing material for nest entrance influences not only its shape, but also coloration and aroma. The size of entrance is connected to the size of stingless bees inhabiting the colony [13].

The nest entrance of *H. itama* has thin and soft texture, heavily smudged with propolis serve to trap predators, while the workers fly around it. Its colour is yellow gold, brown, or black (Figure 4a). The entrance forms a sort of long funnel with wide to slender surface. The length of nest entrance reaches 2 to 5 cm, with nest diameter 1 to 5 cm (Table 2).

In *G. thoracica* colonies, the nest entrances shape was round, full with prominent granules made from resin. The entrance is light brown or black (Figure 4b). The size swere from 3 to 5 cm, with diameter 2 to 5 cm, and 68-118 cm from ground (Table 2). This study did not provide any information regarding the nests or nest entrances of wild colonies of *H. itama* and *G. thoracica* in this study.

Nest entrances of *L. terminata* colonies were all wild colonies that inhibited holes or crevices in trees and rocks with elongated tube-shaped entrance, resembling funnel or trumpet. The colonies of *L. terminata* prefer natural nesting sites available at trees of coconut, kapundung, and bitter bean. The nest entrance with wide, light brown tip that soft and sticky in texture (Figure 4c). *L. terminata* colonies measured 11 to 30 cm length, with diameter 2 to 3.2 cm, and 84 to 187 cm from ground (Table 2).

The nest entrance of *T. laeviceps* colonies were funnels long like a trumpet and yellow in color, surrounded by several workers around the opening (Figure 4d). The size was 2.5 cm length 2 cm diameter, and 185 cm from ground (Table 2).

On the other hand, for *T. fuscobalteata* colonies, the nest entrance shaped like funnel with curved tip and yellow in colour (Figure 4e). The length of entrance is 3 cm, 3 cm diameter, and 73 cm from ground (Table 2).

Table 2. The dimension of nest entrance of stingless bee colonies in Batu Gadang

No	Species	Length of entrance	Entrance diameter	Height from ground	Colony placing	
					Artificial site	Natural site
1	<i>Heterotrigona itama</i>	2-5	1-5	19-129	23	-
2	<i>Geniotrigona thoracica</i>	3-5	2-5	68-118	3	-
3	<i>Lepidotrigona terminata</i>	11-30	2-3.2	84-187	-	4
4	<i>Tetragonula laeviceps</i>	2.5	2	185	-	1
5	<i>Tetragonula fuscobalteata</i>	3	3	73	-	1

This study recorded total 32 plant species from 21 families. Many of these plants, such as coconut, durian, rambutan, and some other wild species provide food source for stingless bees (Table 3). Plants from Arecaceae, Malvaceae, and Anacardiaceae families dominated vegetation community at study site. Trees like *Cocos nucifera*, *Durio*, *Mangifera indica*, and *Nephelium lappaceum* produced both nectar and pollen used by stingless bees. The trees *Elephantopus scaber*, *Zinnia elegans*, and *Oxalis debilis* were observed to supplement food whenever lack of resources provided by the main food sources. According to previous studies, plants that resource nectar, pollen, or resin considered to be important to sustain stingless bee colonies [14]. The availability of food sources is an important factor that influenced the success of honey bee breeding, from which then bee products produced [15].

Table 3. Plant diversity at the surrounding of bee farm in Batu Gadang

No	Plant Identity			Type of Resources
	Family	Species	Local Name	
1	Acanthaceae	<i>Asystasia gangetica</i>	Rumput Israel	Nectar
2	Anacardiaceae	<i>Mangifera indica</i>	Mangga	Nectar
3		<i>Mangifera odorata</i>	Kwuini	Nectar/pollen
4		<i>Spondias dulcis</i>	Kedondong	Nectar/pollen
5	Arecaceae	<i>Cocos nucifera</i>	Kelapa	Nectar/pollen
6		<i>Areca catechu</i>	Pinang	Nectar/pollen
7		<i>Elais guinensis</i>	Kelapa sawit	Pollen
8	Asparagaceae	<i>Agave cantula</i>	Nanas	Nectar
9	Asteraceae	<i>Zinnia elegans</i>	Zinnia Anggun	Pollen
10		<i>Elephantopus scaber</i>	Tapak Liman	Nectar
11	Caricaceae	<i>Carica papaya</i>	Pepaya	Pollen
12	Fabaceae	<i>Archidendrom jiringa</i>	Jengkol	Nectar
13		<i>Mimosa pudica</i>	Putri Malu	Pollen
14	Iridaceae	<i>Eleutherine bulbosa</i>	Bawang Dayak	Nectar
15	Lauraceae	<i>Persea americana</i>	Alpukat	Nectar
16	Lythraceae	<i>Cuphea hyssopifolia</i>	Taiwan Beauty	Nectar
17	Malvaceae	<i>Durio zibethinus</i>	Durian	Pollen
18		<i>Theobroma cacao</i>	Coklat	Nectar

19		<i>Hibiscus rosa-sinensis</i>	Kembang Sepatu Cina	Pollen
20	Melastomataceae	<i>Melastoma malabathricum</i>	Senduduk	Nectar
21	Meliaceae	<i>Lansiu domesticum</i>	Langsat	Nectar
22	Moraceae	<i>Artocarpus heterophyllus</i>	Nangka	Nectar
23	Myrtaceae	<i>Psidium guajava</i>	Jambu Biji	Nectar/pollen
24		<i>Syzygium aqueum</i>	Jambu air	Nectar/pollen
25	Oxalidaceae	<i>Oxalis debilis</i>	Calincing Tanah	Nectar
26		<i>Averroa carambola</i>	Belimbing	Nectar/polen
27	<u>Phyllanthaceae</u>	<i>Baccaurea racemose</i>	Kepundung	Nectar
28	<u>Polygonaceae</u>	<i>Antigonon leptosus</i>	Air Mata Pengantin	Nectar
29	Rutaceae	<i>Citrus aurantifolia</i>	Jeruk	Nectar/pollen
30	Sapindaceae	<i>Nephelium lappaceum</i>	Rambutan	Nectar
31	Solanaceae	<i>Capsicum frutescens</i>	Cabe Rawit	Nectar
32		<i>Solanum melongena</i>	Terong	Nectar

4 Conclusion

This study recorded six honey bee species in Batu Gadang, Padang Pariaman Regency, West Sumatra. *H. itama* was the most common species, while the two members of *Tetragonula* became the rarest. The nest entrance of *H. itama* colonies dark brown in color. The nest entrance of *G. thoracica* colonies had round-shape, with coarse grains around it. The nest entrance of *L. terminata* colonies shape like trumpet, white in color and longer than the entrances of other species. *T. laeviceps* had yellow nest entrance, similar to the entrance of *T. fuscobalteata* in addition to its distinctive curved tip.

The study observed 32 species of flowering plants from 21 families from around stingless bee farm. Plant diversity has connection to the diversity of honey bee species in certain area, as seen in Batu Gadang. Some dominant plant families such as Arecaceae, Malvaceae, and Anacardiaceae provided essential recourses for bees like nectar, pollen, and resin sources throughout the year. The presence of diverse floral resources ensured continuous food availability, supporting colony growth, survival, and honey production, while also offering ecological and economic benefits to local farmers.

The authors appreciate the beekeepers in Batu Gadang that allowed sampling and data collection process at their meliponiculture sites. The gratitude is also given to all parties that provided assistance and support throughout the research journey.

Reference

1. B. Sarwono. Honey bees. Agro Media Library. Jakarta. (2001).
2. S. Kahono, P. Chantawannakul, and M. S. Engel. Social Bees and the Current Status on Beekeeping in Indonesia: *Springer Nature Singapore Pte.* 287-306. (2018).
3. N. Segueni, A. Zelligui, F. Moussaoui, M. Lahouel, and S. Rhouati. Flavonoids from Algerian propolis. *Arabian Journal of Chemistry.* **1**, 425-428. (2016). doi:10.1016/j.arabjc.2011.05.013
4. S. Salmah, T. Inoue, and S. F. Sakagami. *Ananalysis of Apid Bee Richness (Apidae) in Central Sumatra. Dalam Sakagami, S.F., R. Ogushi, dan D.W. Roubik (eds.), Natural History of Social Wasps and Bees in Equatorial Sumatra.* hal. 139-174. Hokkaido Univ. Press, Sapporo. (1990).
5. H. Herwina, S. Salmah, Jasmi, Yaherwandi, Mairawita, M. N. Janra, Rusdimansyah, B. Y. Christy, D. A. Sari, & G. Putri. West Sumatran Stingless Bees (Hymenoptera: Apidae: Meliponini): What can be told from its Local Distribution. IOP Conf. Series:

- Earth and Environmental Science **757** (2021) 012084. (2020).
<https://doi.org/10.1088/1755-1315/757/1/012084>
6. M. S. Engel, S. Kahono, D. Peggie. A key to the genera and subgenera of stingless bee in Indonesia (Hymenoptera: Apidae). *Treubia*. **45**, 65-86. (2018).
 7. A. N. Suprianto, and C. G. A. G. N. Kirana. Morphological Character and Conserved Region of Elongation Factor 1 α (EF1 α) Gene Analysis in *Lepidotrigona terminata*. *Metamorfosa: Journal of Biological Sciences*. **2**, 30-39. (2020).
[10.24843/metamorfosa.2020.v07.i02.p05](https://doi.org/10.24843/metamorfosa.2020.v07.i02.p05)
 8. S. Hadisoelilo. Keanekaragaman spesies lebah madu asli Indonesia. *Biodiversitas* **2**, 123-128. (2001).
 9. N. Kelly, M. S. N. Farisyah, T. K. Kumara, dan P. Marcela. Species Diversity and External Nest Characteristics of Stingless Bees in Meliponiculture. *Tropical Agricultural Science*. **3**, 293-298. (2014). <http://www.pertanika.upm.edu.my/>
 10. N. T. Suriawanto, S. Atmowidi, and Kahono. Nesting sites characteristics of stingless bees (Hymenoptera: Apidae) in Central Sulawesi, Indonesia. *Journal of Insect Biodiversity*. **10**, 1-9. (2017). <http://dx.doi.org/10.12976/jib/2017.5.10>
 11. M. Trianto, and H. Purwanto. Morphological and morphometrics characteristics of Stingless Bees (Hymenoptera: Meliponini) in Yogyakarta, Indonesia. *Jurnal Biodiversitas*. **21**, 2619-2628. (2020). <https://doi.org/10.13057/biodiv/d210633>.
 12. H. Herwina, S. Salmah, M. N. Janra, Mairawita, J. Nurdin, Jasmi, Yaharwandi, Rusdimansyah, and D. A. Sari. Stingless bee-keeping (Hymenoptera: Apidae: Meliponini) and Its Potency for Other Related-Ventures in West Sumatra. *Journal of Physics: Conference Series* 1940 (2021) 012073 IOP Publishing. (2021).
doi:10.1088/1742-6596/1940/1/012073
 13. Syafrizal, D. Tarigan, and R. Yusuf. Diversity and Habitat of *Trigona* spp bees in Wet Tropical Secondary Forest in Lempake Educational Forest, Samarinda, East Kalimantan. *Journal of Agricultural Technology*. **1**,34-38. (2014).
 14. H. Herwina, S. Salmah, Mairawita, Nurainas, Jasmi, M. N. Janra, and D. A. Sari. Assessing the Environmental Friendliness of Universitas Andalas for Stingless Bees Species (Hymenoptera: Apidae:Meliponini). *IOP Conf. Series: Earth and Environmental Science*. 1059 012081 IOP Publishing. (2022). [10.1088/1755-1315/1059/1/012081](https://doi.org/10.1088/1755-1315/1059/1/012081)
 15. Dominggus, J. S. A Lamerlabel, and W Ingrid. Honey Bee *Apis mellifera*. *Agrinimal Journal*. **7**(2):77-82. (2019).