STRUCTURE OF THE NEST ENTRANCE OF STINGLESS BEE (APIDAE: HYMENOPTERA) AT MALAYSIAN GENOME INSTITUTE, MALAYSIA

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ABSTRACT

The stingless bees construct their own species-specific nest entrance, using different material and on the various substrate. Using a comparison approach, a study on the structure of the nest entrance was carried out on 20 species of stingless bees' comprising of 9 genera at Malaysian Genome Institute (MGI), Malaysia. The aim of this study was to find out the difference in the structure and shape of the nest entrance for the 20 species studied. Observation and measurement on the nest entrance were done at the field. Our study revealed that 11 species having an elliptical shape, eight of round shape, while one species having a slot-shaped or irregular shaped entrance. Based on the colouration, most of the nests were in black and white colour. The nest mostly was made up of tree resin.

Keywords: nest entrance, stingless bee, Malaysia

INTRODUCTION

Stingless bees are essentially group of bees that have no sting as compared to honey bees. It is estimated that there are 500 species of stingless bees worldwide and there are about 35 species in Malaysia alone (Schwarz 1939). Currently, the number of stingless bees recorded has increased to 45 species as of 2014. Previous studies reported 29 species were recorded in Peninsular Malaysia and 19 of them inhabit virgin forests (Jaapar et al. 2016). All stingless bee species build elaborate nests, with structure that often have species-specific characteristics (Michener 2007; Sakagami 1982). Stingless bees construct their nests on various substrate types including underground cavities, tree trunks, on branches of living trees, in rocks, brick walls, active or abandoned termites, arboreal ant nests, active bird nests or nests loosely connected with tree branches (Schwarz 1948; Wille 1983; Roubik 2006). Additionally, different species of nests has also been found in buildings and other human development sites a phenomenon likely to be caused by habitat fragmentation, which always reduces the number of existing nesting sites which are important for the survival of these insects (Brosi et al. 2007).

The materials used for the construction of the bee hive are mostly from natural candles, resins, rocks, trees and clay. The number of bees in a stingless bee colony can range from a few dozens to over 100,000. The nest is usually made of five parts: brood comb, involucrum, store pots, batumen and an entrance. The horizontal construction of combs and honey pots is a unique characteristic of stingless bees while honey bees construct honey combs for storing honey (Jaapar et al. 2016).

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MATERIALS AND METHOD

This study was conducted at the stingless bee repository, located at Malaysian Genome Institute (MGI), Bangi Malaysia. A total of 56 bees nest consisting of 20 species of stingless bee were studied (Table 1). The observation was done on the structure of the nest entrance, and the entrance to each nest was measured using a micrometer caliper. Stingless bees construct their own species-specific nest entrances (Roubik, 2006), and come in a variety of shapes including round, elliptical, slot-shaped or irregular. Adapted a method established by (Couvillon 2008), an approximate geometric shape for each entrance are needed to measure the crosssectional area for the opening. For circular entrances, we measured the diameter of the circle and calculated area using $A = \pi(½D)^2$. For elliptical entrances, we measured horizontal (X) and vertical (Y) diameters and calculated area using the formula A = pR1R2, where R1 . X⁄2 and R2 . Y⁄2. For the few that were slot⁄rectangular-shaped, we calculated the area as XY. We measured the entrance of every nest used in this study to determine variability in size between and among species and calculated the average.

Table 1. The stingless bee species studied and number of nest per species examined

No.	Species	Number of Nest
1.	*Geniotrigona thoracica*	2
2.	*Heterotrigona erythrogastra*	3
3.	*Heterotrigona itama*	2
4.	*Homotrigona fimbriata*	4
5.	*Lepido terminate*	1
6.	*Lepidotrigona* sp.	1
7.	*Lepidotrigona doipaensis*	1
8.	*Lepidotrigona terminate*	2
9.	*Lophotrigona canifrons*	2
10.	*Tetrigona apicalis*	11
11.	*Tetrigona binghami*	16
12.	*Tetrigona melanoleuca*	1
13.	*Tetrigona peninsularis*	1
14.	*Tetragonilla collina*	1
15.	*Tetragonula* sp.	1
16.	*Tetragonula dresceri*	1
17.	*Tetragonula fuscobalteata*	1
18.	*Tetragonula laeviceps*	4
19.	*Tetragonula minangkabau*	1
20.	*Tetragonula testaceitarsis*	4
	TOTAL	56

RESULTS AND DISCUSSION

There was a slight difference on the structure and shaped of the nest entrance for the 20 species studied. The nest entrance of the different species can be easily differentiated based on the geometrical shape. A total of 11 species, namely *Geniotrigona thoracica* (Fig. 4.1A), *Tetragonula testaceitarsis* (Fig. 4.1B), *Tetragonula minangkabau* (Fig. 4.1C), *Tetrigona apicalis* (Fig. 4.1D), *Tetragonula laeviceps* (Fig. 4.1E), *Lepido terminate* (Fig. 4.1F), *Tetrigona binghami* (Fig. 4.1G), *Tetrigona melanoleuca* (Fig. 4.1H), *Homotrigona fimbriata* (Fig. 4.1I), *Tetragonula* sp. (Fig. 4.1J) dan *Tetragonula dresceri* (Fig. 4.1K) have an elliptical nest entrance shape (Table 2). This results are in accordance to the study by Couvillon et al. (2008) in which the elliptical shapes are the most dominan nest entrance shape of stingless bees in Brazil. The elliptical shape is a strategic design for most species as it was wider and bigger to facilitate the activity (going in and out) of the stingless bees' worker. According to the entrance area measured, the smallest entrance area for the elliptical shape was 91.88 mm^2 (*Tetragonula minangkabau)* (Fig. 4.1C), whilst the wider entrance area is 1000.94 mm^2 by *Tetrigona apicalis* (Fig. 4.1D). For *Homotrigona fimbriata,* the elliptical shape of the nest entrance is meant for a defense mechanism (Grüter et al. 2011). Based on the Figure 4.1I, the nest entrance can only accommodate the bees from this particular species, and it is very important to avoid any disturbance or intrusion to the colony. Only one species namely *Tetrigona melanoleuca* (Fig. 4.1H), which having an elliptical shape with a long tube of nest entrance. This is also a kind of defense mechanism which the long tube functioned as a bridge that connected the nest entrance to the main colony.

The round shape nest entrance reported to have smaller entrance area. There were few categories of round-shaped entrance recorded in this study, namely round-shaped *Heterotrigona erythrogastra* (Fig. 4.2L), *Tetrigona peninsularis* (Fig. 4.2M) and *Tetragonula fuscobalteata* (Rajah 4.2N) round-shaped with short tube (*Heterotrigona itama* (Fig. 4.2O), *Lepidotrigona sp.* (Fig. 4.2P) and *Lepidotrigona terminata* (Fig. 4.2Q), round-shaped with intermediate tube (*Lepidotrigona doipaensis*) (Fig. 4.2R), and round-shaped with a long tube (*Tetragonilla collina*) (Fig. 4.2S). The smallest entrance area for the round-shaped was 25.88 mm^2 (*Lepidotrigona doipaensis*) (Fig. 4.18), whilst the most wider entrance area is 192.19 mm^2 by *Heterotrigona erythrogastra* (Fig. 4.12). The majority of the round-shape nest entrance is equipped with a long tube. This is believed to be a defense mechanism for the particular nests. The *Tetragonilla collina* was identified to have about four entrance, ie. round-shaped with the long tube as mentioned before. In such, it increases the productivity of the colony by smoothing the traffic onto the colony thus boosted an active foraging activity of the stingless bees' worker for the particular species. Only one species of stingless bee reported to have a slot-shaped of nest entrance, namely *Lophotrigona canifrons* (Fig. 4.3). This kind of shaped also provide a wider and bigger area for the entrance to the colony, which

770.36 mm^2 of the entrance area was reported. This shape of nest entrance also facilitates the stingless bees to freely move onto the nest for foraging activity.

Based on coloration, most of stingless bee nest in this study was blackish or whitish. It was related to the age and environmental factor that determined the color of the nest entrance. Whilst for the material used for nest construction, the observation has identified that most of the nest entrance was constructed using a tree resin.

Table 2. The entrance area and information on the nest characters of stingless studied

Species	Entrance Area (mm^2)	Characteristic of Entrance	Color	Building Materials
1. Geniotrigona thoracica	229.07	Elliptic	Black	Resin/ Rubber
2. Heterotrigona erythrogastra	192.19	Round	White	Resin
3. Heterotrigona itama	120.42	Round; Short Tube	Black whitish	Resin
4. Homotrigona fimbriata	150.61	Eliptical; Closed slightly	Light brown	Resin
5. Lepido terminate	270.18	Eliptical	Reddish white	Resin
6. Lepidotrigona sp.	119.84	Round; Short tube	White	Resin
7. Lepidotrigona doipaensis	25.88	Round; Intermediate tube	White	Resin
8. Lepidotrigona terminata	34.85	Round; Short tube	White	Resin
9. Lophotrigona canifrons	770.36	Slot/rectangle	White	Resin
10. Tetrigona apicalis	1000.94	Elliptic	White; black spots	Resin
11. Tetrigona binghami	216.64	Elliptic	Yellowish white	Resin
12. Tetrigona melanoleuca	335.75	Elliptic; Long tube	White	Resin
13. Tetrigona peninsularis	148.98	Round	Brown	Resin
14. Tetragonilla collina	68.06	Round; Long tube x 4	Brown	Resin
15. Tetragonula sp.	171.95	Elliptic; Mossy	Black	Soil/Rubber
16. Tetragonula dresceri	340	Elliptic: Ants mound	Black greenish	Soil/ Rubber
17. Tetragonula fuscobalteata	34.75	Round; Underground	Black reddish	Soil/ Resin
18. Tetragonula laeviceps	154.78	Elliptic	Black yellowish	Resin
19. Tetragonula minangkabau	91.88	Elliptic	Black	Resin
20. Tetragonula testaceitarsis	183.3	Elliptic	Black	Resin

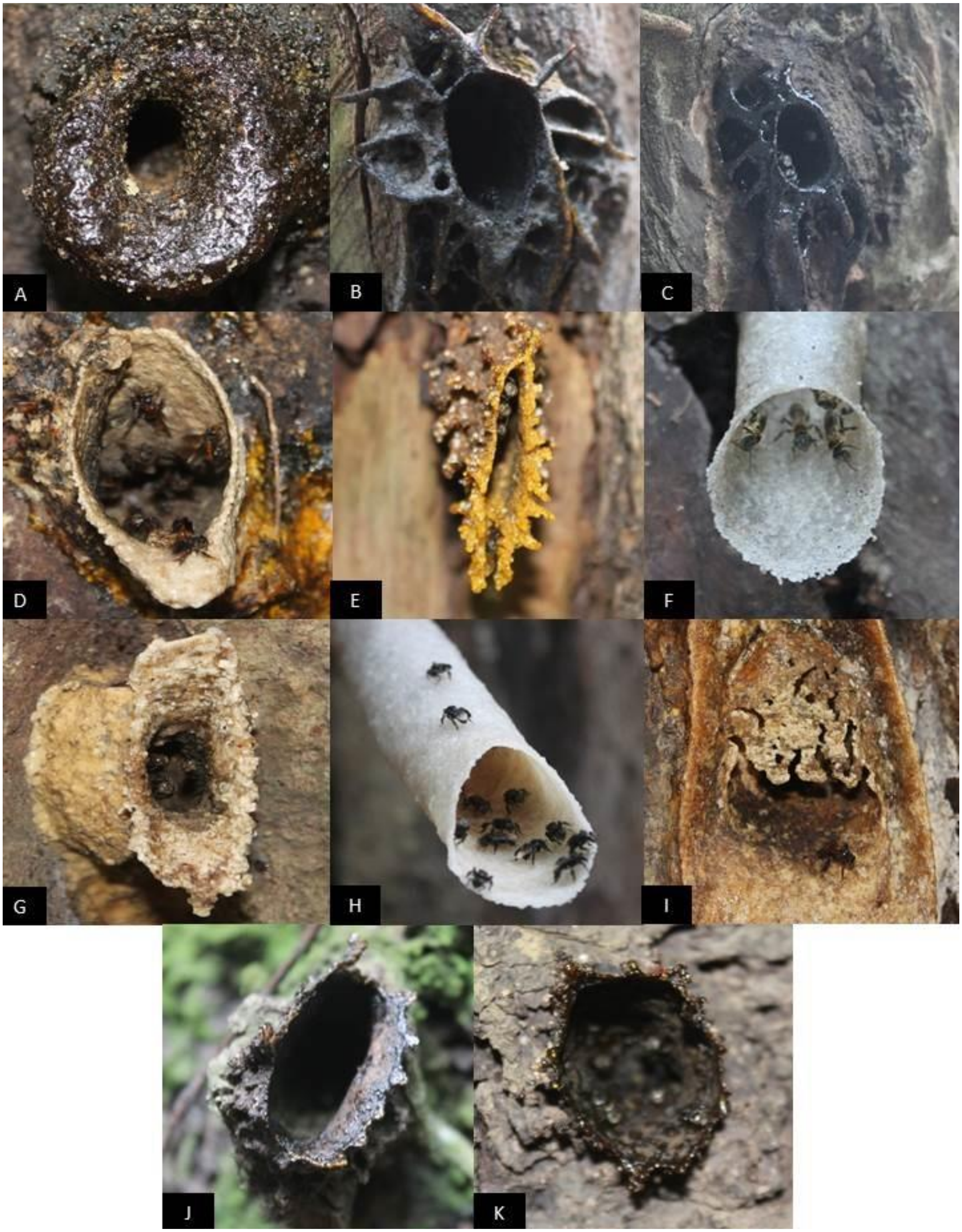
A
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Figure 4.1 (A-K) Group of stingless bee with elliptical nest entrance shape. (A) *Geniotrigona thoracica*, (B) *Tetragonula testaceitarsis*, (C) *Tetragonula minangkabau*, (D) *Tetrigona apicalis*, (E) *Tetragonula laeviceps*, (F) *Lepido terminate*, (G) *Tetrigona binghami*, (H) *Tetrigona melanoleuca*, (I) *Homotrigona fimbriata*, (J) *Tetragonula* sp. (K) *Tetragonula dresceri*.

Figure 4.2 (L-S) Group of stingless bee with round-shaped nest entrance. (L) *Heterotrigona erythrogastra,* (M) *Tetrigona peninsularis*, (N) *Tetragonula fuscobalteata*, (O) *Heterotrigona itama*, (P) *Lepidotrigona* sp. (Q) *Lepidotrigona terminata* (R) (*Lepidotrigona doipaensis* (S) *Tetragonilla collina*.

Figure 4.3 *Lophotrigona canifrons* with slot-shaped nest entrance

CONCLUSION

As a conclusion, this study successfully reported that the elliptical shaped as the most dominant nest entrance structure, in comparison to round-shaped and slot-shaped. A different species of stingless bee as studied showed a different character, which with further studies can help in taxonomy studies.

REFERENCES

Brosi, B. J., Daily, G. C., Shih, T. M., Ovieido, F. & Duran, G. 2007. The effects of forest fragmentation on bee communities in tropical countryside. *Journal of Applied Ecology* 45(3): 773-783. London

Couvillon, M. J., Wenseleers, T., Imperatriz-Fonseca, V. L., Nogueira-Neto, P. & Ratnieks, F. L. W. 2008. Comparative study in stingless bees (Meliponini) demonstrates that nest entrance size predicts traffic and defensivity. *Journal of Evolutionary Biology* 21: 194-201.

Grüter, C., Kärcher, M. H. & Ratnieks, F. L. W. 2011. The natural history of nest defence in a stingless bee, Tetragonisca angustula (Latreille) (Hymenoptera: Apidae), with two distinct types of entrance guards. Neotropical Entomology 40: 55-61.

Japar, F., Jajuli, R. & Muhamad Radzali, M. (pnyt). 2016. Lebah Kelulut Malaysia – Biologi dan Penternakan. Serdang: Penerbit Institut Penyelidikan dan Kemajuan Pertanian Malaysia (MARDI).

Michener, C. D. 2000. The Bees of the World. Baltimore, Maryland: Johns Hopkins University Press.

Michener, C. D. 2007. The Bees of the World. Ed. ke-2. Baltimore, Maryland: The John Hopkins University Press. Rasmussen & Camargo 2008

Roubik, D.W. 2006. Stingless bee nesting biology. *Apidologie* 37: 124–143.

Sakagami, S. F. 1982 Stingless bees. In: Hermann HR (ed) Academic Press, New York. *Social Insects* 3: 361–423

Schwarz, H. F. 1939. The Indo-Malayan species of Trigona. *Bulletin of the American Museum of Natural History,* 73: 281-328

Schwarz, H. F. 1948. Stingless bee (Meliponidae) of the western hemisphere. Lestrimellita and the following subgenera of *Trigona: Trigona, Paratrigona, Schwarziana, Parapartamona, Cephalotrigona, Oxytrigona, Scaura* and *Mourella. Bulletin of the American Museum of Natural History,* 90: 1-546.

Wille, A. 1983. Biology of the stingless bees. *Annual Review of Entomology* 28: 41– 64.