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# THE INTERNAL NEST ARCHITECTURE AND THERMOREGULATION OF *GENIOTRIGONA THORACICA* (HYMENOPTERA: MELIPONINI)

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## ABSTRACT

The internal nest structure of stingless bee comprise of broods, honey pots and pollen pots whereas thermoregulation has significant ecological consequences to the stingless bee because the internal heat generation enables bees to forage under colder surrounding temperature. In this study, colonies (n=6) of *Geniotrigona thoracica* were measured for its brood cell size, volume of honey, foraging frequency, internal and external temperature, size of honey pot and pollen pot monthly from July 2013 - September 2013. Results showed the diameter and height of brood cells, honey pots and pollen pots were 3.9 ± 0.72 mm, 6.1 ± 1.29 mm, 15.1 ± 4.02 mm, 24.4 ± 5.31 mm, 22.9 ± 5.37 mm and 16.25 ± 6.58 mm, respectively. The mean honey production was 206.8 ± 25.27 ml. The mean internal and external temperatures were 26.7 ± 0.15 ºC and 26.6 ± 0.36 ºC respectively. The foraging frequencies for this species were at peak from 10 a.m – 12 p.m.

**Keywords:** stingless bee, thermoregulation, temperature, colony, foraging

## ABSTRAK

Struktur dalaman sarang kelulut terdiri daripada telur, kantung madu dan kantung debunga manakala termo-regulasi mempunyai kesan ekologi yang penting terhadap kelulut kerana penjanaan haba dalaman membolehkan kelulut terbang keluar dari sarang untuk mencari makanan. Dalam kajian ini, koloni (n=6) *Geniotrigona thoracica* telah digunakan, dimana saiz sel telur, isipadu madu, kekerapan keluar mencari-makanan, suhu dalaman dan persekitaran telah diukur dan direkodkan setiap bulan dari Julai 2013 - September 2013. Hasil kajian menunjukkan diameter dan ketinggian sel telur, kantung madu dan kantung debunga adalah seperti berikut 3.9 ± 0.72 mm, 6.1 ± 1.29 mm, 15.1 ± 4.02 mm, 24.4 ± 5.31 mm, 22.9 ± 5.37 mm dan 16.25 ± 6.58 mm. Purata penghasilan madu adalah 206.8 ± 25.27 ml. Purata suhu dalaman sarang dan suhu persekitaran adalah 26.7 ± 0.15 ºC dan 26.6 ± 0.36 ºC. Kekerapan puncak untuk kelulut keluar mencari-makanan bagi spesies ini adalah di antara 10 a.m – 12 p.m.


**Kata kunci:** kelulut, termo-regulasi, suhu, koloni, mencari-makanan

## INTRODUCTION

In Malaysia, the stingless bees are not well-known compared with honey bee. They can be found in the dipterocarp forest in Malaysia (Hannah *et al.*, 2012). The stingless bees living in permanent colonies, nesting in old walls, logs, crevices and such other concealed places (Danaraddi, 2007).This stingless bee can produce the commercial products which were honey, propolis and bee pollen. These bees hive products rich in nutrient and have high medical value. The activity of beekeeping with stingless bee known as meliponiculture, where this activity widely used in Brazil, Mexico and Africa (Cortopassi-Laurino *et al.*, 2006). The meliponiculture bring a lot of advantages in produce more bee hive products. Besides, the stingless bee can be commercialized as the pollinator agent, where commercial beekeepers rent hives of stingless bees to the growers (Heard, 1988).

In general, the internal nest architecture of stingless bees consists of different shapes and arrangements of brood cells and food storage containers. The food storage containers were pollen pot and honey pot. Their honey pot and pollen pot was stored in nest cavity surrounding the brood area. Most stingless bee arrange the brood cells in the nest in horizontal comb or in a cluster form and these brood cells ranging from individual cells on pillars to sheets of orderly cells on combs separated by the pillars (Michener, 2007). The shapes of the brood cells are spherical to ovoid and the food storage containers are small to large spheres and often pressed together in odd conglomerates (Roubik, 2006). The colour of the brood cells were light brown and the colour of food storage containers were brown.

Malaysia hosts wide variety of stingless bees. Up to date, there were about 29 species of local stingless bees were identified (Eltz *et al.*, 2003; Hannah *et al.*, 2012; Mohd Norowi *et al.*, 2010).The species of stingless bees that commonly used in meliponiculturein Malaysia were *Heterotrigona itama*, *Lepidotrigona terminata, G. thoracica,* and *Tetragonula leaviceps.* It was claimed that *G. thoracica* is the largest stingless bee species in Malaysia (Mohd Norowi *et al.*, 2010).

The thermoregulation is found among large-bodied insects where the thermoregulation has significant ecological consequences because the internal heat generation enables solitary and social bees to forage and pollinate under colder surrounding temperature (Nieh and Sánchez, 2005). It is important for bees maintain the thermal condition of their nest in order to promote the successful breeding in their colonies. Researchers found that only a few species of stingless bees able to maintain the temperature in the nest. For example, *Trigona ventralis hoozana* can maintain temperature of nest in between 29 – 32 ºC (Sung *et al.*, 2008). However, there is lack of biological data for *G. thoracica*. Thus, this research explored internal nest architecture and thermoregulation of *G. thoracica* and the study of internal structure and thermoregulation will bring positive impact to meliponiculture industry in Malaysia.

The objectives of this research were to investigate the internal nest structure of colony of *G. thoracica*, to investigate the thermoregulation *G. thoracica*, and to investigate foraging frequency of *G. thoracica*.

## MATERIAL AND METHODS

### Sampling of Internal Nest Architechture

There were six colonies of *G. thoracica* were established in Agropark Universiti Malaysia Kelantan (UMK) Jeli (05º 44'N 101º 51'E). These colonies were maintained inside the wooden box and each colony of stingless bee was placed randomly with distance range between 60 cm to 150 cm. The investigation of internal structures include size of honey pots, size of pollen pots, size of brood cells, volume of honey produced. The sizes of internal nest architecture were measured using digital callipers (Kern 6"/150 mm) monthly from July 2013 to September 2013 for each colony. Honey was collected monthly using syringe and measured using measuring cylinder (500 ml).

### Investigation for Thermoregulation

Data Logger (Extech RH520 Hygro-Thermometer) was used to record the external temperature and Data Loggers (Watchdog BTemperature/RH Logger) were used to record internal temperature of beehives. The data loggers were set up to record the temperature for every one hour. The temperatures recorded were collected monthly (July 2013- September 2013). The mean temperatures of each colony were calculated and subjected to *t* test.

### Observation of Foraging Activity

The foraging frequencies of *G. thoracica* were observed from July 2013 to Sept 2013 where the foraging frequencies were recorded once a week in every month. Observation for foraging activity of *G. thoracica* was started from 08 00 until 16 00, where the numbers of forgers were counted every two hours for five minutes intervals. The observation were focus on the foraging activity in terms of the number of foragers leaving their hives, number of foragers returning to their hives with pollen load and without pollen load.

## RESULT AND DISCUSSION

### Internal Nest

The internal nest architecture of *G. thoracica* showed the structures of brood combs surrounded with the food storages, honey pots and

pollen pots (Figure 1). The honey and pollen were stored in separated pots, but these pots were often intermixed. The broodswere arranged in horizontal form. The sizes of brood cells were smaller than the food storage pots. The shapes of pollen and honey pot were oval. These storage pots were made from soft cerumen, a mixture of wax and propolis (Wille, 1983). The shape of brood cells was spherical to ovoid. These brood cells were covered by involucrum. The involucrum was a series of sheath that made from cerumen (Roubik, 2006). These involucrum functioned to protect the brood cells from intruders and to maintain the temperature surround the broods.

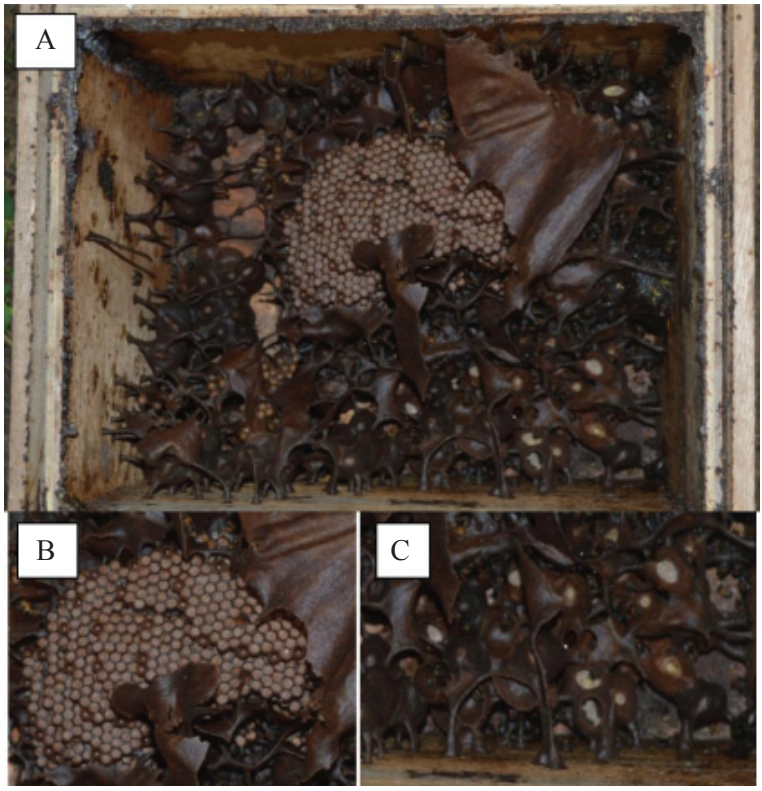


**Figure 1.** The internal nest architecture of *G. thoracica*; A) The arrangement of nest architectures component, brood cells in the middle and surround with pollen and honey pot; B) Layers of brood cells; C) Pollen and honey pots

**Table 1.** Sizes and characteristics of internal nest architecture of *G. thoracica*

| Parameters | Brood cell | Honey pots | Pollen pots |
|---|---|---|---|
| Diameter (mm) | 3.9 ± 0.72 | 15.1 ± 4.02 | 22.9 ± 5.37 |
| Height (mm) | 6.1 ± 1.29 | 24.4 ± 5.31 | 16.3 ± 6.58 |
| Colour | Light brown | Brown | Brown |

**Honey Production**

The honey harvested from closed storage pots from each colonies. About 70% of honey was collected from colonies and another 30% honey was left for colonies survival. Mean honey production of *G. thoracica* was 206.83 ± 25.27 ml (n=6) monthly (July 2013 - September 2013). Honey production of stingless bee depends on the quality of environment and competition with other bees for special floral resources (Cortopassi-Laurino *et al.*, 2006). The production of honey was lower during raining season or lack of pollen resources.

**Thermoregulation**

The monthly mean of internal temperature for three month (July 2013 - September 2013) were 26.7 ± 0.15 ºC, The monthly mean of external temperature were 26.6 ± 0.36 ºC.

**Table 2.** Internal and external monthly temperatures of *G. thoracica*

| Month | Internal temperature ºC | External temperature ºC |
|---|---|---|
| July | 26.7 ± 0.17 | 26.7 ± 0.19 |
| August | 26.7 ± 0.15 | 27.0 ± 0.26 |
| September | 27.0 ± 0.13 | 26.3 ± 0.25 |

Data showed that there were no differences between the internal and external of beehives. From *t* test, there was no significance difference between internal and external temperature since p = 0.214,

$\alpha = 0.05$. This can assume that the *G. thoracica* do not have the ability to thermoregulate their nest.

**Foraging Frequency**

For the foraging frequencies, four types of foraging frequencies were observed such as the forager move out of colony without carry anything or carry something also the foragers move in with pollen or without pollen. These foraging frequencies having peak time from 1000 hours until 1200 hours.The resultsof foraging frequency were similar with the result for pollination time of Hymenoptera (ants, bees, and wasps), Diptera (flies), Heteroptera (bugs) and Lepidoptera (Butterflies, moths) (Mohd Norowi *et al.*, 2010).

## CONCLUSION

The study of internal nest structure of *Geniotrigona thoracica* gives idea on how this species arrange their internal nest components. This species has been found not thermoregulate their nest. However, the brood temperature which covered with involucrum might regulate the internal temperature. This need future study in depth on thermoregulation of this stingless bees species.

## ACKNOWLEDGEMENT

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