NOTES ON RESIN COLLECTED BY STINGLESS BEES IN TAMAN TROPIKA TASIK KENYIR, TERENGGANU, MALAYSIA

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ABSTRACT

A study to investigate the resin collection behaviour of stingless bees was conducted on three different species of Dipterocarpaceae trees, namely Keruing (*Dipterocarpus grandiflorus*), Damar hitam (*Shorea balanocarpoides*) and Meranti (*Shorea parvifolia*) between January to March 2018. Three digital single-lens reflexes DSLR with macro lens attached was used to record resin collection of stingless bees in front of three trees for 5 min per hour between 0900 to 1600 h for a day per 3 months. Result showed that there was a significant difference in the mean numbers of resin-foraging stingless bees ($F=9.91$; $df=7, 23$; $P<0.05$) on Keruing between 0900 h to 1600 h for three months samplings. Similar result was observed on Meranti ($F=7.21$; $df=7, 23$; $P<0.05$) and Damar hitam ($F=21.37$; $d=7, 23$; $P<0.05$) in the mean number of resin collecting by stingless bees right between 0900 h to 1600 h. The highest number of resin collected by stingless bees was at 1300 hours followed by 1200 hours. A total of 2,730 individual embracing 11 species of stingless bees were recorded collecting resin headed by *Homotrigona fimbriata* followed by *Tetragonilla collina* and *Tetrigona apicalis*. Thus, it is hope these data would be a guideline for farmers to enhance their meliponiculture.

Keyword: Stingless bees; Resin; Dipterocarpaceae, Behaviour

ABSTRAK

Kajian untuk melihat pengumpulan resin oleh spesies lebah kelulut telah dijalankan ke atas tiga spesies pokok berdamar daripada Dipterocarpaceae iaitu, Keruing (*Dipterocarpus grandiflorus*), Damar hitam (*Shorea balanocarpoides*) and Meranti (*Shorea parvifolia*) antara bulan Januari sehingga Mac 2018. Tiga kamera digital dengan lensa makro telah digunakan untuk merekod pengumpulan damar oleh lebah kelulut pada tiga pokok yang telah dipilih pada setiap 5 minit untuk setiap jam antara jam 9.00 pagi sehingga 4.00 petang, sehari bagi setiap bulan untuk 3 bulan. Hasil kajian menunjukkan perbandingan yang beerti bagi min jumlah individu lebah kelulut yang mengumpul resin pada pokok Keruing ($F=9.91$; $df=7, 23$; $P<0.05$) di antara 9.00 pagi ke 4.00 petang untuk tiga bulan pensampelan dijalankan. Hasil

yang sama telah diperhatikan ke atas pokok Meranti ($F=7.21$; $df=7, 23$; $P<0.05$) dan juga Damar hitam ($F=21.37$; $df=7, 23$; $P<0.05$). Daripada ini, jam 1.00 tengahari menunjukkan waktu di mana resin paling tinggi dikumpul oleh lebah kelulut diikuti dengan jam 12.00 tengahari. Sebanyak 2730 individu daripada 11 spesies lebah kelulut telah direkodkan mengumpul resin didahului oleh *Homotrigona fimbriata* dan diikuti oleh *Tetragonilla collina* dan *Tetrigona apicalis*. Oleh itu, menjadi harapan agar hasil kajian ini dapat menjadi panduan kepada penternak lebah kelulut bagi melestarikan lagi sistem penternakan lebah kelulut.

INTRODUCTION

Resin has been used in the nest construction by stingless bees and collected from various plant in Malaysia. Most plant that produce resin were in Dipterocarpaceae and well-liked by stingless bees (Eltz et al. 2003). Stingless bees collected resin for construction of their nest and for defense from the enemy (Roubik 2006). In a colony of *Sundatrigona moorei*, resin has been used to enter the ant nest and also for other species which is used as a defense (Sakagami et al. 1989). In the colony, different ages will have different task. Normally in *Heterotrigona itama* workers aged from 45-70 days normally collected the resin (Sakagami 1982).

The foraging behaviour of stingless bees depends on climatic factor such as temperature and humidity (Dos Santos et al. 2016). They will start to forage in the early morning and end it in the late afternoon influenced by weather conditions, with less forage on hot weather and rainfall (Keppner & Jarau 2016). In Malaysia, foraging behavior of the stingless bees high in the early morning with the normal temperature was 25°C and will be decrease when the temperature reaches 36°C (Wan Nur Asiah et al. 2015). The suitable temperature for stingless bees to forage was between 29°C to 32°C (Fahimee et al. 2018). Normally the stingless bees will return to the nest when the light intensity falls and some of the worker will stayed under the leaves or flower on night (Fahimee et al. 2018). Whereby the resin collector normally will start from 1000 h to 1300 h. Foraging behavior has been studied and the pattern of foraging behavior has been identified in Malaysia (Fahimee et al. 2016). There is limited study on resin collected by stingless bees before (Sakagami & Camargo 1964). Most of the studies normally focused on chemical properties in resin collected by stingless bees. There is a need of study about the resin collected by stingless bees and the tree as a resin sources for stingless bees. As such, the aim of this study was to investigate stingless bees resin source in the tropical forest area.

METHODS

Study Site

Taman Tropika Kenyir is located at 5.1631604, 102.7438281 in Tasik Kenyir, Terengganu and consists of secondary forest. The forest around Tasik Kenyir was classified as a mixed dipterocarp forest and has been logged in the 1970s. This island has been developed by MARDI as a tropical fruit island which planted more than 2,000 trees from 200 species of underutilised fruits.

Resin Collection Observation

Three DSLR cameras (Nikon D5300) with macro lens were set up in front of three different Dipterocarpaceae namely Keruing (*Dipterocarpus grandiflorus*), Damar hitam (*Shorea balanocarpoides*) and Meranti (*Shorea parvifolia*) trees in Taman Tropika Tasik Kenyir, Terengganu. With the tripod all cameras were placed randomly at the bark of the trees with 30cm distance. In addition, the places which lens was focused has been notched to make resin

from the trees melt. The focus area has been recorded for 5 minutes per hour between 0800 to 1700 h for a day for 3 months using a DSLR camera with macro lens manually. A total of 216 observations comprising of 1080 minutes record data was recorded during the experiment.

Species and Nesting Tree Identification

Stingless bee workers which collect the resin at the focusing area were collected using sweep net after 5 minutes video recording finished. The sample has been stored in the insect jar with 70% alcohol. The sample has been identified based on several taxonomic key books, especially that of Sakagami et al. (1990) and Siti Fatimah et al. (2018). In addition, surrounding area also was observed to identify nesting tree of stingless bees. Nesting habitat of the stingless bees was recorded as an additional data.

Video Interpretation and Statistical Analysis

The video was brought back to laboratory and played back to record and count the number of stingless bee species collecting the resin. Data of incoming foragers to the resin for every month were analyzed by using Microsoft Excel for mean and standard deviation. One-way ANOVA was used to evaluate to find differences between trees visited by the stingless bees at different times. Means were separated by Tukey's Test at $P<0.05$ using Minitab 17.

RESULTS

Result showed that there was a significant different in the mean numbers of bees collecting resin ($F=9.91$; $df=7, 23$; $P<0.05$) on Keruing (*D. grandiflorus*) between 0900 h and 1600 h for three months' samplings. The highest mean number of bees collecting resin was at 1300 h [62.7] followed by 1200 h [58.33]. The lowest mean number of bees collecting resin was at 0900 h [16] (Figure 1).

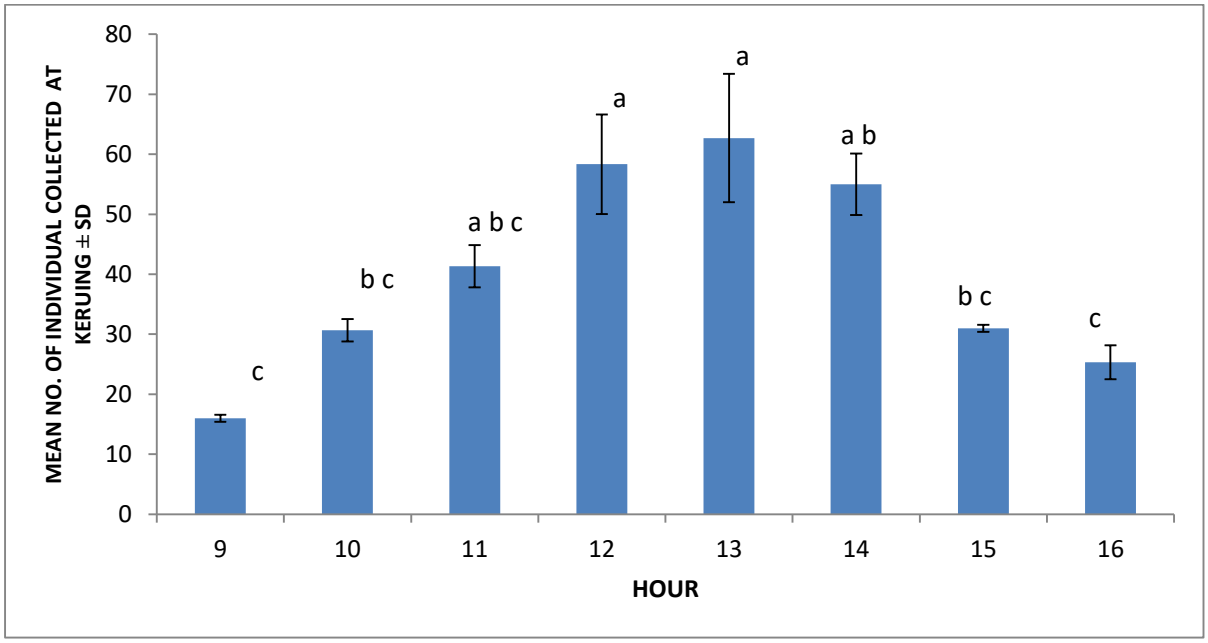

Figure 1. Mean number of individual recorded at notched bark of Keruing tree in Taman Tropika Kenyir between 0900 h to 1600 h from January to March 2018

Similar result showed on Meranti (*S. parvifolia*) which is significantly different [F=7.21; df=7, 23; P<0.05] in the mean number of resin collected between hourly observation per day. The highest mean number of resin collecting bees was at 1200 h and 1400 h (49.67) followed by 1300 h (49.0) while the lowest was at 0900 h (14.3) (Figure 2).

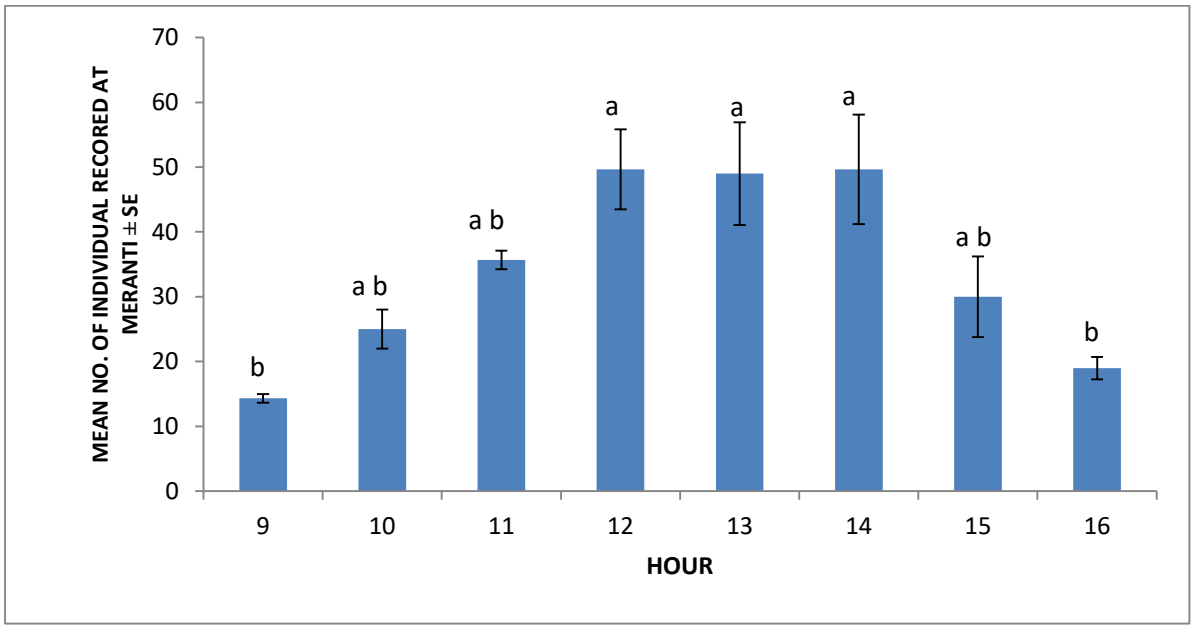

Figure 2. Mean number of individual recorded at notched bark at Meranti tree in Taman Tropika Kenyir between 0900 h to 1600 h from January to March 2018.

For Damar hitam (*S. multiflora*), result also showed significant different (F=21.37; df=7, 23; P<0.05) in the mean number of bees collecting resin collected between 0900 h to 1600 h. The highest mean number was at 1300 h (64.67) followed by 1200 h (56.67) and 1400 h (55.33) while the lowest mean number was at 0900 h (18.66) (Figure 3). The process of resin collection started with the mandible chewed the resin, then transferred it to middle leg before deposited on corbicula. In addition, while biting the resin, the head of stingless bees showed forward and backward movement. Resin was deposited from left leg to right leg alternately until the capacity to bring the resin is full (Figure 4). We also observed the stingless bees species of *Heterotrigona itama* and *Tetragonula* sp collecting resin from the flower of *Garcinia prainiana* (Figure 5).

A total of 2730 individual comprising of 11 species of stingless bees were recorded collecting resin from the study at Taman Tropika Tasik Kenyir (Table 1). The highest number of bees collecting resin in the Taman Tropika Kenyir were *Homotrigona fimbriata* (299 individual), followed by *Tetragonilla collina* (512 individual), and *Tetrigona apicalis* (299 individual). Six species were found nesting in the island. The lowest number was *Tetragonula reepeni* (117 individual). There were 14 nests from six species found in Taman Tropika Tasik kenyir and three species of tree were chosen by the stingless bee as nesting sites. The tree species were Kelat Jambu Laut (*Syzygium grande*), Rengas (*Semecarpus curtisii*) and another one species found nesting on an abandoned ant nest (Table 2). From the observation, the highest nesting located 30 feet from the ground. However, the *Tetragonula collina* was found nesting on the ground and the entrance was build 1metre vertically. The

nest entrance of *Tetragonulla fuscobalteata* was the most beautiful since their structure look like the shape of sun and some of researchers call them as a sun ray bee.

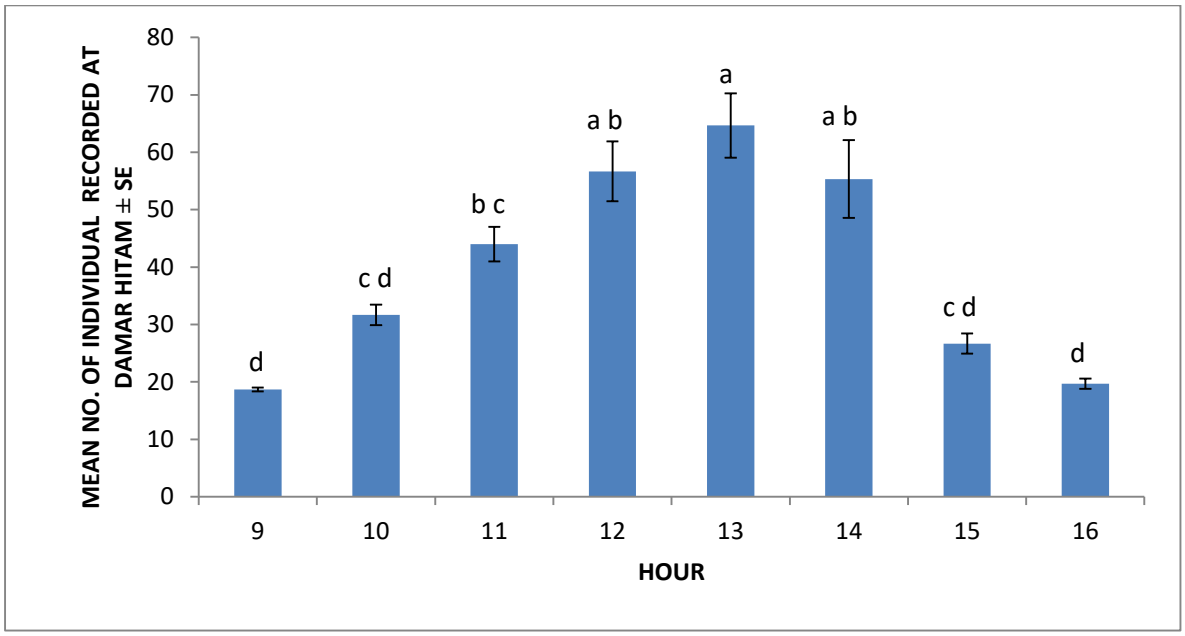

Figure 3. Mean number of individual recorded at notched bark of Damar hitam tree in TamanTropika Kenyir between 0900 h to 1600 h from January to March 2018

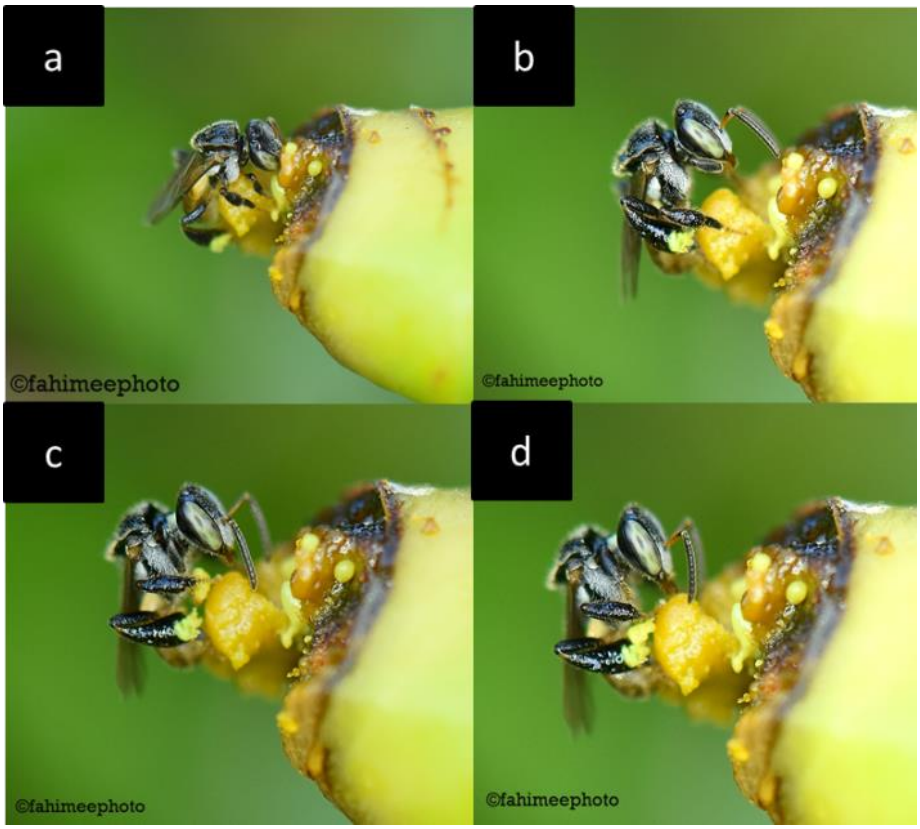

Figure 4. Resin collected process by stingless bees. (a) worker of stingless bees biting the resin. (b) Resin will be chewed using their mandible. (c) Resin transferred to middle leg. (d) Resin transferred to corbicula.

Table 1. Number of species and individual recorded collecting resin in sampling area

No.	Spesies	No of Individual	Percentage
1	*Geniotrigona thoracica*	205	7.51
2	*Tetrigona melanoleuca*	212	7.77
3	*Homotrigona fimbriata*	522	19.12
4	*Tetrigona apicalis*	299	10.95
5	*Tetragonula collina*	512	18.75
6	*Tetragonilla atripes*	212	7.77
7	*Lepidotrigona ventralis*	129	4.73
8	*Tetragonula fuscobalteata*	119	4.36
9	*Tetragonula laeviceps*	122	4.47
10	*Tetragonula reepeni*	117	4.29
11	*Heterotrigona itama*	281	10.29
	Total	2730	100.00

Table 2. Tree had been chosen as nesting sites of stingless bee in Taman Tropika Kenyir

No	Tree	Species	No. of nest
1	*Syzygium grande*	*Tetrigona apicalis*	2
		Tetrigona melanoleuca	2
		Homotrigona fimbriata	1
2	*Semecarpus curtisii*	*Tetrigona apicalis*	1
		Tetragonula collina	1
3	*Shorea* sp.	*Tetragonula apicalis*	2
		Lepidotrigona ventralis	1
4	Abandoned ant nest	*Tetragonula fuscobalteata*	1
5	Building	*Tetragonula fuscobalteata*	4
Total			14

DISCUSSION

Resin from the three normally will be used as a foundation for nesting development such as honey pot, involucrum and entrance (Sakagami 1975). Resin will be mixed with wax from their abdomen and deposited to the nesting area as a structure. Stingless bees honey has been identified as rich with antioxidant properties and other medicinal value (Suri et al. 2012). The medicinal value of honey came from the pot of honey. It is believed that honey has ability to absorb medicinal properties from the pot. Data showed, stingless bees collected resin from the Dipterocarpaceae family. Resin from Dipterocarpaceae species were identified as an anti-inflammatory and can be used in medicinal practices (Chen et al. 2017).

There are more than 157 species of Dipterocarpaceae species in Malaysia (Saw & Sam 2000). Taman Tropika Kenyir has lot of Dipterocarpaceae, and most of them are Keruing (*D. grandiflorus*), Damar hitam (*S. balanocarpoides*) and Meranti (*S. parvifolia*). The abundance of these species are probably the key of the tree selection. In addition, the

Dipterocarpaceae phenology which flowing the resin non-stop (60 DBH above) (Ang et al. 1995) is probably the best reason for bees selecting them. Other than that, result showed resin from this tree species has been collected by stingless bees.

Resin has been used as a nest defence, nest maintenance and colony survival. There are three species of stingless bees reported as a resin collector namely *Tetrigona binghami, Tetragonila collina, Homotrigona fimbriata and Odontotrigona haematoptera* (Leonhart et al. 2007). From the finding two from the four species stated by the Leonhart et al. (2007) were found to collect resin which is *H. fimbriata* and *T. collina*. Resin collected by stingless bees was high between 1100 h and 1400 h. Compared to species of other region, such as the *Nannotrigona testaceicornis* is also reported to collect resin between 1000 h and 1300 h (Silva & Gimenes 2014).

With the high temperature on that period, normally resin will melt faster and easy for stingless bees to collect the resin. Stingless bees build their nest on the hollow tree normally from the ground and up to 50m (Fahimee et al. 2016). In addition, they will choose tree with 60cm DBH (Diameter of breast height) above and Dipterocarpaceae family as a nesting site (Eltz et al. 2003). In Taman Tropika Kenyir, since the island was logged at 1970, not much Dipterocarpaceae family achieve 60 DBH above. However, our finding not contradicted with Eltz et al. (2003) which the tree found as a nesting tree also found in Taman Tropika Kenyir.
The taxonomy of the bees and the nest architecture also played a major role in resin collecting behaviour. Species of *H. fimbriata*, *T. collina* and *T. apicalis* build their nest with crystal cavity. These structure, protect the colony from the pest, predator and other (Roubik 2006). With this behaviour, this species must forage more resin compared to other species such as *Heterotrigona itama* which build their nest using less resin. For example, *Geotrigona subterranean* build their nest with 115mm thickness of the pillar (Barbosa et al. 2013) must have a lot of resin and not refuted with our result which these three species need more resin to build their nest.

CONCLUSION

Resin collected by stingless bees high during the noon or on the high temperature. However, not all species of stingless bees have a similar behaviour on collecting a resin. The nest with the crystal cavities normally collect more resin compared to other. In addition, the size and the taxonomy of the bees also play a major role on resin collecting behaviour. Resin tree presence are important for the stingless bees to sustain their colony.

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