UNIVERSITI PUTRA MALAYSIA

COLONY DEVELOPMENT OF STINGLESS BEES Heterotrigona itama Cockerell (HYMENOPTERA: APIDAE: MELIPONINI) USING DIFFERENT HIVE MODELS

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By

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Chair : Associate Professor Nur Azura Adam, PhD
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The meliponiculture is an activity of beekeeping with stingless bees by which bee keepers maintain, propagate and utilize stingless bee colonies of various species for profit has increased. *Heterotrigona itama* is the most preferred species of meliponiculturists in Malaysia due its abundance and high in demand. However, the major constraints for meliponiculture were the non-availability of colonies to the interested people, the harvesting practice requiring cutting down trees and there were no standardized practices to manage the colonies. This study was conducted at Ladang 10, Universiti Putra Malaysia to i) describe the morphological characteristics of different caste in stingless bee *H. itama*, ii) to compare the different hive models for colony development of stingless bee *H. itama*, iii) investigate the best artificial propagation technique for stingless bee *H. Itama.* All castes of *H. itama* specimens namely queen, virgin queen, workers and drones were obtained in the study site. The morphological characteristics and morphometric measurements of the specimens were observed and measured. Ten layers of brood cells were transferred into four artificial hive models i) horizontal hive, ii) large vertical hive, iii) medium vertical hive and iv) small vertical hive were left for two weeks to enable adaptation to the new environment before all the particular parameters were measured and recorded for five consecutive months. Three artificial propagation techniques namely splitting, bridging and splitting-bridging were conducted for eight consecutive weeks. The successful of colony division under different artificial propagation techniques and the measured parameters were observed and recorded weekly. Results showed there were significant differences ($P < 0.05$) for fifteen of the morphometric measurements of four different castes of *H. itama*. The morphological description on several characters of *H. itama* in four different castes namely queen, virgin queen, worker and drone were successfully described. Queen were recorded with longest body length and abdomen, widest

abdomen and had shortest hind wing compared to other castes. There was a significant interaction (F=2.51, df= 12, P= 0.0096) between month and the hive model on the number of pollen pot. The colony development of *H. itama* developed well in horizontal hive model as compared to other hive models and pollen was the major and very essential for initial stage in term of colony development. New brood cells and queen of *H. itama* were obtained by splitting technique. There were new brood cells developed but without new queen in splitting-bridging technique while there were only pollen and honey pots obtained for the bridging technique. The presence of matured queen can failure the artificial propagation technique due to its pheromones function.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

PEMBANGUNAN KOLONI KELULUT, *Heterotrigona itama* Cockerell (HYMENOPTERA: APIDAE: MELIPONINI) DENGAN MENGGUNAKAN MODEL SARANG YANG BERBEZA

Oleh

MOHAMAD SYUKRI BIN TAN SHILAN

Februari 2021

Pengerusi : Profesor Madya Nur Azura Adam, PhD
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Meliponikultur ialah satu aktiviti dimana penternak kelulut mengurus, mengganda dan menggunakan koloni kelulut dari pelbagai spesis bagi tujuan keuntungan telah meningkat. *Heterotrigona itama* ialah spesis kelulut yang paling digemari oleh penternak kelulut disebabkan oleh permintaan yang tinggi dan ianya mudah didapati. Walaubagaimanapun, terdapat beberapa halangan besar bagi para penternak kelulut antaranya ialah kekurangan sumber koloni kelulut akibat permintaan yang tinggi di pasaran, sumber koloni kelulut yang melibatkan penebangan pokok dan tiada piawaian yang khusus dan seragam bagi pengurusan koloni kelulut. Kajian ini dijalankan di Ladang 10, Universiti Putra Malaysia bertujuan i) untuk membuat pencirian karakter morfologi luaran bagi kasta yang berbeza untuk kelulut spesis *H. itama*, ii) untuk membandingkan pelbagai model sarang yang berbeza terhadap perkembangan koloni kelulut spesis *H. itama*, iii) mengkaji kaedah penggandaan koloni yang terbaik bagi kelulut spesis *H. itama*. Kesemua spesimen kasta bagi spesis *H. itama* iaitu ratu, ratu muda, kelulut pekerja dan kelulut pejantan diperolehi di kawasan kajian. Karakter dan ukuran morfologi bagi kesemua spesimen diperhatikan dan diukur. Sepuluh l*Apis*an sel anak dipindahkan ke empat model sarang iaitu i) sarang melintang, ii) sarang menegak besar, iii) sarang menegak sederhana and iv) sarang menegak kecil dan dibiarkan selama dua minggu di lapangan untuk proses mengadaptasi ke persekitaran baru sebelum semua ukuran parameter diambil dan direkodkan bagi tempoh lima bulan berturut-turut. Tiga kaedah penggandaan koloni kelulut iaitu “splitting”, “bridging” dan “splitting-bridging” dijalankan selama lapan minggu berturut-turut. Kaedah penggandaan koloni yang berjaya diperhatikan dan semua parameter yang terlibat diukur secara mingguan selama lapan minggu. Keputusan menunjukkan terdapat perbezaan seerti ($P < 0.05$) bagi lima belas ukuran morfologi untuk empat kasta kelulut

spesis *H. itama*. Pencirian morfologi luaran dibuat bagi beberapa karakter untuk empat kasta kelulut spesis *H. itama* iaitu ratu, ratu muda, kelulut pekerja dan kelulut pejantan. Ratu memiliki badan yang panjang dan lebar, abdomen yang lebar dan mempunyai sayap belakang yang pendek berbanding kasta yang lain. Terdapat perbezaan seerti (F=2.51, df= 12, P= 0.0096) diantara faktor bulan dan model haif pada parameter bilangan pot debunga. Koloni kelulut spesis *H. itama* berkembang baik di dalam model melintang jika dibandingkan dengan model-model sarang yang lain dan debunga merupakan perkara utama dan penting dalam peringkat awal perkembangan koloni. Sel anak baru dan ratu yang baru berjaya dihasilkan dengan menggunakan kaedah "splitting". Terdapat penghasilan sel anak baru tetapi ratu baru tidak berjaya dihasilkan dengan kaedah "splitting-bridging" tetapi hanya pot debunga dan madu sahaja yang dihasilkan di dalam kotak haif melalui kaedah "bridging". Kewujudan sang ratu dapat menjejaskan dan menggagalkan sesuatu kaedah penggandaan koloni disebabkan fungsi feromonnya.

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

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Declaration by Members of Supervisory Committee

This is to confirm that:

- the research conducted and the writing of this thesis was under our supervision;
- supervision responsibilities as stated in the Universiti Putra Malaysia (Graduate Studies) Rules 2003 (Revision 2012-2013) are adhered to.

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LIST OF ABBREVIATIONS

%	Percentage
ANOVA	Analysis of Variance
cm	centimetre
MARDI	Malaysian Agriculture Research and Development Institute
m	meter
mm	millimetre
POP	Provisioning and ovipositing process
UPM	Universiti Putra Malaysia

CHAPTER 1

INTRODUCTION

1.1 Background of the study

Apis mellifera populations have been declining in recent years as a result of parasitic mite infestation in their nests, according to the researchers. (de Guzman *et al.,* 2017). On contrary, the infections and parasites aren't a problem for stingless bees (Delfinado *et al.,* 1984; de Guzman *et al.,* 2017). Most tropical and temperate regions were indigenous to stingless bees despite their resemblance to another well-known honey-producing bee (Carreck, 2014). Since they store honey and lack of functional sting, the demand of stingless bee honey in Malaysia has increased as compared to honey bee. There were 145, 856 kilogram of stingless bee honey produced in Malaysia and estimated value of RM 21 million (DOA, 2020).

Heterotrigona itama is the most preferred species of meliponiculturists in Malaysia due its abundance and high in demand. The meliponiculture is an activity involving culturing stingless bee and to profitably cultivate and use stingless bee colonies of different species (Halcroft *et al.,* 2013c). Stingless bee farmers can benefit from selling the colonies, pollen, hive bread, propolis, pollination sevices, educational facilities and agro-tourism (Halcroft *et al.,* 2013c). Stingless bee farmers usually collected wild colonies nested in tree trunks before moving them to a new artificial hive and selling them later.

1.2 Problem Statement

Meliponiculture is increasingly gaining popularity and the colonies are managed with no standardization. One of the main drawbacks of meliponiculture is the inaccessibility of colonies to interested individuals. The colonies of stingless bees are seen most of the time in cavities from which they cannot be harvested. Stingless bee nests are primarily located in tree hollows and the nest products are difficult to collect for bee farmers. The current method of harvesting is not safe and threatens the natural habitat, the stingless bee's nests are lodged inside jungle tree trunks and harvesters by cutting down whole parts of trees to get at the nests. The disappearance of vast numbers of stingless bee colonies from their natural environments, such as the forest region, has a negative impact on the environment and biodiversity.

The artificial hive is one the major component uses in meliponiculture. Design and materials are also essential for artificial hive construction to maintain and

propagate the stingless bee colony (Cortopassi-Laurino *et al.,* 2006). The problem will occur when the stingless bee colonies are being transferred into inappropriate or unsuitable artificial hive. The colonies which are moved from their natural sites to the appropriate artificial hives will eventually be able to fully grow and naturally divided. If those colonies are not divided, swarming will occur, and the colonies will perish. (Mythri *et al.,* 2018).

Thus, the only better option for increasing the number of stingless bee colonies is to separate the existing colonies. Colony division is another critical method in which many people follow an unrefined approach to split their colonies, which results in a lower success rate (Mythri *et al.,* 2018). There were limited number of studies regarding the suitable artificial hive models and the best technique to propagate the colonies to increase their numbers. Nevertheless, since stingless bees are eusocial insects, it is crucial to study and identify and recognize all the castes in a colony before dividing the colonies.

1.3 Significance of the study

This study mainly focuses on the most abundance stingless bee species in Malaysia, *H. itama* will provide the information for beekeepers to help them recognize all castes which is important in the dividing of colony process and also in monitoring the colony development. In order to maintain the stingless bees' farmer's industry in Malaysia, study on the biology and behaviour of their colonies especially for the colony development of stingless bees were needed.

In order to reduce the activity of cutting down trees, providing the stingless bee colonies with artificial (man-made) hives is a way to solve the problem. A scientific study on the best hives model for stingless bee's colony development is also lacking. Thus, it is crucial to understand the behavioural changes and colony development of stingless bee in the new environments. This study will help meliponiculture's farmers to gain information about all the castes of *H. itama*, the artificial hive models, how to propagate colonies and also the colony development.

1.4 Research Objective(s)

The objectives of the research: -

1. to describe the morphological characteristics of different caste in stingless bee *Heterotrigona itama*

2. to compare the different hive models for colony development of stingless bee *Heterotrigona itama*

3. to investigate the best artificial propagation technique for stingless bee *Heterotrigona itama*

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