REVIEW PAPER

THE RELATIONSHIP BETWEEN STINGLESS BEE AND NATIVE PLANTS STUDIES

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ABSTRACT

In the past decade, the benefits of stingless bee honey as an anticancer agent has increased in demand in Malaysia. Despite the increasing demand, the quality produced highly depends on a certain plant, *Ixora* spp. The practice of planting design in landscape development only by considering the aesthetic values leads to the poor productivity of stingless bee honey. Therefore, this review focuses on the suitability of native plants used in landscapes designed for stingless bees. This study employed thematic analysis related to the issues between native plants, stingless bee and landscape development. Based on the assessment, literature on stingless bees discussed issues related to its habitat in the tropical rain forest, the behaviour of finding food, characteristics of its honey and the benefits of consuming the honey. Meanwhile, studies on native plant demonstrated the use of plants in providing food and habitat to the local insects which contribute to the continuity of the species. As a conclusion, the quality of honey is dependent on the relationship between stingless bees and native plants. Hence, the native plants can be potentially used in planting design for the improvement of stingless bee honey production.

Keywords: Planting design, stingless bees, native plants, apiculture garden, honey productivity.

ABSTRAK

Dalam dekad lalu, permintaan di Malaysia terhadap kelebihan madu kelulut sebagai anti-kanser telah meningkat. Dengan peningkatan permintaan, kualiti madu yang dihasilkan sangat tertumpu kepada tumbuhan tertentu seperti *Ixora* spp. Amalan rekabentuk penanaman dalam pembangunan landskap yang hanya tertumpu kepada nilai estetika membawa kepada penghasilan madu kelulut yang tidak berkualiti. Oleh itu, ulangkaji ini menumpu kepada kesesuaian tanaman asli dalam rekabentuk landskap terhadap kelulut. Kajian ini mengunakan analisis terma yang berkaitan dengan isu di antara tanaman asli dan kelulut dalam pembinaan landskap. Berdasarkan kepada penilaian, literatur terhadap kelulut telah berbincang berkenaan habitat kelulut dalam hutan hujan tropika, tingkahlaku

dalam mencari makanan, ciri-ciri madu kelulut dan kelebihan memakannya. Sementara itu, kajian terhadap tanaman asli menunjukkan penggunaan tanaman dalam menyediakan habitat dan makanan kepada serangga asli yang menyumbang kepada kesinambungan spesies tersebut. Sebagai kesimpulan, kualiti madu kelulut boleh bergantung kepada hubungan diantara kelulut dan tumbuhan asli. Oleh itu, tumbuhan asli boleh digunakan dalam rekabuntuk penanaman sebagai peningkatan kepada penghasilan madu kelulut.

Kata Kunci: Rekabentuk penanaman, Kelulut, tanaman asli, kebun apikultur, produktiviti madu.

INTRODUCTION

The genus *Trigona* or commonly known as the stingless bee is found in tropical and subtropical regions especially in the Central and South America, Australia, Africa and Southeast Asia. They nest in the hollows of rotten logs that can be found in small and protected space (Patricio et al. 2002). Stingless bee which is indigenous and native is one of five hundred social native bee species that produce honey (de Lima et al. 2017). The monofloral honey produced by stingless bees is traditionally believed to be used for treatment purposes (da Costa et al. 2018; Ranneh et al. 2018). Melipoculture is trending in Malaysia by increasing of demand for source of colony either log system or hive system. Worth of hive system by 23% cheaper than log system with both systems offer margin exceeding 55% by RM32, 400 sale value per system indicates the better opportunity for the local to actively involved in meliponiculture (Basrawi et al. 2017). Available literature on stingless bee discuss issues pertaining to the quality of the honey (Aziz et al. 2017; Biluca et al. 2017; de Sousa et al. 2016) to fight disease (Kustiawan et al. 2014; Wan Omar et al. 2016) and as medicine (Choudhari et al. 2012; Rao et al. 2016). Besides, some studies also included the topic on the behaviour in finding food (Mc Cabe et al. 2015; Ragasa et al. 2015).

Stingless bees need suitable plants for surviving, as a suitable food source and shelter from danger. Honey is produced by stingless bees from gathered plant nectar which is then modified and stored it in their hive (Ranneh et al. 2018). Hence, the quality and productivity of honey are influenced by the available plants. Based on the behaviour of the stingless bee, native bees were observed to prefer native plants. The examples of Malaysian native plants visited by stingless bee are *Ixora* spp., *Averrhoa* spp., *Basilicum polystachyon*, *Biden pilosa*, and *Turnera ulmifolia*. In general, native plants provide several benefits to the surrounding ecosystem. Their resilience in their origin minimizes the impact on existing site ecology (Hoyle et al. 2017). For instance, native plants are adapted as phytoremediation elements in abandoned mining areas purposely to recover the land from the negative effects of the mining activities (Fernández et al. 2017). Besides, plant's adaptability to survive in constraint soil condition contribute to soil management studies (Salah et al. 2016). In addition, plants adaptability also increases the natural resources for creating long-term sustainability of ecology and environment (Phondani et al. 2016) by indirectly helping insects in many ways (Thomas et al. 2014). Therefore, the available literature indicated the suitability of native plants in term of their botanical properties for the sustainability of the native bees, i.e. stingless bees.

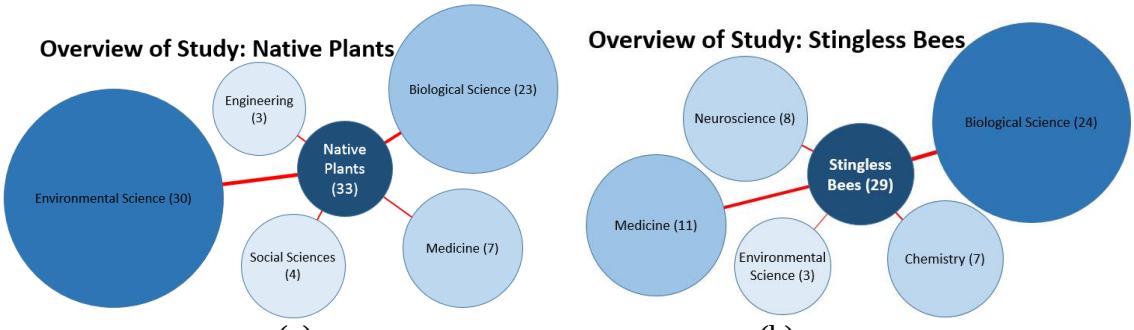
Stingless Bee Garden in Malaysia

Landscape development is one of the ways to improve our environments for quality living in urban or rural areas (National Landscape Department 2011). For example, in Malaysia,

landscape design was introduced before we attained independence in 1957. The landscape design was introduced by colonists according to their preferences (Abdul Malek 2016). Hence, the landscape design that was rapidly developed and designed were based on foreign ideology with the introduction of foreign plants (Abu Bakar 2002; Said & Wan Mohamad 2017). As a result of such development, the inaccessibility of native plants indirectly affected the quality of honey production by the stingless bees.

This paper reviews the suitability of native plants to be used in a landscape designed for the stingless bees. Therefore, this paper reviews available literature related to native plants and stingless bee in order to identify the relationship between these keywords, native plants and stingless bees, to the landscape design development.

Based on the screening and defining steps, the related articles published from 1996 to 2018 were defined into six disciplines which include (a) biological science, (b) chemistry, (c) medicine, (d) neuroscience, (e) materials science, and (f) environmental science. Lastly, the outcome stage is the process of identifying and finalizing the articles to be review in this study, a connection between native plants and stingless bees in landscape development is evident. The literature on native plants can be categorised into five disciplines namely, (i) environmental science, (ii) biological science, (iii) medicine, (iv) social science and (v) engineering as illustrated in Figure 1 (a). Meanwhile, Figure 2 (b) indicates that the overview of the literature on stingless bees categorised into five disciplines, which are (i) biological science, (ii) medicine, (iii) neuroscience, (iv) chemistry and (v) environmental science. Based on the disciplines, studies on native plants concentrate on the issues related to environment and biology, while the literature on stingless bee is only on the biology. Hence, the studies on stingless bee and native plant are primarily on biology, while the nature of stingless bee and the native plant were also frequently discussed.



(a) (b)

Figure 1. Review of two keywords (a) Native Plants and (b) Stingless bee

The overview based on the two keywords, stingless bee and native plants, directed this study to three major disciplines which are biological science, environmental science, and medicine as illustrated in Figure 2.

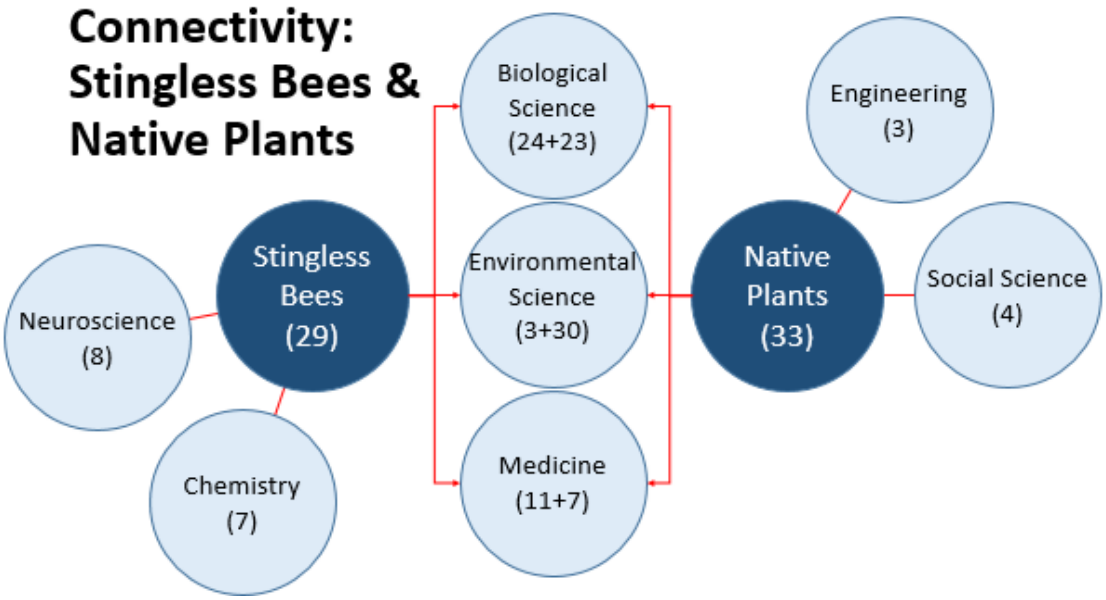


Figure 2. Interaction of studies between Stingless bees and Native plants

Table 1. The Related Themes of Stingless Bee and Native Plant

Stingless Bee	Native Plant
Biological Science	
-Structure of stingless bees' honey (Improvise structure/chemical; Structure profile of honey; Quality of structure (Abu Hassan et al. 2019; Biluca et al. 2017; da Costa et al. 2018; de Lima et al. 2017; MdZaki & Abd Razak 2018; Patricio et al. 2002; Ranneh et al. 2018)	
-Behavioural effects of stingless bees with flora (Differentiate food; Genus effects) (Azmi et al. 2016; Mc Cabe et al. 2015; Rosa et al. 2003; Roselino & Hrncir 2012)	-Benefits of native plants to human and environments (Water, air and land purification; Impacts of non-native plants) (Chandra et al. 2017; Mc Cabe et al. 2015; Sasmaz & Sasmaz 2017) -Plants survival (Effects of soil structure and quality; Growing capacity locally and globally) (Deng et al. 2016; Salah et al. 2016; Thomas et al. 2014)
Environmental Science	
-Effects of floral to the quality of honey produced (de Sousa et al. 2016; Ragasa et al. 2015; Rao et al. 2016)	-Perception of native plants (Impacts of landscape design; Sustainability and suitability; Functions of native plants in landscape development) (Hoyle et al. 2017; Phondani et al. 2016)
-Association between stingless bees and nest influencing their behaviour (Guard	-Ecological effects on plantings development (The quality of native plants; Animals habitats)

their nest against virus/parasite; Define their colony/community) (Kelly et al. 2014; Samsudin et al. 2018; Mohd Fahimee et al. 2016; Quezada-Euán et al. 2013; Reichle et al. 2013) -Behavioural effects of stingless bees with flora (Recall their memory; Communication; Pollen Collected; Bees Environment) (Jalil 2014; Lob et al. 2017; Mc Cabe et al. 2015; Rosa et al. 2003; Roselino & Hrncir 2012) -Effects of Human activities towards stingless bees' community (Floral effects) (Samejima et al. 2004)	(Samejima et al. 2004; Skurski et al. 2013) -Plants survival (Landscape management and maintenance; Effects of human settlements) (Deng et al. 2016; Salah et al. 2016; Thomas et al. 2014)
Medicine -Benefits of stingless bee honey (Anticancer agents; Induce diabetic in male rats; Traditional medicine; Agriculture) (Aziz et al. 2017; Kustiawan et al. 2014; Mustafa et al. 2018;Ngalimat et al. 2019; Norowi et al. 2010)	-Benefits of native plants to humans and the environment (Healing; Foods and medicine; Honey quality) (Chandra et al. 2017; Fernández et al. 2017; Sasmaz & Sasmaz 2017; Yaacob et al. 2018)

Table 1 presents the relative connectivity or relationship between stingless bee and native plant (keywords) in biological science, environmental science, and medicine based on the available literature. Articles related to biological sciences suggested a relationship between keywords to the plants in an ecosystem. Besides, the studies related to native plants presented the benefits of native plants in an environment to humans, animals or insects. The studies present the natural functions of native plants in purifying polluted water, air and land, which is not possible by non-native plants. Moreover, native plants serve as a food source for the stingless bees as these native bees are able to find and differentiate food from native plants due to the genus effects as shown in Table 1.

In the environmental science discipline, the literature focused on two aspects. The first aspect is the impacts of native plants in landscape development due to their suitability and sustainability as they can easily grow and survive in the local condition. The native plants offer nutrients and suitability for the stingless bees in order to produce a good quality of honey.

On the other hand, the second aspect of the environmental science discipline described the behaviour of the stingless bees with native plants. Stingless bees build nests

in the hollow of the rotten logs. In their nests, they store food and nectar for the queen bee. They find quality food in plants by avoiding virus or parasite-infected plants. Besides, due to their familiarity, stingless bees depend on the floral to recall their memory and use it as a point for communication. Therefore, ecologically the native plants influence the behaviour and reactions of stingless bees.

The studies on stingless bees and native plants in the discipline of medicine described the functions and properties for healing and curing diseases. Based on the literature, stingless bee honey is an anticancer agent. Besides, the honey can also be used to induce diabetes in male rats and in traditional medicine. Meanwhile, studies on native plants also explained how plants could be used as medicine and food. Some of the available literature indicated the health benefits from the relationship between stingless bee honey and native plant which include healing, disease cure, as an anticancer agent, to induce diabetes and as medicine.

Conceptually, native plants can positively affect the stingless bees in producing good quality of honey in the structure profile. The suitability of nectar in plant species with the behaviour of stingless bee in selecting the nectar affects the production of honey. However, studies in showing the benefits of native plant and stingless bees in Malaysia is still minimal which indicating that apicultural farmer tend to choose non-native plant to increase their production. Thus, the landscape design by considering native plants can aid in the production of good quality honey by the stingless bee and preserved the survival of native plant. Further investigation such as experimental tests on the plant species to producing a good quality of honey with structure profile is required. Moreover, guidelines for landscape developments are required in the field of the built environment to produce designs that support the needs of the local ecology especially stingless bees.

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