Stingless bee-keeping (Hymenoptera: Apidae: Meliponini) and Its Potency for Other Related-Ventures in West Sumatra

H Herwina1*, S Salmah1, M N Janra1, Mairawita1, J Nurdin2, Jasmi3, Yaherwandi4, Rusdimansyah5, D A Sari6

1 Animal Taxonomy Laboratory, Biology Department, Faculty of Mathematics and Natural Sciences, Universitas Andalas, Padang West Sumatra 25163, Indonesia.
2 Ecology Laboratory, Biology Department, Faculty of Mathematics and Natural Sciences, Universitas Andalas, Padang West Sumatra 25163, Indonesia.
3 Program of Nursing Science, College of Health Science Indonesia, Khatib Sulaiman Street, Padang, West Sumatra 25173, Indonesia.
4 Department of Pests and Plant Diseases, Faculty of Agriculture, Universitas Andalas, Padang, West Sumatra 25163, Indonesia.
5 Faculty of Animal Science, Universitas Andalas, Padang, West Sumatra 25163, Indonesia.
6 Biology Study Program, Sumatra Institute of Technology, Lampung Selatan Lampung 35365, Indonesia.

*hennyherwina@sci.unand.ac.id

Abstract. Stingless bees play important role in many aspects of human livelihood since people have now recognized the benefit of pollen, honey, and cerumen of stingless bees. From survey conducted across the beekeepers in West Sumatra Province, a total of 13 stingless bee species were identified from the West Sumatran beekeeping activities. The survey also aimed to assess the current condition of stingless beekeeping in this province. Heterotrigona itama was recorded as the most popular species for beekeeping, followed by Geniotrigona thoracica and Tetragonula laeviceps, while several Tetragonula members were the least favoured by the beekeepers, i.e. T. minangkabau, T. fuscoabacata and T. testaceitarsis. The number of colonies, experience in practicing beekeeping, marketing, beekeeper networking and other related aspects were also discussed in this paper.

1. Introduction

Stingless bees (Meliponini) are the largest and most diverse group of highly eusocial bees. They are restricted to tropical and subtropical habitats [1]. Indonesia as a tropical country has high species diversity of stingless bee. The stingless bees are globally more diverse than Apis bee, with approximately 500 species; most produce honey which can be sustainably exploited for humans’ needs [2].

Stingless bees play important role in ecological and economical aspects. Many people use bee pollen, honey and propolis produced by stingless bees. Traditional people with their indigenous knowledge has proved to be vital in understanding local dynamics of stingless bee faunas as well as the supporting sustainable ecosystems for stingless, in which local people can culturally and...
financially get benefit from it [3]. This indigenous knowledge fully understands that the increase of bees and other pollinator in their environment will in turn induce the better agriculture production to the maximum level. In reciprocal point of view, floral diversity in the form of hedges, weed patches, field margins, and uncultivated land should be maintained available to keep the abundant and diverse pollinator assemblages including the stingless bees [4].

In nowadays, the stingless beekeeping bees have been widely developed in many areas in Indonesia. Current record lists 46 stingless bee species exist across Indonesia, with most of these occurring on Sumatra and Kalimantan [5]. The purpose of this study was to make the inventory of stingless bee species involved in the beekeeping in West Sumatra, the current progress of provincial stingless beekeeping, possible problem(s) and other ventures that can be tailored to the stingless beekeeping in West Sumatra.

2. Materials and Methods
2.1. Study Site and Sampling Method
This research had been conducted from April of 2019 to August of 2020 by Direct Sampling Method to collect stingless bee species. The stingless bee was collected by using pincers then kept in a vial with 96 % alcohol. A questionnaire was developed to collect social information regarding beekeeping through in-depth interview with selected respondents from 16 stingless beekeeping locations in West Sumatra (Figure 1). The information from respondents were recorded, including respondent’s identities, number of colony possessed, their knowledge on reared stingless bee species, the source of colony they raise, production improve strategy, technical problem (e.g. pest and diseases), beekeeping education or training status and problem solving strategy for beekeeping activities. A renown education activity for stingless beekeeping and strategy meeting in Desa Santur, Sawahlunto City was also visited for further study.

2.2. Data Analysis
Stingless bee samples were observed for their morphological characters using microscope, in which their identity determined upon. It was continued with mounting and photographing the specimens. Identification key used proper reference for West Sumatra [6]. The data obtained from questionnaire survey was clustered in according to its question criteria to draw the tendency from respondents’ answers. The results were then thoroughly discussed.

3. Result and Discussion
3.1. The stingless bee species in West Sumatran beekeeping
A total of 13 stingless bee species identified from the beekeeping in West Sumatra; they belong to six genera. Ten stingless bee species (of five genera) were recorded as the favourite species for beekeeping. The number of stingless bee species and genera identified in current study exceeded the number of stingless bee species and genera reared in India with only two genera and six species [7].

Stingless bee colonies were generally settled within roofed wood box that topped of original nesting; infrequently, the colony removed into box immediately following the colony trapping or hunting from the wild. Most stingless beekeeping was arranged to produce main products such as honey, propolis and bee pollen (Figure 2) [3].
Figure 1. Map of stingless beekeeping (Meliponiculture) at 16 locations of West Sumatra. 1 = Biological Education and Research Forest (BERF) of Universitas Andalas, Padang, 2 = Sungai Lasi, Solok, 3 = Kelok Macan, Sawahlunto, 4 = Lalan, Sijunjung, 5 = Dasawisma Nagari Lalan, Sijunjung, 6 = YF Farm, Sijunjung, 7 = Sungai Dareh, Dharmasraya, 8 = 7 Koto, Padang Pariaman, 9 = Sicincin, 10 = Pariangan, Batusangkar, 11 = Padang Panjang, 12 = Dinas Kehutanan, Payakumbuh, 13 = Sarilamak, Payakumbuh, 14 = Sianok, Bukittinggi, 15 = Solok Selatan, 16 = Ngungun Saok, Lubuk Minturun Padang.

Figure 2. The stingless beekeeping (Meliponiculture) in West Sumatra. a. Stingless bee colonies reared inside roofed wood box atop the original nesting logs, b. Honey extraction from H. itama colony, c. Fresh stingless bee honey.

Stingless bee H. itama was the most common species for beekeeping as it is reared by at least 20 stingless beekeepers surveyed in this study (77 %). It was followed by G. thoracica, kept by 15 beekeepers (58 %) and T. laeviceps that found in seven beekeeper locations (27 %). Meanwhile, T. minangkabau, T. fuscobaleta and T. testaceitarsis were observed keeping in four, three and two beekeeping locations. The species T. bingham, L. terminata, L. carnifrons and H. fimbriata were only recorded in one beekeeping location respectively (Figure 3 and Figure 4).
Figure 3. Three dominant stingless bee species used for beekeeping (Meliponiculture) in West Sumatra. a. Worker of *Heterotrigona itama*, b. Worker of *Geniotrigona thoracica*, and c. Worker of *Tetragonula laeviceps*.

Figure 4. Stingless bee species and number of beekeepers that rear it in West Sumatra. H.f = *Homotrigona fimbriata*, L.c = *Lophotrigona canifrons*, L.t = *Lepidoptrigona terminta*, T.b = *Tetrigona binghamii*, T.t = *Tetragonula testaceitarsis*, T.f = *Tetragonula fuscobaelata*, T.m = *Tetragonula minangkabau*, T.l = *Tetragonula laeviceps*, G.t = *Geniotrigona thoracica*, H.i = *Heterotrignona itama*.

The favourableness in rearing *H. itama*, *G. thoracica* and *T. laeviceps* by most beekeepers is presumed to be based on the specific features of each species. *H. itama* size becomes the middle among the three favourite species. These stingless bees can build large colonies which in turn increase the production of honey, propolis and other bee products. A colony of *H. itama* can produce more than 500 ml honey in its monthly harvest, freshly tasted as sweet and sour (*pers. obs.*). The stingless bee *G. thoracica* was reported as the biggest in Malaysia with significant production of honey and propolis, and in addition behave friendly toward the beekeepers [8]. Albeit its honey tasted sour, the price for its colony was recently reported to be expensive. On the other hand, *T. laeviceps* is quite small, but this lack in size is balanced with its eagerness in building new colony. The honey is sweet and bee workers are friendly to human (Figure 3).

There were three stingless bee species that were collected around beekeeping locations, but not yet including as rearing species. They were identified as *Sundatrigona moorei* (collected from a tree near beekeeping area in Ngarai Sianok Bukittingi), *Tetragonula collina* (it was with a colony on tree near
beekeeping area in Lubuk Minturun Padang) and *Tetragonula biroi* that was non-Sumatran native species brought in by a beekeeper in Sijunjung area. It is found out that *Tetragonula* become genus with the most species observed in this study (five species), similar with our previous finding in Universitas Andalas Campus Complex (*pers. obs.*) but fewer than what recorded in Malaysia [8].

3.2. Conditions, problems (pests, diseases) and improvement plan for stingless beekeeping

Based on the survey, most of the beekeepers’ experience in beekeeping stretch back to around a year. Most of them develop their rearing population through hunting in the wild or through buying the colony from other succeeded beekeepers. They also attempt to divide the developed colony by putting a new box next to the old one and let the colony extend their population into the new box. The development of colony population in each respondent beekeeper is shown in Figure 5. This figure mean the ongoing efforts attempted by the beekeepers in order to multiply their stingless colonies that help in improving the bee products.

![Figure 5. The dynamics of stingless bee colony observed in 26 stingless beekeepers.](image)

The beekeepers revealed that they sell the honey they collected by themselves (Figure 6), aside using it for their own need. There was indication of infrequent use of online market for selling bee products and, in very rare occasion, through the service of broker agent. The latter mentioned party unfortunately buy the honey and other bee products with low prize. In many case, the selling of bee products is arranged upon appointment, recall the still limited volume of bee products can be currently provided by the beekeepers.

Stingless bee products promise potential and profit in the market, a fact that should drive the beekeepers to put their best effort in achieving it, e.g. through the multiplication of stingless bee colonies. Adding to this, the beekeepers should also understand what essential for improving bee products: providing sufficient space and food. Experienced beekeepers will afford planting abundant flowering plants as food resources; it usually stimulates the stingless bees to produce more honey and other bee products. This effort should be easily implemented by other beekeepers to reach the same objective [4].

Knowing diet composition and food sources for stingless bee is essential for furthering the beekeeping activity as some stingless bee species may have restricted foraging range, meaning they only visit certain plant species for its nectar or resin. Some species may depend on a narrow amount of plant species, some others may gain their food from some plant genera, while others independently use wider range of plant from one or several plant families [9]. Maintaining water content within the honey is believed to be a way to better the honey quality. Beekeepers usually achieve this through
careful maintenance humidity in stingless bee colonies. They also upgrade the appearance of the bee products through the use of interesting product package (Figure 7).

Figure 6. The marketing strategy applied for bee products in Padang West Sumatra.

The beekeepers also shared their knowledge on what factors determining the volume and quality of stingless bee products (Figure 8). There were accumulatively 12 factors recorded as problems in stingless beekeeping, with the most considered one come from the ants’ infestation upon the stingless bee colonies (14 respondents), following by predation by gecko (8) and the growth of disadvantageous fungi (8). Spiders, centipedes, insect larvae, frogs and termites were found to play certain amount of disturbance in beekeeping, while the use of pesticides, the existence of dragonflies and BSF was reported as the minor pests.

Figure 7. Efforts to improve the amount and quality of stingless bee products in West Sumatra
Figure 8. Potential disturbance and disruption in beekeeping in West Sumatra.

Beekeepers prevent the damage on colony by removing the stingless bee colonies and regularly cleaning them to avoid the disturbance from predators (ant and gecko), diseases mediated by the growth of fungi and other possible disturbing factors. The beekeepers frequently use chemicals as the fastest method to eliminate the disturbing factors. Sticky traps, that indiscriminately trap any incoming insects including the bees, were also observed in use (Figure 9). Most of the stingless beekeeper do not have proper training in beekeeping (81%); nevertheless, around 65% of surveyed beekeepers admitted their use social media (beekeeping community group) to discuss about their beekeeping problems with others in order to find solution (Figure 10).

Figure 9. Prevention efforts to maintain stingless bee colony from damage in West Sumatra
3.3. Possible related-ventures tailored with stingless beekeeping in West Sumatra

Aside from producing the standard products (honey, propolis and bee pollen), the stingless beekeepers actually sense the possibility to broaden the scope of their activities with something related to and support the beekeeping, such as erecting the plant nursery in the nearby. This will provide source of food (nectar) or resin, in addition to have commercial decorative plants they can also sell. Other beekeepers also do side job in manufacturing colony boxes, portable vacuum for honey harvesting, beekeeper apparels, various honey bottles and product packaging for propolis and bee pollen. The latter two products are priced highly in pharmacy due to their important chemical content that can be processed into medicines, health supplements or cosmetics. The improvement for these products require training and collaboration with scientists, experts and industry sectors.

Ecotourism can also be developed and integrated into the stingless bee farms. The uniqueness of stingless bee colony, their interaction with plants and environment and the experience to harvest honey and propolis can be sold to the tourists and visitors. Some of beekeeping farms in West Sumatra have seen this opportunity and started to improve their location with stingless bee friendly conditions. In
Sawahlunto City, less than a year after the training on stingless beekeeping and strategic planning was conducted, a young beekeeper started his collaboration with municipal authority and forming joint activities mainly focus on stingless beekeeping inside the Kandi Fruit Park that located in the city.

In Kandi Fruit Park of Sawahlunto City, the exhibition and presentation of beekeeping process was prepared in an interesting way to deliver to the coming visitors, while the honey harvesting experience should be available on appointment-base and charged with special rate. Some stingless beekeepers developed a combination between the attractive life of the stingless beekeeping with cafeteria service or with herbal shops and fruit tree nursery.

Observing this exciting development in stingless beekeeping, support from government authority and collaboration between beekeepers with related institution is deemed very important. Creating appropriate environment for stingless bees that integrated with agricultural sector can create high diversity edge zone that assist the conservation and sustainability of bees and stingless bees. This, in turn, will also guarantee the pollination that is crucial for agricultural plants. The diversity of flowering plants as food source should be continuously improved in all beekeeping locations. It is not only to maintain the health of stingless bee colonies and ensure their productivity, in overall, the diversity of plants will enhance the diversity of pollinators in general.

4. Conclusion
A total of 13 species of stingless bee species from six Meliponini genera were collected from 16 stingless beekeeping locations and 26 stingless beekeepers surveyed in this study. Ten stingless bee species were used as beekeeping, where *H. itama*, *G. thoracica* and *T. laeviceps* become the most popular species to rear in the beekeeping farms. Integrating beekeeping with other related ventures (ecotourism, experience sharing) can improve the total revenue earned from this activity. Meanwhile, the improvement effort for gaining better volume and quality of bee product not only help in diversifying the flowering plants in the surrounding, but also extending to the pollination process and help other pollinators to co-exist.

Acknowledgement
We thank all of the beekeeper that agree to be the respondents in this study. We also deliver our gratitude to the West Sumatra Stingless Bee Expedition teams for their help during fieldwork. This study was made possible through the funding provided by FMIPA Universitas Andalas, using Riset Dasar Research Funding with contract no: No: 29 /UN.16.03.D/FMIPA/2020 (Team Leader: Henny Herwina). The final manuscript of this publication was presented at Webinar SEMIRATA 2020 on The 4th International Conference on Mathematics, Science, Education and Technology (ICOMSET) in conjunction with The 2nd International Conference on Biology, Science and Education (ICoBioSE) virtually at Universitas Negeri Padang, Padang City, Indonesia on September 19th, 2020.

References
[1] Michener CD 2000 The bees of the world. JHU Press
[2] Engel MS, Kahono S and Peggie D 2018 A Key to the Genera and Subgenera of Stingless Bees in Indonesia (Hymenoptera: Apidae) *Treubia* 45: 65-84.
[3] Ayala R, Gonzalez VH and Engel M.S 2013 Mexican stingless bees (Hymenoptera: Apidae): Diversity, distribution, and indigenous knowledge Springer Verlag: 135–152.
[4] Nicholls CI and Altieri MA 2012 Plant biodiversity enhances bees and other insect pollinators in agroecosystems. *Agron Sustain*. Dev p 1-15. INRA and Springer-Verlag. France. DOI 10.1007/s13593-012-0092-y
[5] Kahono S, Chantawannakul P and Engel M S 2018 Social Bees and the Current Status of Beekeeping in Indonesia. In P. Chantawannakul, G. Williams & P. Neumann, eds. *Asian Beekeeping in the 21st Century*. Springer Verlag, 287–306.
[6] Sakagami S F and Salmah S 1990 Stingless Bees of Central Sumatra. In Sakagami S F Ogushi R and Roubik D W (eds.) *Natural History of Social Wasps and Bees in Equatorial Sumatera,*
pp.139-174. (Sapporo: Hokkaido University Press).

[7] Rahman A, Das PK, Rajkumari P, SAikia J and Sharmah 2013 Stingless Bees (Hymenoptera: Apidae: Meliponini) Diversity and Distribution in India International Journal of Science and Research 3: 77-81

[8] Samsudin SF, Mamat MR and Hazmi IR 2018 Taxonomic Study on Selected Species of Stingless bee (Hymenoptera: Apidae: Meliponini) in Peninsular Malaysia Serangga 2: 203-258

[9] Murray TE, Kuhlmann M and Potts SG 2009 Conservation Ecology of bees; populations, species and communities Apidologie 40: 211-236