ABSTRACT

Cultural Management of Stingless Bees for Sustainable Honey Production

Anthony S. Agravante, Francisco Gil N. Garcia, Neil Pep Dave N. Sumaya and Josephine R. Migalbin

Abstract. Stingless bees also known as Meliponini are highly sociable insects that are native to tropical and subtropical environments. These bees locally known as “kiyot” and “pilot” are important in a number of ways. These include pollination, production of medicinal honey and other hive products as well as their value in aesthetics. The study was conducted to determine the diversity of stingless bees at the University of Southern Mindanao and the environmental factors affecting diversity and abundance. In addition, pests and disease were identified in bee colonies and an agricultural system was developed for honey production. Using honey-bait technique, only *Tetrogonula biroi* dominated the stingless bee population in USM. Ecological factors affecting stingless bees diversity are temperature and relative humidity with an average of 31.62^{0}C and 75.50%, respectively. *Aspergillus* spp. is the fungus observed to be associated with mummified stingless bees. A one hectare was developed for a diversified cropping system. The area has existing crops like calamansi, coffee and papaya. The vacant area in between the existing crops were planted with different vegetables crops such as sweetpotato, eggplant, okra, pepper, bottle gourd, bitter gourd, alugbati, kangkong as intercrop. In addition, flowering plants like marigold, zinnia and sunflower were planted. The area was developed as bee pastures.

Keywords: stingless bees, *Tetrogonula biroi*, *Aspergillus* spp, agricultural systems, bee pastures

Cultural Management of Stingless Bees for Sustainable Honey Production

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UNIVERSITY OF SOUTHERN MINDANAO
Kabacan, Philippines

NARRATIVE REPORT

A. BASIC INFORMATION		
1. **Title**	Cultural Management of Stingless Bees for Sustainable Honey Production	
2. **Status**	☐ Ongoing ☐ Completed	
3. **Project Leader** **Study Leader** (Indicate College/Unit)	**Project Leader:** ANTHONY S. AGRAVANTE, MSc, Instructor I, USM PALMA Cluster Campuses **Project Staff:** FRANCISCO GIL N. GARCIA, PhD, Professor VI, University of Southern Mindanao NEIL PEP DAVE N. SUMAYA, MSc, Instructor 1, University of Southern Mindanao JOSEPHINE R. MIGALBIN, PhD, Professor VI, University of Southern Mindanao	
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4. **Lead Unit/College**	College of Agriculture	
Collaborating Unit/College	CBDEM, College of Agriculture	
5. **Category**	☐ Program ☐ Project ☒ Study	
6. **Classification**	☐ Research	☐ Development ☐ Extension
	☐ Basic ☐ Applied	☐ Pilot Testing ☐ Prototype Development ☐ Tech. Promotion/Commercialization
7. **Thematic Area**	☐ Quality Learning, Skills Development, and Literacy ☐ Social Development, and Strong Institutions ☐ Preservation of Culture ☒ Environmental Protection, Conservation, and Risk Reduction ☐ Food Security and Poverty Reduction ☐ Good Health and Well-being ☐ Innovations in Science, Engineering, and Technology ☐ Sustainable Entrepreneurship and Management	
8. **Project Duration**	One year (January 1, 2022- December 31, 2022)	
9. **Project Location**	University of Southern Mindanao	
10. **Total Budget Requested (Php)**	272,174.72	

B. TECHNICAL DESCRIPTION

1. Rationale / Significance

Stingless bees (also known as Meliponini) are highly sociable insects that are native to tropical and subtropical environments. These insects are the most diverse and largest group of corbiculate bees, with about 550 discovered species (Euglossini, Bombini, Apini, and Meliponini)(Shanahan & Spivak, 2021). In recent years, beekeeping activities in Malaysia, Southern Thailand, Indonesia, and Sri Lanka have increased the potential of honeybees as sources of food, additional income, and natural pollinators on crops. Pollination is an important service that increases food production and improves livelihoods. Some animals, such as bees, are the primary pollinators that provide this service. Bees play a critical role in the pollination of flowering plants, which results in a greater quantity and quality of fruits and seeds.

Honeybees are the most studied of all the bee species, and they are the most common. The stingless bee, on the other hand, may be of even greater importance as a pollinator in the tropics. Stingless bees, for example, are more effective pollinators of mango trees than honeybees, syrphids, and blow flies. Stingless bees are close relatives of honeybees and some workers of larger species. Their diminutive size reduced stinging apparatus, and lack of wing venation distinguish these bees from actual honeybees, which are distinguished by their larger size.

The diversity of stingless bees and the sustainability of honey production have not yet been studied in region 12, specifically in North Cotabato. Unfortunately, there are no data available, notably on the distribution of stingless bees and species richness. A study in this vein is therefore necessary so that knowledge about stingless bees may be shared with farmers and other individuals who are interested in learning more about them.

The study aimed to determine the diversity of stingless bees at the University of Southern Mindanao and to establish an agricultural system for sustainable honey production.

The specific objectives of the study are as follows:

1. to determine the distribution and species richness of stingless bees in USM;
2. to determine the ecological factors affecting stingless bees diversity and abundance;
3. to identify pests and diseases in bee colonies and
4. to develop an agricultural system for sustainable honey production.

2. Methodology

Component 1. Diversity and Abundance of Stingless Bees in USM

Bee surveys were carried out on cassava and lanzones areas near the College of Agriculture building using honey-baiting technique. Honey baits were created by combining honey and water in a 1:2 (honey:water, v:v) ratio with salt (NaCl) added at a 2 cm3 per 500 ml of the solution to produce a bait solution. At each site, one to three transect lines ranging from 0.5 to 1 km were established. Thirty jets (each containing 100 mL of bait solution) were sprayed on the plants between 30 and 100 cm above the ground and marked with colorful flagging tape every 20 m along the transects to indicate where the bait solutions were applied. Visual counting was done through careful observation of stingless bees in various plants. Ten continuous pendulum sweeps also employed sweeping techniques at 180 degrees taken from a single straight row. Insects were collected and stored in the laboratory for identification.

Fig 1. Spraying honey baits using honey and water in Lanzones area, USM, Kabacan, Cotabato.

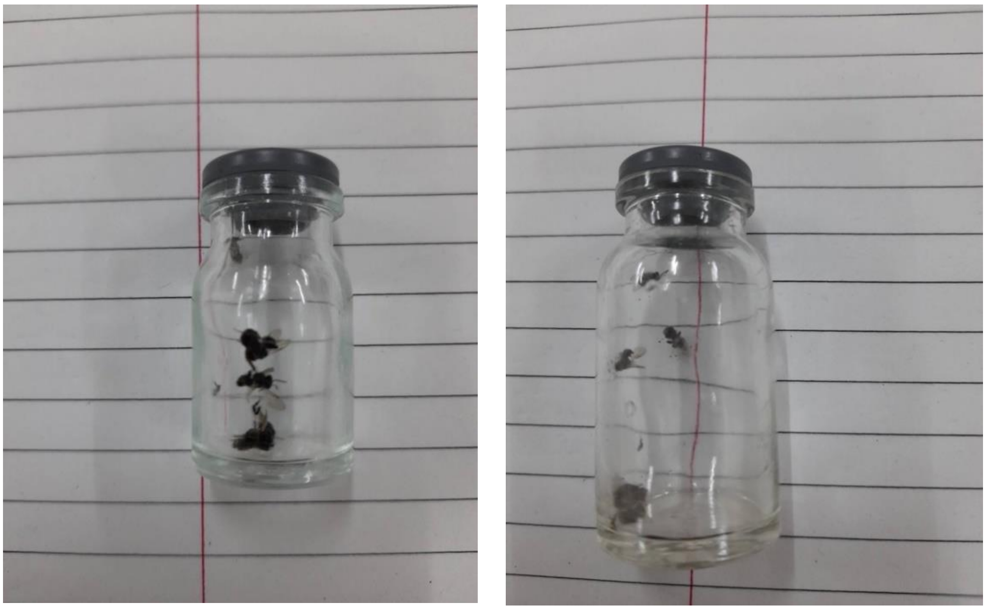

Fig 2. Collected stingless bees using honey bait technique

Component II. Ecological factors affecting diversity and abundance of stingless bees

Ecological factors such as daily temperature, relative humidity, and sunlight were gathered and recorded during the study.

Component III. Pests and Diseases of Beehives in USM

An initial search for stingless bee colonies was conducted on the USM campus. Isolation of potential entomopathogenic fungi (EPFs) from stingless bee samples collected in different areas within the University of Southern Mindanao (USM) was done following the methods described by Gandarilla-Pacheco et al. (2021) with modifications. Naturally-infected stingless bees were collected and brought to the Plant Pathology laboratory for processing. Briefly, all insect samples were disinfected with 0.05%

sodium hypochlorite for three minutes and then rinsed three times using sterile distilled water. Samples were then placed on the surface of the prepared potato dextrose agar (PDA) supplemented with 500 ppm of ampicillin. Cultures were incubated in an inverted position at room temperature. Purification of isolated EPF was done by transferring mycelial bits onto a fresh PDA slant to obtain axenic culture.

Insect pest identification was also carried out inside and near the colony/entrance. Hive's mites were sampled directly by randomly opening brood cells, particularly drone cells. With fine forceps, 100 to 200 cells were removed and inspected for the presence of mites. Adult bees were captured from brood combs and placed in jars with chloroform, ether, or alcohol introduced on a piece of cotton wool. The bees were buzzing, and the mites crawled all over the glass. Insect pests found near the hive's entrance were collected and stored in the laboratory for identification.


Figure 3. Survey of Stingless bee colonies and sample collection in USM.

Component 4: Establishment of agricultural system for sustainable honey production

An area of one hectare planted with calamansi, papaya, and coffee was utilized for the establishment of an agricultural system for sustainable honey production. The area was divided into four sections wherein the two sections with existing papaya, calamansi and coffee were planted with sweetpotato, okra, eggplant, squash, bottle gourd and bitter gourd in between the said crops. The remaining two sections were mostly planted with vegetable crops like egg plant, pechay, radish, eggplant, bottle gourd, alugbati, kakngkong and pigeon pea (kadyos). In addition, flowering plants like cosmos, marigold, zinnia and sunflower were planted around the area and in between the calamansi, coffee and vegetable crops to create an ambiance of bees pasture where stingless bees can be able to utilize the nectar of the flowers for honey production.


Fig 4. Clearing of area for the establishment of an agricultuiral system for honey Production.

Fig 5. Preparation of area for the development of agricultural system for honey production, USM, Kabacan, Cotabato

Fig. 6. Area prepared for the planting of different vegetable crops anf flowering plants

3. **Accomplishments**

Component 1: **Diversity and Abundance of Stingless Bees in USM**

Fig 7. Distribution of stingless bee colonies at University of Southern Mindanao - Main Campus, Kabacan, Cotabato. *Source: Google earth*.

Component 2: Ecological factors affecting diversity and abundance of stingless bees

The average temperature and relative humidity taken from February to October are shown in Table 1. The average temperature was 32.16 C and relative humidity of 75.44%

Table 1. Summary data or daily temperature and relative humidity

Month	Average Temperature (°C)	Relative Humidity (%)
February	30.92	75.64
March	32.32	74.96
April	32.92	75.60
May	32.32	75.64
June	31.92	75.96
July	32.32	76.64
August	31.94	74.96
September	31.32	74.64
October	33.42	74.96
Average	32.16	75.44

Component 3:

The diseased specimens of stingless bees were collected at the College of Agriculture, University of Southern Mindanao, Kabacan, Cotabato. Majority of the abandoned and active colonies were discovered in building crevices and tree branches (Fig. 1). Afterwhich, diseased samples were brought to the Plant Pathology Research Laboratory - USMARC for isolation and microscopic examinations.

Fig. 8. Active stingless bee colonies: tree branches (A), building crevices (B); abandoned colonies: building crevices (C), tree branches (D & E), and beehives with mummified stingless bees (F).

Cultural and Morphological Characterization

The colony characteristics and morphological structures of the most prevalent isolates were identified as presented in Fig. 3 and Table 1.

Aspergillus spp.

Colony growth, 25 mm in diameter at 7 days after incubation (DAI). Colony morphology, circular greyish-blue obverse, yellowish white reverse. Colony texture dominantly powdery, dense without zonation. Morphological structures, conidial heads radiate stipes, smooth, non-septate, thick-walled, hyaline conidiophore, and dark brown, biseriate, non-sepate, globose conidia.

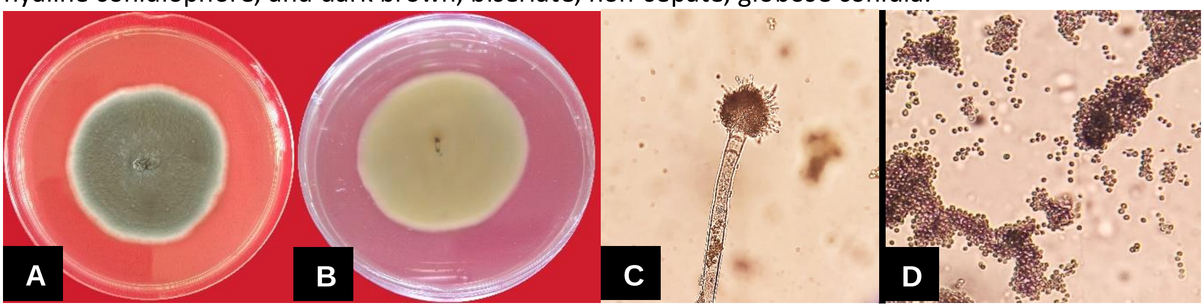

Fig. 9. *Aspergillus spp.* showing greyish-blue powdery colony (A), yellowish white (B), smooth, thick-walled, hyaline conidiophore (C), and pale brown, globose conidia (D).

Table 2. Colony and morphological structures of isolated fungi associated with mummified stingless bees. University of Southern Mindanao, Kabacan, Cotabato. 2022.

ISOLATES	CULTURAL CHARACTERISTICS	MORPHOLOGY		DIAMETER (mm)
		Conidia	Conidiophore &/or other structures	
CA-ISO 1	Circular, powdery, greyish-blue (obverse) and yellowish-white (reverse), medium dense, without zonation	Biseriate, dark brown, globose, non-septate	Hyaline, smooth, non-septate, thick walled	25.0 (7DAI)

Table 3. Occurrence of diseases of stingless bees in the premises of University of Southern Mindanao.

Location	Sampling Site (Building/Tree)	Coordinates	Disease
College of Agriculture Annex Building	Building crevices	7.0649°N, 124.4955°E	-
	Tree branches	7.0649°N, 124.4955°E	-
College of Agriculture Main Building	Building crevices	7.0647°N, 124.5000°E	+
Agricultural Training Institute Building	Building crevices	7.0636°N, 124.5037°E	-
USMRDC Administration Building	Building crevices	7.0637°N, 124.5102°E	-
	Tree branches	7.0637°N, 124.5102°E	+

Component 4: Establishment of agricultural system for sustainable honey production

An area of one hectare planted with calamansi, papaya, and coffee was utilized for the establishment of an agricultural system for sustainable honey production. The area was divided into four sections wherein the two sections with existing papaya, calamansi and coffee were planted with sweetpotato, okra, eggplant, squash, bottle gourd and bitter gourd in between the said crops. The remaining two sections were mostly planted with vegetable crops like egg plant, pechay, radish, eggplant, bottle gourd, alugbati, kakngkong and pigeon pea (kadyos). In addition, flowering plants like cosmos, marigold, zinnia and sunflower were planted around the area and in between the calamansi, coffee and vegetable crops to create an ambiance of bees pasture where stingless bees can be able to utilize the nectar of the flowers for honey production.

The development of the area as an agricultural system for sustainable honey production started with land preparation in between the existing calamansi and coffee trees. After the area was tilled, vegetable crops were planted, harvested, planted again and harvested again during the whole duration of the study.

Twelve bee houses were made and placed strategically within the one hectare area for bee culture (meliponiculture) and production of honey.

Fig. 10. Cleaning and maintenance of area planted with vegetable crops planted in between calamansi and coffee trees

Fig. 11. An area planted with indigenous vegetables within the one ha. area developed.

Fig. 12. Area developed was also planted with flowering plants like zinnia, cosmos, marigold

Fig. 13. The area in between calamansi and coffee trees are planted with camote and okra.

Fig.14. Another part of the area developed as agricultural system planted with other crops.

Fig. 15. Beehive houses/shelters within the one hectare area developed as bee pastures planted with different vegetables, calamansi, coffee and flowering plants like zinnia, cosmos and marigold

Shanahan, M., & Spivak, M. (2021). Resin use by stingless bees: a review. Insects, 12(8), 719.

Kwapong, P., Aidoo, K., Combey, R., & Karikari, A. (2010). Stingless bees. Importance, management and utilization. A training manual for stingless beekeeping.

Silva, F. D. S., Carvalheiro, L. G., Aguirre-Gutiérrez, J., Lucotte, M., Guidoni-Martins, K., & Mertens, F. (2021). Virtual pollination trade uncovers global dependence on biodiversity of developing countries. Science Advances, 7(11), eabe6636.

Howlett, B. G., Todd, J. H., Willcox, B. K., Rader, R., Nelson, W. R., Gee, M., ... & Davidson, M. M. (2021). Using non-bee and bee pollinator-plant species interactions to design diverse plantings benefiting crop pollination services. In Advances in Ecological Research (Vol. 64, pp. 45-103). Academic Press.

Angelella, G. M., McCullough, C. T., & O'Rourke, M. E. (2021). Honey bee hives decrease wild bee abundance, species richness, and fruit count on farms regardless of wildflower strips. Scientific reports, 11(1), 1-12.

Barrera Jr, W. B., Brosas, J. V., & Sacil, M. D. (2021). Pollen sources of Tetragonula biroi (Friese, 1898)(Hymenoptera: Apidae, Meliponini) in two agroecosystems in Nagcarlan, Laguna, Philippines. Palynology, 45(2), 215-223.

Anderson, D. L., Sedgley, M., Short, J. R. T., & Allwood, A. J. (1982). Insect pollination of mango in northern Australia. Australian Journal of Agricultural Research, 33(3), 541-548.

Almazol, A. E., & Cervancia, C. R. (2014). Pollen sources of bees in Pagbilao mangrove ecosystem. The Philippine Entomologist, 28(2).

Fenster, C. B., Armbruster, W. S., Wilson, P., Dudash, M. R., & Thomson, J. D. (2004). Pollination syndromes and floral specialization. Annu. Rev. Ecol. Evol. Syst., 35, 375-403.

Heard, T. A. (1999). The role of stingless bees in crop pollination. Annual review of entomology, 44(1), 183-206.

Kearns, C. A., & Inouye, D. W. (1993). Techniques for pollination biologists. University press of Colorado.

Malerbo-Souza, D. T., Nogueira-Couto, R. H., & Couto, L. A. (2004). Honey bee attractants and pollination in sweet orange, Citrus sinensis (L.) Osbeck, var. Pera-Rio. Journal of Venomous Animals and Toxins including Tropical Diseases, 10, 144-153.

Morgan, M. T., Wilson, W. G., & Knight, T. M. (2005). Plant population dynamics, pollinator foraging, and the selection of self-fertilization. The American Naturalist, 166(2), 169-183.

Schemske, D. W., & Horvitz, C. C. (1984). Variation among floral visitors in pollination ability: a precondition for mutualism specialization. Science, 225(4661), 519-521.

4. Problems Met and Recommended Action

1. Suppliers of beehive are not PhilGEPS-compliant
2. Resignation of Project Leader

5. Budget Utilization

Component	Allocation	Utilized	% Utilized

6. **Attachment**s:

   a. Data, supplementary table and/or figures, photo documentation (when applicable)
   b. Workplan