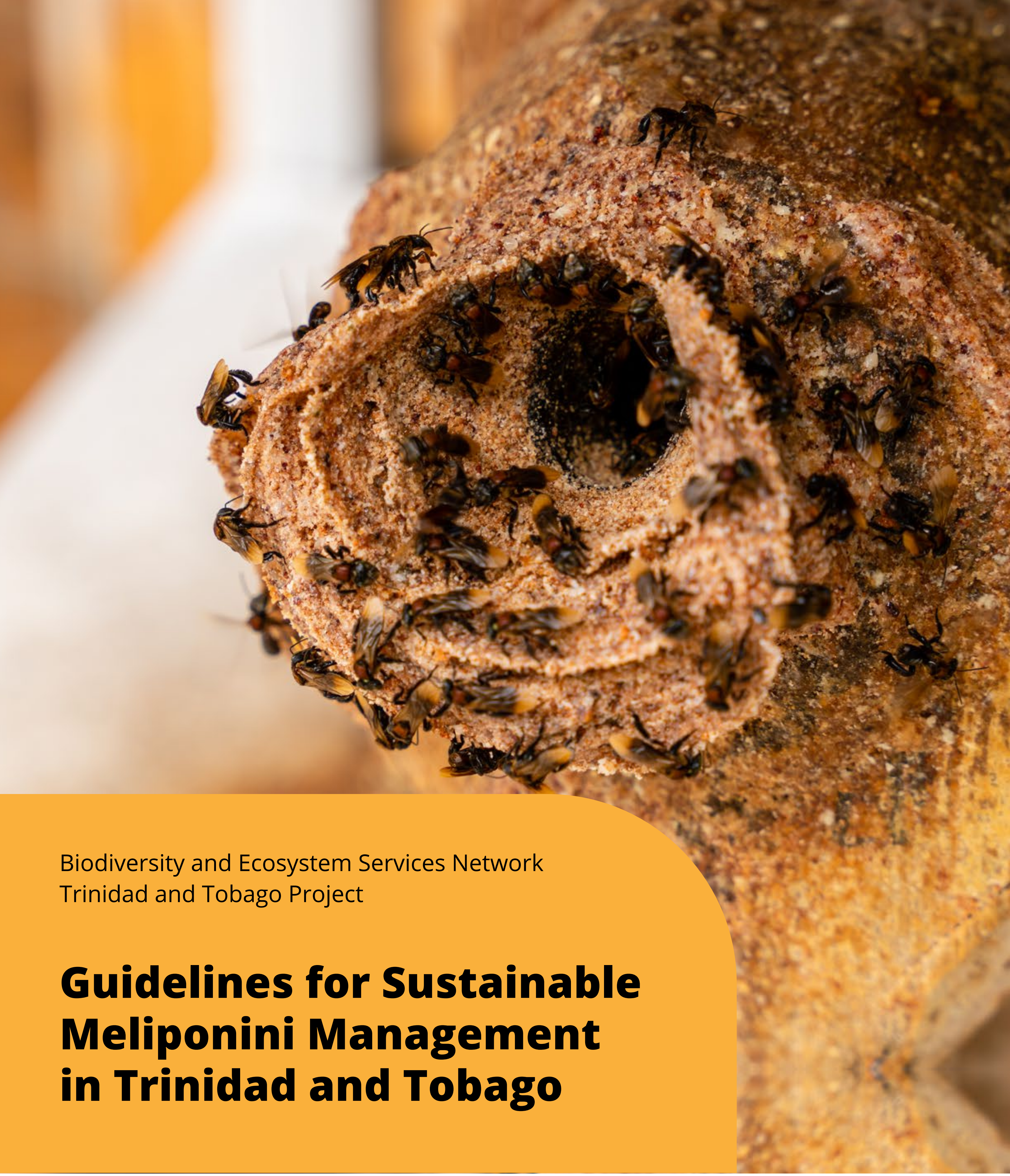

Biodiversity and Ecosystem Services Network
Trinidad and Tobago Project

Guidelines for Sustainable Meliponini Management in Trinidad and Tobago

Government of the Republic of Trinidad and Tobago
Ministry of Planning, Economic Affairs and Development

BESNet
Biodiversity and Ecosystem Services Network

UNDP

Biodiversity and Ecosystem Services Network
Trinidad and Tobago project

Guidelines for sustainable Meliponini management in Trinidad and Tobago

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The document was researched and compiled by Ms Celeste Chariandy, Science Communication Officer, BES-Net TT project, with a special contribution on stingless bee biology by Dr. Christopher K. Starr*, retired Professor of Entomology. Editorial support was provided by Mr. Shane Ballah, Project Manager and Dr. Lena Dempewolf, Biodiversity Specialist.

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Background

The Biodiversity and Ecosystem Services Network Trinidad and Tobago project or BES-Net TT project was administered by the Ministry of Planning and Development (MPD) with the support of the United Nations Development Programme (UNDP). The project was financed by the BES Solutions Fund of the Global Biodiversity and Ecosystem Services Network over the two-year period, 2021-2023.

Issues facing pollinators in Trinidad and Tobago largely stem from a lack of data, public awareness and pollinator-appropriate management. This project approached these challenges by engaging a broad range of stakeholders through a range of activities to address the science, policy and practice of pollination and pollinator management in Trinidad and Tobago.

The three expected outcomes were as follows:

- **Outcome 1:**
  Improved scientific knowledge of pollinators and pollination services in Trinidad and Tobago for improved decision-making
- **Outcome 2:**
  Improved conservation of pollinators and pollination services through improved plans and policies
- **Outcome 3:**
  The provision of education, tools and support to improve the practice and application of pollinator and pollination science in multiple contexts.

A practical approach undertaken in the project to achieve desired outcomes was building knowledge of threatened pollinator groups and passing on skills to assist in conservation of these organisms. To this end, the project undertook a series of workshops to share information on native stingless bees and how they are being successfully managed by local beekeepers. The activity sought to encourage growth of stingless bee beekeeping to conserve this particular group of very important pollinators.

Interaction with keepers of stingless bees yielded additional practical information on successful culturing of bee colonies which was documented and distilled for sharing with a wider audience. A Roundtable Discussion held among key stakeholders yielded advice for the development of this guidelines document.

Introduction

Pollination is a crucial process which is important for reproduction of many plant species. The transfer of pollen grains – which bear male reproductive material – to the external female reproductive parts of a flower is a first step in the process that leads to fertilisation, fruit and seed production and hence, plant reproduction. This is a critical process in the larger scheme of things, as the viability of plant species also impacts the viability of ecosystems and the many animal populations that depend upon plants for their nutrition, habitat and survival.

Over time, some pollinators have co-evolved with the plants they pollinate, with the plant architecture being particularly accommodating of the pollinating organism. Some native plants and pollinators demonstrate such close relationships, which underscore the importance of conservation of key pollinator species and maintaining populations of native plant species.

Bees are a well-known group of pollinators, they perhaps come closest to being the most deliberate pollinating agents, given that they actively as well as passively remove pollen from flowers, as they use pollen to feed their broods. In terms of general awareness, more persons seem to be familiar with exotic honeybees than native bees, and among native bees, people's awareness and knowledge of Meliponini or stingless bees was not widespread, according to results of a Knowledge, Attitudes and Practices (KAP) survey (BES-Net TT, 2022) undertaken by the BES-Net TT project.

Alongside limited awareness of these bees is limited awareness of threats they face. By sharing more information about these organisms with the public, it is hoped that harmful practices can be curtailed. The more obvious of these threats is widespread and unregulated pesticide use, however less understood is the importance of maintaining key habitats and niches where bees can safely exist and thrive. Another aspect less well known is how to supply bees with food sources to which they are most attracted, and which support their nutritional needs and the resources for hive maintenance and development.

The guidelines document therefore serves to present information to build knowledge of local Meliponini species and provide a 360° view of the best options for sustainable management of Meliponini in Trinidad and Tobago, to assist in maintenance of healthy populations of these insects locally.

Biology of Stingless Bees

Within the very large insect order Hymenoptera is a group of wasps that have made the radical switch from prey to pollen and nectar to feed their developing larvae. Their lives, therefore, are closely associated with flowering plants. This group – amounting to about more than 20,000 species worldwide – is known as bees. Among these is a distinctive group, the *corbiculate bees*, one of whose diagnostic features is a modification of the hind legs in females to form a device for carrying pollen. This *pollen basket*, or corbicula (Figure 1), gives the group its name. Corbiculae are polished depressions surrounded by a fringe of setae (hairs), which are not to be confused with scopae, which are composed of a mass of dense setae but lacking the depression and the fringe.

The corbiculate bees comprise four groups, two of which are the highly social honey bees and stingless bees (Michener 1974, 2007). Authors such as Grüter (2020), Melo (2021) and Roubik (2006) provide detailed reviews of the biology of stingless bees.

While the honey bees (genus Apis) comprise an estimated 11 species whose native ranges do not include the north-western hemisphere, there about 550 known species of stingless bees classified into more than 30 genera found throughout the tropical regions of the world. About three-quarters of these species are found in the New World tropics (Melo 2021). By present count, Trinidad is home to species of nine genera, namely *Cephalotrigona, Frieseomelitta, Lestrimelitta, Melipona, Nannotrigona, Partamona, Plebeia, Trigona* and *Trigonisca*, while Tobago is home to *Frieseomelitta, Melipona, Partamona, Plebeia, Trigona* and *Trigonisca* (Camargo and Pedro 2007, DeDijn 1998, Starr and Hook 2003). The South and Central American continental area has a great richness in species, while diversity within the Caribbean islands is much lower. Furthermore, it is uncertain whether any of the very few species found in the Antilles are native to those oceanic islands.

Along with the very large number of species, there is broad variation in body size, although most stingless bees are distinctly smaller than all but the smallest of the other corbiculate bees (Melo 2021). Associated with this small size is a tendency toward simplification of some body features. Among other things, the venom apparatus (i.e. the stinger and associated glands) is reduced to almost nothing and is nonfunctional, hence the group's common name. As is noted below, this does not mean that these bees are defenceless in the face of attack by natural enemies.

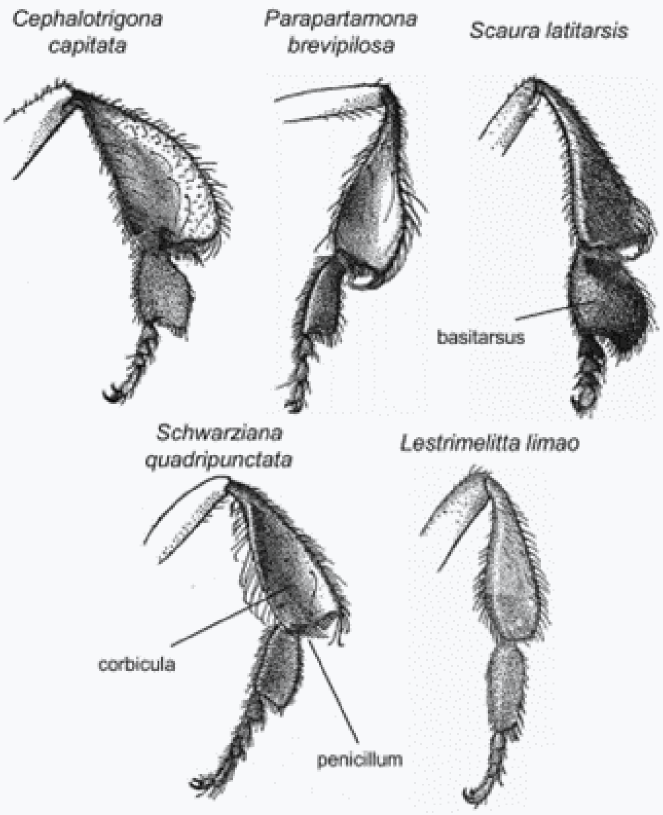


Figure 1. Hind legs of worker stingless bees to show the pollen basket on the outer side of the tibia. From Grüter (2020).

Species recorded from Trinidad and Tobago

All of the species recorded from these islands can confidently be assigned to genus. In some cases, the particular species is in doubt, either because the genus is in need of revision or because existing identification literature does not allow the matching of specimens to descriptions with certainty. Accordingly, some of the species' designations found here may be subject to change as more information is obtained. Thus far, seventeen (17) species of stingless bees have been recorded in Trinidad and Tobago; they are listed by scientific and common names in Table 1. This information has been compiled from Starr and Hook (2003), Moure's Bee Catalogue, Discover Life and the results of a 2023 bee survey undertaken by the BES-Net TT project, GEF SGP and the Trinidad and Tobago Field Naturalists' Club (see Resources section).

Table 1. A list of the stingless bee species (Meliponini) recorded in Trinidad and Tobago.

#	Scientific name	Common name	Island(s) on which recorded
1.	*Cephalotrigona capitata*		Trinidad
2.	*Frieseomelitta paupera*	Petite angel	Trinidad and Tobago
3.	*Lestrimelitta limao*	Lemon cab	Trinidad
4.	*Lestrimelitta spinosa*		Trinidad
5.	*Lestrimelitta guyanense (tentative, pending verification)*		Trinidad
6.	*Melipona favosa*	Erik, Moko chiquita	Trinidad and Tobago
7.	*Melipona lateralis*		Trinidad
8.	*Melipona trinitatis*	Guanot, Moko grande	Trinidad
9.	*Nannotrigona (new species)*		Trinidad
10.	*Nannotrigona nr. chapadana*		Trinidad
11.	*Nannotrigona testaceicornis*	Irai	Trinidad
12.	*Partamona nigrior*	Petit pegone	Trinidad and Tobago
13.	*Plebeia frontalis*		Trinidad
14.	*Plebeia tobagoensis*	Mirim	Trinidad and Tobago
15.	*Trigona amalthea*	Pegone	Trinidad and Tobago
16.	*Trigonisca pediculana*		Tobago
17.	*Trigonisca sp.*		Trinidad

Species descriptions are given with reference to Engel et al. (2023) and the Brazilian Association for the Study of Bees (see Resources section). Photographs (Figures 2 - 11) are provided with permission of contributors to the iNaturalist platform (https://www.inaturalist.org/) and the BES-Net TT team.

Cephalotrigona capitata

Cephalotrigona capitata is a very widespread species recorded from South America east of the Andes, including Trinidad. However, the genus needs revision and, according to Camargo and Pedro (2007) bees corresponding to *C. capitata* probably represent a complex of several species.

*Figure 2. Photograph of **Cephalotrigonisca capitata** bees.*

SIZE:
Worker bees are 8-10mm in length.

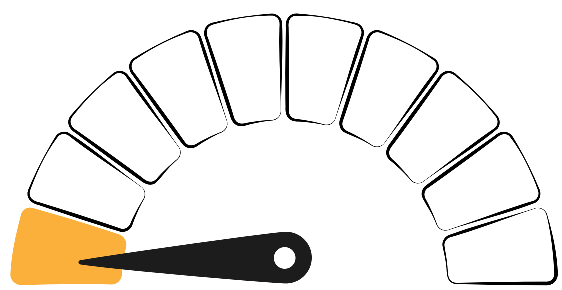
COLONY SIZE:
C. capitata colonies commonly number more than 1000 bees.

COLOUR AND MARKINGS:
Dark brown to black, wings appear to have a brown tint.

NEST STRUCTURE:
These are generally built in tree cavities, with entrances containing a small hole just large enough to fit one bee on a short, rounded platform. Materials used for construction are limited to cerumen and dark solid materials.

HONEY PRODUCTION:
Good quality, abundant storage of propolis.

GLOBAL DISTRIBUTION:
Mexico to southern Brazil and northern parts of Argentina.



SUITABILITY FOR BEEKEEPING:
Fairly difficult to maintain.

Notes on behaviour:

Important pollinator of annatto.

Limitations for study and identification:

Currently, there are only keys for the species from Mexico and Central America (Ayala, 1999) and a revision of the genus is needed.

Frieseomelitta paupera

Frieseomelitta paupera is found from northern South America (including Trinidad) north to Guatemala. This small, black bee has a superficial resemblance to *Partamona nigrior*, but is readily distinguished by its very long and narrow abdomen. Recognition of the genus is aided by the presence of yellow marks on the face bordering the compound eyes on the paraocular area and genae, among other features

Figure 3. Photographs of Frieseomelitta paupera (a) bee and (b) boxed colony.

SIZE:
Worker bees are 4–7mm in length.

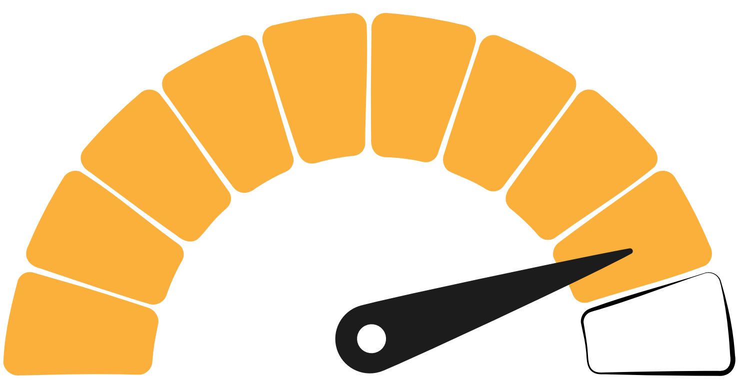
COLONY SIZE:
The average colony size is around 500 bees.

COLOUR AND MARKINGS:
Adults possess a black body with clear wings, while immature bees are whitish in colour. Adults begin to turn black fairly soon after emergence but the for the most part remain whitish for more than a week. *F. paupera* bees change colour with age and while immature bees are rarely seen outside of the hive, the colour variations give some indication of the ages of the various bees within the hive, which can be useful to beekeepers. This is illustrated in Appendix 1.

NEST STRUCTURE:
Internal nest structure is distinctive and brood is arranged in clusters.

HONEY PRODUCTION:
Honey produced by *F. paupera* has been used traditionally for medicinal purposes and not necessarily for food as it has a rather acidic taste. It is highly valued for its medicinal properties.

GLOBAL DISTRIBUTION:
Colombia, Costa Rica, Guatemala, Panama, Panama Canal Zone, Trinidad and Tobago, Venezuela.



SUITABILITY FOR BEEKEEPING:

Easy to box, manage and maintain but sensitive to phorid fly invasions.

Notes on behaviour:

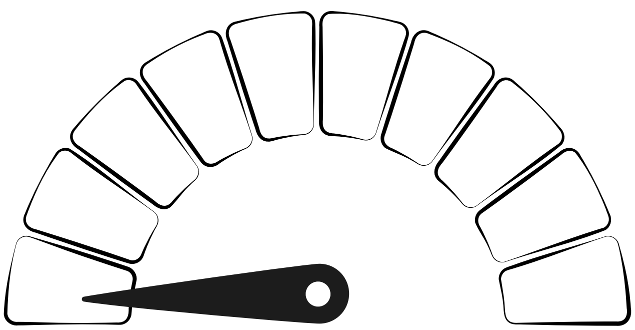
Members of the species do not bite or sting. *F. paupera* is known to pollinate avocado trees.

Limitations for study and identification:

Other listed species names include *Melipona paupera* and *Trigona parastigma*, although the latter may be an entirely separate species. Members of the genus found in Trinidad and Tobago may have previously been misidentified as *Frieseomelitta nigra*.

Genus Lestrimelitta

Thus far, *Lestrimelitta limao* and *Lestrimelitta spinosa* are recorded for the country, however, it should be noted that according to experts, it is likely that the *L. limao* identified in Trinidad and Tobago may actually belong to *L. spinosa* as identifications were completed before *L. spinosa* was described as a species. Additionally, *Lestrimelitta guyanense* resembles a species recorded from French Guiana, so it is plausibly also found in Trinidad. Their presence in Trinidad and Tobago remains to be verified through further study of the specimen. *Lestrimelitta* bees are not found at flowers as they instead rob other social bees of their resources.



SUITABILITY FOR BEEKEEPING:
It is not recommended to keep these bees as they negatively impact other Meliponini and are said to produce toxic honey.

Notes on behaviour:
Lestrimelitta are kleptobiotic (Roubik, 1980; Bego et al., 1991), in that they raid and rob other social bee species of resources to maintain their colonies, focusing mostly on brood provisions. The species that also reside in Trinidad and Tobago that are among those most frequently targeted include *Nannotrigona*, *Plebeia*, and *Melipona* (Sakagami *et al.*, 1993). Lemon-scented pheromones are released during an attack on a nest designed to confuse defense communication (Breed *et al.*, 2004). Raids can last from a few hours to several days.

Figure 4. Photograph of Lestrimelitta limao bees.

SIZE:
Worker bees are 4-7mm in length.

COLONY SIZE:
Colony composition has not been studied in *L. guyanense*, but colonies in this genus typically number a few thousand bees.

COLOUR AND MARKINGS:
Dark in colour (brown to black), with a shiny appearance and usually sparse hairs.

NEST STRUCTURE:
These bees are known to not initiate their own nests, but rather raid and displace other species of theirs and subsequently convert and build on the previous occupant's nest. Entrance tubes are often elaborate with several blind sacs, and often resemble the general shape of a saxophone, making it easy to distinguish from other species. The only other local species that builds more elaborate external structures is *Partamona nigrio*r, however, these are largely oval and bulbous in shape, and do not have long protruding entrance tubes.

HONEY PRODUCTION:
All *Lestrimelitta* bees are kleptoparasitic, which refers to their habit of raiding other Meliponini hives for honey instead of foraging on flowers for pollen and nectar. Additionally, the honey that *Lestrimelitta* bees produce is poisonous and should not be consumed.

GLOBAL DISTRIBUTION:
Mexico to Argentina.

Limitations for study and identification:
Lestrimelitta in Trinidad and Tobago requires further study as little is known about the various species inhabiting the islands. Data is further lacking on the composition and toxicity of their honey, including its application in medicine as its traditional use in some Latin American cultures has been focused on treating paralysis, specifically the honey derived from *L. limao*. It should once again be noted that consumption of the honey has been linked to illness and paralysis known as "mad honey disease".

Melipona favosa

Melipona favosa is widespread in northern South America, including both Trinidad and Tobago. Bees of the genus *Melipona* typically near the size of honey bees, although there is some variation. These are easily identified by their bright yellow and black stripes, orange-brown thorax and distinctive facial markings.

Figure 5. Photographs of Melipona favosa bee.

Photo courtesy wilsonlombada / iNaturalist

Figure 5. Photographs of Melipona favosa bee. cont'd

Photo courtesy miguel1080 / iNaturalist

Photo courtesy roger_ayazo/ iNaturalist

Photo courtesy elkinjmf / iNaturalist

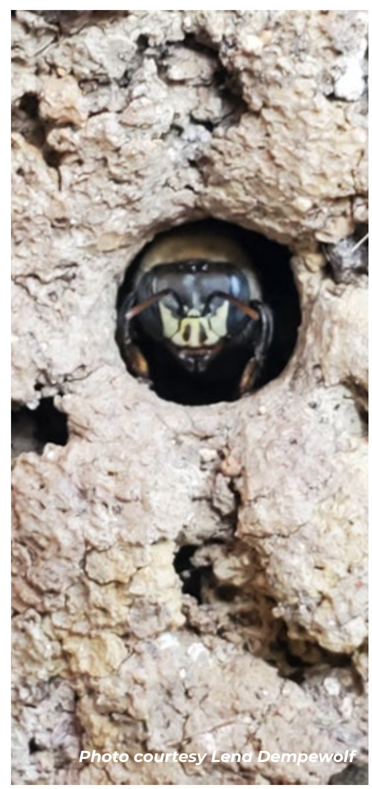


Photo courtesy Lena Dempewolf

SIZE:
Worker bees are approximately 9-15mm in length.

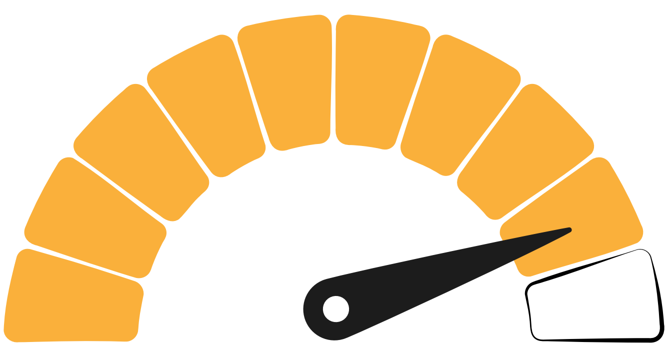
COLONY SIZE:
Several thousand bees.

COLOUR AND MARKINGS:
The thorax is quite hairy and reddish-brown in colour, while the abdomen possess black and yellow stripes, the latter of which are quite bright and lighter in colour than those of a honey bee (*Apis mellifera*). The heads of these bees are generally dark brown to black, with particular pale yellow to whitish facial markings.

NEST STRUCTURE:
These bees mainly nest inside of tree trunks. No external nest structure is visible besides a single entrance hole surrounded by a rim of radiating mud ridges (Sommeijer and de Bruijn, 1988). The entrance allows for the passage of one bee at a time. Interestingly, *Melipona* bees rear all castes and sexes from a single-sized brood cell, as opposed to a queen cell, which is done by all other social bees. Brood cells share walls and exist in a plane. Honey and pollen pots surround these.

HONEY PRODUCTION:
The honey is said to possess some medicinal properties, although information on this is scarce. Honey harvesting usually takes place once per year for up to 30 years, and volumes produced approximate 750-1000ml annually.

GLOBAL DISTRIBUTION:
Colombia, French Guiana, Guyana, Suriname, Trinidad and Tobago, Venezuela



SUITABILITY FOR BEEKEEPING:
These bees produce a comparatively large quantity of honey and are easily managed.

Notes on behaviour:

None

Limitations for study and identification:

None

Note on *Melipona lateralis*

Little is known on the presence of *Melipona lateralis* in Trinidad and Tobago, and there have been no recent reports of any observations of this species. It is, however, captured here for completeness of the record.

Melipona trinitatis

Melipona trinitatis is known from Trinidad and possibly Venezuela. These are the largest of the stingless bees known to Trinidad and Tobago. Colony size is unknown, but those of *Melipona spp.* tend to be no more than a few thousand bees.

Photo courtesy CChariandy / BES-Net TT

Figure 6. Photographs of Melipona trinitatis (a) bees and (b) boxed colony.

SIZE:
Approximately 9-15mm in length.

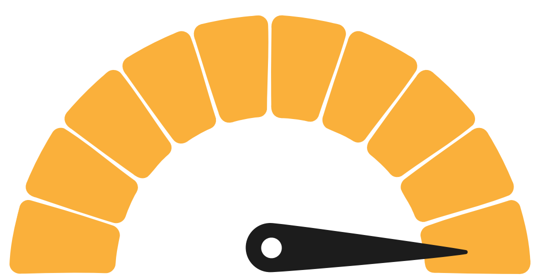
COLONY SIZE:
Several thousand bees.

COLOUR AND MARKINGS:
Head is dark brown, abdomen is reddish-brown, with lighter brown and fairly hairy thorax.

NEST STRUCTURE:
These bees mainly nest inside of tree trunks. No external nest structure is visible besides a single entrance hole surrounded by a rim of radiating mud ridges (Sommeijer and de Bruijn, 1988). The entrance allows for the passage of one bee at a time. Interestingly, *Melipona* bees rear all castes and sexes from a single-sized brood cell, as opposed to a queen cell, which is done by all other social bees.

HONEY PRODUCTION:
Anecdotally, this species produces the most honey of all of the stingless bees known to inhabit Trinidad and Tobago. The honey is considered to be of a high quality and much sought after for food and medicinal purposes.

GLOBAL DISTRIBUTION:
Trinidad and possibly Venezuela.



SUITABILITY FOR BEEKEEPING:
High. Honey production is comparatively high, and colonies are relatively easy to manage.

Genus Nannotrigona

Nannotrigona, together with *Plebeia*, and *Trigonisca* are the smallest of the Trinidad and Tobago Meliponini species.

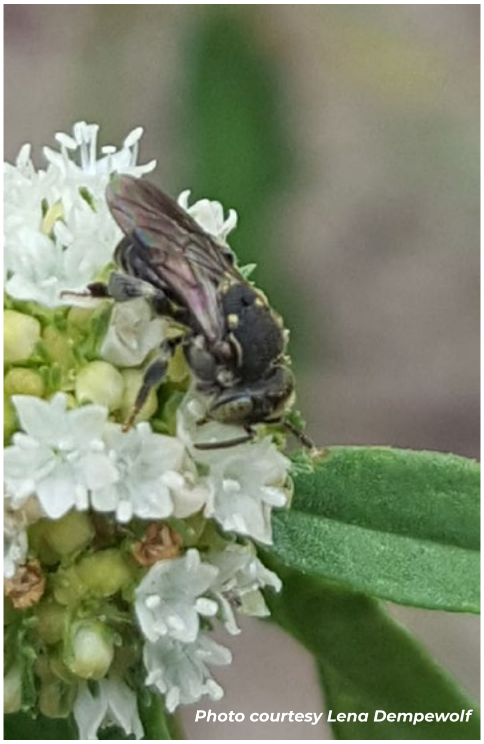
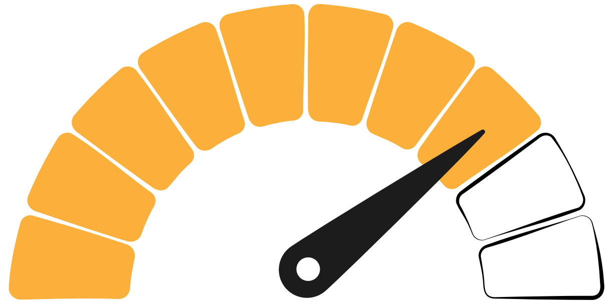


Figure 7. Photographs of Nannotrigona testaceicornis bees.

Limitations for study and identification:
Little is known about the species within Trinidad, and therefore requires further study.



SUITABILITY FOR BEEKEEPING:
The bees anecdotally produce little honey, but are easy to keep and manage and are excellent pollinators. It has been noted in some scientific papers that some species show potential for agricultural pollination and are easy to manage in meliponiculture. This is an area that needs to be further explored and studied.

SIZE:
3-5mm in length.

COLONY SIZE:
Studied members of the genus *Nannotrigona* have average colony sizes between about 1000 and 2500 bees.

COLOUR AND MARKINGS:
Nannotrigona testaceicornis has been described as black with grey hairs and coarse, wrinkled thorax, although members of the genus *Nannotrigona* that have been observed in Trinidad often appear brown in colour. Their diminutive nature sets them apart from many other species, and they are most easily separated from *Plebeia*, which are of approximately the same size, by *Nannotrigona's* bright yellow-green eyes. A newly discovered species of this genus (in Trinidad) is yet to be described.

NEST STRUCTURE:
The genus nests in tree cavities, but is also frequently found in built structures, such as walls and other cavities, such as holes in the ground. The entrance to the nest is often inconspicuous and either round or oval in nature, with some bees guarding the entrance. The brood is arranged in a similar way to that of *Melipona* sp.

HONEY PRODUCTION:
Volumes of honey produced by this species are anecdotally quite low.

GLOBAL DISTRIBUTION:
The genus has been found from Mexico to Argentina and Peru, but the distribution of the yet to be described species is unknown. *Nannotrigona testaceicornis* has reportedly been found in Argentina, Brazil, Paraguay, and Trinidad.

Partamona nigrior

Partamona nigrior is widespread in northern South America, including Trinidad and Tobago. This small, black bee superficially resembles *F. paupera*, but its broad abdomen sets it apart. Another member of this genus is shown to have an average colony size of about 2000, which is probably not very different from that of *P. nigrior*.

Photo courtesy L. Dempewolf / iNaturalist

Figure 8. Photographs of Partamona nigrior bee.

SIZE:
5-6.5mm in length.

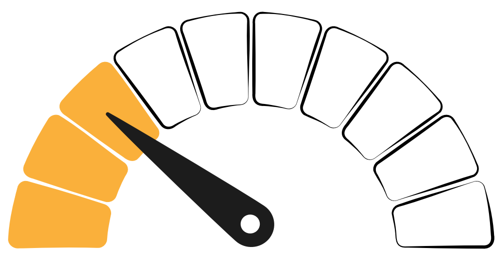
COLONY SIZE:
Approximately 2000.

COLOUR AND MARKINGS:
Generally black with opaque wings.

NEST STRUCTURE:
These bees build semi-exposed nests which can be found in tree cavities, structures such as houses and walls, and the ground. Additionally, *P. nigrior* builds external nest structures far exceeding a simple entrance tube that are easily spotted. Nest entrances can be wide and are often constructed of mud-like substances.

HONEY PRODUCTION:
Honey production: There have been mixed reports on honey production and more information is needed in this area.

GLOBAL DISTRIBUTION:
Brazil, Guyana, Trinidad and Tobago, Venezuela.



SUITABILITY FOR BEEKEEPING:
Beekeepers have been reporting difficulties in keeping this species and there have been mixed reports on honey production. Additionally, this species tends to bite to defend the nest, they are therefore challenging to maintain. They are, however, among the more abundant species found in Trinidad and Tobago

Notes on behaviour:
These bees bite to defend their colonies, so wearing appropriate beekeeping protective gear is recommended when interacting with hives.

Limitations for study and identification:
More information is needed on honey production and appropriate methods of management for this species.

Genus Plebeia

Two species of *Plebeia* have been reported for Trinidad and Tobago: *Plebeia frontalis* and *Plebeia tobagoensis*. Plebeia tobagoensis, based on current knowledge, was originally found in Tobago, hence the name. The species is thought to be endemic to Trinidad and Tobago. It is a very small bee, about the size of *Nannotrigona sp*. Its common name, "sugar-fly", derives from its attraction to dry sugar. The few studied colonies had an average of about 1200 bees.

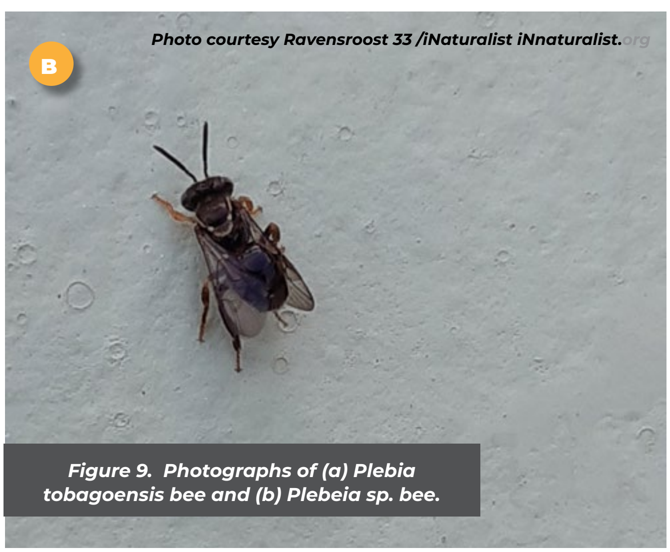


Figure 9. Photographs of (a) Plebia tobagoensis bee and (b) Plebeia sp. bee.

SIZE:
3-5mm in length.

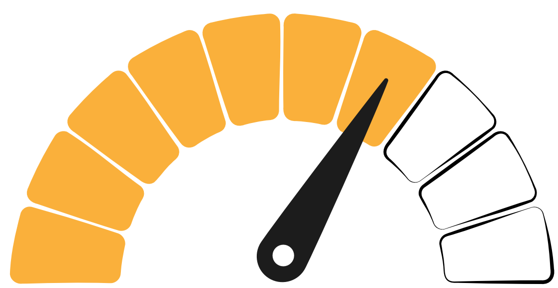
COLONY SIZE:
Approximately 1200 bees.

COLOUR AND MARKINGS:
Members of the genus *Plebeia* observed in Trinidad are either black or dark brown, or have a light brown abdomen with a dark brown or black thorax and a dark brown or black head. All of the observed members of the genus possess what resembles a yellow "U" outlining the dorsal area of the thorax (top view).

NEST STRUCTURE:
The only external indication of the nest is a narrow entrance tube. Nests are found in tree cavities and human built structures. They are further known to build brood combs.

HONEY PRODUCTION:
Anecdotally, honey production is low, however, more data is needed.

GLOBAL DISTRIBUTION:
For the genus *Plebeia*: Mexico to Brazil and Northern Argentina; *Plebeia frontalis:* Mexico, Colombia, Costa Rica, Guatemala, Honduras, Nicaragua, Panama, Panama Canal Zone, Trinidad and Tobago; *Plebeia tobagoensis:* Trinidad and Tobago.



SUITABILITY FOR BEEKEEPING:
These bees are excellent pollinators but there is little information available on the quality of the honey. Honey production is thought to be low, but more data is needed.

Trigona amalthea

Trigona amalthea is found throughout approximately the northern half of South America, including Trinidad and Tobago. Like *F. paupera* and *P. nigrior*, it is all black. However, it is much bigger than either of these, about the size of *M. favosa*. This large genus shows a great deal of variation in average colony size, from fewer than 1000 to more than 10,000, and in two species of *Trigona* this is even above 100,000. While the form of the inside of *T. amalthea* colonies is not known, it is reasonable to suppose that a healthy colony has some thousands of adults.

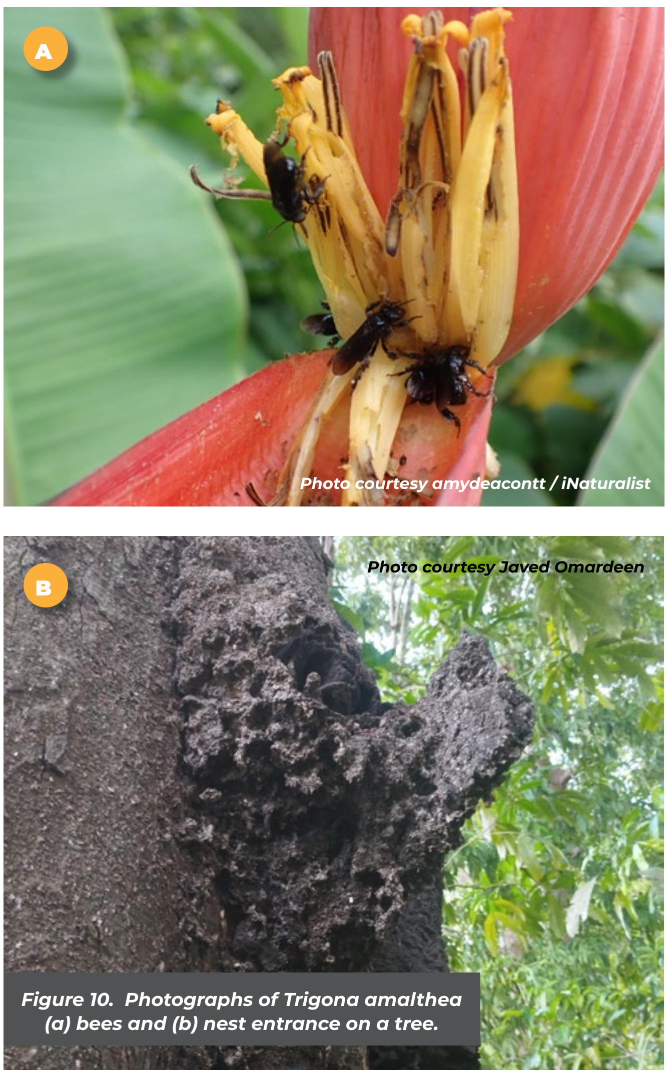


Figure 10. Photographs of Trigona amalthea (a) bees and (b) nest entrance on a tree.

SIZE:
8-12mm in length.

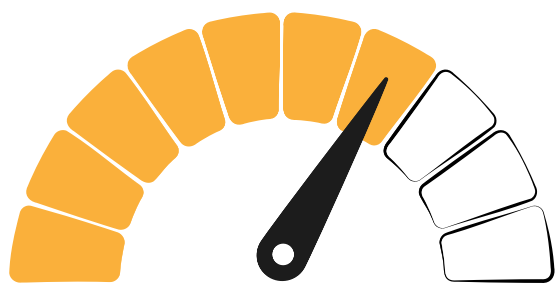
COLONY SIZE:
Highly variable, likely between 1000 and 10,000 bees.

COLOUR AND MARKINGS:
Black with opaque wings, often with a black tint.

NEST STRUCTURE:
Nests have been observed in tree trunks, built structures, palm treetops and in the ground, among others.

HONEY PRODUCTION:
Anecdotally, honey quality is high but more data is needed on the quantity and quality produced.

GLOBAL DISTRIBUTION:
Bolivia, Brazil, Colombia, Ecuador, French Guiana, Guyana, Peru, Suriname, Trinidad and Tobago, Venezuela.



SUITABILITY FOR BEEKEEPING:
More information is needed on the suitability of keeping these bees.

Notes on behaviour:

These bees are likely to bite to protect the nest, and will specifically aim for eyes, ears and hair when defending their colonies. Bee suits are recommended when working with this species. On a separate note, these bees have been reported for nectar robbing on some plants, as well as feeding on fruits. Caution is therefore advised if consideration is given to keeping this species on or near agricultural land.

Genus Trigonisca

Information on the genus *Trigonisca* in Trinidad and Tobago is scarce. The genus was first recorded in Trinidad by *DeDijn* in 1998. The recent bee survey conducted by BES-Net TT, GEF SGP and TTFNC found *Trigonisca pediculana* in Tobago. No updates have been made to the single observation in Trinidad in 1998. Overall, the two studied species in this genus (not found in the country) have very small colonies, typically fewer than 400 bees.

Figure 11. Photograph of Trigonisca pediculana bees.

SIZE:
2-5mm in length.

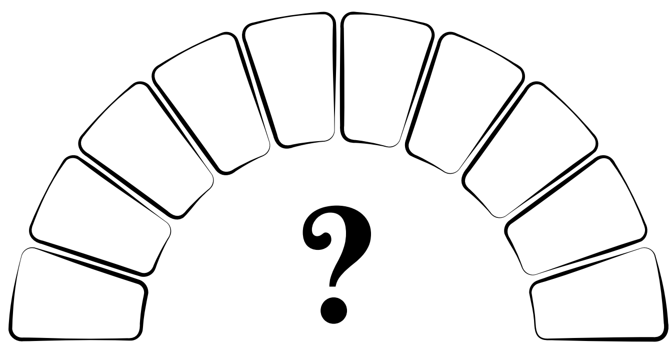
COLONY SIZE:
Typically fewer than 400 bees.

COLOUR AND MARKINGS:
These bees are very smooth, shiny, and polished and possess no yellow or white markings. They are usually dark in colour.

NEST STRUCTURE:
Small and inconspicuous nest entrance.

HONEY PRODUCTION:
More information needed.

GLOBAL DISTRIBUTION:
Bolivia, Brazil, Guyana, Trinidad and Tobago.



SUITABILITY FOR BEEKEEPING:
Unknown

Nest structure

The nests of stingless bees are more elaborate and certainly structurally more diverse than those of any other group of bees (Roubik 1989, 2021). Some, such as *Partamona nigrior*, build exposed nests on such substrates as tree branches and buildings, but most nest inside pre-existing cavities, often including within the walls of buildings. *T. amalthea* is reported to nest inside active arboreal termite nests in some areas. Regardless of whether the nest is exposed or hidden, its presence is revealed by a species-characteristic entrance tube that can vary considerably in length, diameter and degree of flaring toward the opening (Figure 12).

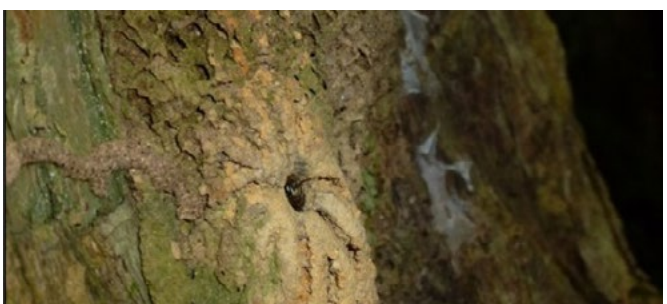


Figure 12. Nest-entrance tubes of stingless-bee species that typically nest inside hard-walled cavities.

Top left: Nannotrigona sp entrance tube projecting from a nest inside a building wall. The bees will usually close the opening at night. Right: Lestrimelitta sp, also in a building wall. Bottom left: Melipona favosa in a tree cavity. Note that the tube projects very little, in contrast to the others shown.

Photo by Amy Deacon.

Someone familiar with the local fauna can census the colonies in a given locality by walking about slowly, recording these entrance tubes. Some entrance tubes are relatively simple and uniform, while that of P. nigrior has a distinctive flare (Figure 13). Lestrimelitta *sp* makes a very broad, conspicuous tube that can extend for a considerable distance from the main part of the nest. Note very short, flaring entrance tube near the middle.

Figure 13. Photograph of Partamona nigrior nest largely exposed on the outside of a building.

A remarkable adaptation shared by stingless bees and the other social corbiculates is the production of wax in glands in the abdomen, which serves as the key nesting material. In honey bees this is used in pure form to make their distinctive combs, while in stingless bees it is mixed with plant resins to form a very pliable, durable material called *cerumen*. It is usually of a medium brown colour.

Inside the nest of stingless bees is an orderly arrangement of components. The main such components are the brood cells and food storage pots in the central part of the nest. This area is sometimes surrounded by a thin dividing sheet, and the nest sometimes include one or more hard internal dividing plates. There is usually a specific garbage dump off to one side, where faeces and other detritus are deposited.

The central chamber contains the *brood cells* and *food storage pots*. Brood cells show two main arrangements in stingless bees. In many species they are clustered in the manner of a bunch of grapes with connecting pillars between them. This is especially adaptive in narrow, irregular nest cavities. Clustered cells are known or supposed to be the pattern in *Frieseomelitta*, some *Plebeia* and *Trigonisca*.

In the other main arrangement, the cells are in a plane with shared walls, so that they form a comb. This is commonly extended into a spiral, so that two layers of a single comb form one above the other. This is the pattern found in *Cephalotrigona*, *Lestrimelitta*, at least some *Melipona, Nannotrigona, Partamona*, some *Plebeia* and *Trigona amalthea*. Note that *Plebeia* varies in this respect. *P. tobagoensis* is not among the species whose nest structure has been studied.

After a larva spins its cocoon and pupates, the adult bees remove and reutilize the brown cerumen, exposing the white cocoon. Figure 14 provides an example of this in an Asian species, but it is representative of those in this region that form their cells in a cluster, rather than a comb. Note that the cerumen has been removed from the lower cells, so that the silk cocoons of the pupae are exposed. The food storage pots are considerably larger than brood and are usually found flanking the area of brood combs.

Figure 14. A cluster of brood cells of an Asian stingless bee species.

Cerumen is also used in some species to form a thin involucrum around the main chamber. Where a thicker, harder sheet is formed, this is known as a batumen. Where the colony occupies a nesting cavity too big for its needs, a batumen may be built to seal the nest from the extra space.

Nest homeostasis

A colony of stingless bees comprises some hundreds or thousands of living insects occupying close quarters. As such, it must be kept very clean if it is not to become an incubator of disease. As noted above, the nest usually has an area for deposit of waste material. This waste material is not allowed to accumulate in the nest but is taken outside of the nest and discarded by worker bees. In addition, a healthy nest environment requires that temperature, humidity and CO_2 concentration be kept within acceptable bounds (Beshers 2021). The choice of nest site and structure can provide a large measure of such control by itself. The main way to supplement this passive control is by active ventilation. This is done by wing fanning, flying motions while standing in place in such a way as to create an air current into or out of the nest. Control of temperature in the brood area is especially critical and usually serves to keep it within 28–34° C.

Nest symbionts

Like many other social insects, colonies of stingless bees attract a variety of other organisms (Parmentier 2021), some of which are adapted to live nowhere else. The nest itself, as a stable environment, may form a suitable living space for some organisms. However, there are also those that benefit from a more or less close association with the bees. Foremost among these are some beetles and mites. While it might be assumed that these are parasites, it may be that most feed on detritus and on moulds growing in the nest. If this is the case, then these *nest symbionts* are, if anything, of benefit to the bees. In fact, very little is known about the nature of nest associations.

Social organisation

Stingless bees form sizeable societies with between a few hundred to many thousand adults and (when the colony is in good health) roughly two or three times as many immature brood individuals. As in all hymenoptera, these latter develop through stages (egg, several larval stages, and pupa) before emerging as adults. Among the native species, the largest colonies are probably formed by *Trigona amalthea*, although exact counts are not available. Next in colony size among local species is probably *Lestrimelitta nr. guyananensi*s with up to several thousand. Despite their relatively large body size (and value in meliponiculture), it is unlikely that either of the local *Melipona* species often has as many as 1000 adults.

The core to understanding social organisation in insects is the concept of caste. This rests on the idea that different cohorts of individuals differ in their colony-maintaining jobs. The primary difference is between those females that reproduce (queens) and those that undertake all the other jobs (workers). In stingless bees there is almost always just a single queen. Males are not regarded as a caste, as in no social hymenoptera (unlike in termites) do they contribute substantially to the life of the colony. In fact, in stingless bees, as in other social hymenoptera, the role of male bees is to mate with the queen.

In the primitive condition in social hymenoptera, queens and workers are physically alike. However, in stingless bees and honey bees the queens are larger and can usually be distinguished without much difficulty. They also differ in various other physical features.

Among the workers there are also more or less distinct sub-castes, according to the groups of tasks that they undertake. In almost all stingless bees the workers in a colony are physically remarkably uniform, so that the division of labour is not according to physical attributes. Rather, it is a manifestation of age *polyethism*, in which individuals change their jobs as they age. These changes follow a progression that is much the same in other social hymenoptera with an age-based division of labour. As a strong general rule, it goes from the center of the nest (e.g. care of the queen and brood) to its edge (guarding at the nest entrance) and on to foraging. This makes good biological sense in terms of the colony's economy, as the earlier tasks are the safest, while foragers tend to either work themselves to death or fall prey to predators. It is in the colony's interest to deploy those workers that are near the end of their natural lives where the risk is highest.`

Colony founding

In the greater number of social bees and social wasps, a new colony is founded by a mated queen or group of queens without the aid of workers, a pattern known as *independent founding*. In contrast, as in honey bees, stingless bee colonies reproduce by *swarm founding*, in which the founding group (swarm) consists of a queen and a large group of workers. The result of this process is the formation of a new colony at a distance from the older one.

Swarm founding proceeds by a number of steps. First, scout bees identify a suitable new nest site. Workers then bring building materials from the mother nest -- mostly cerumen and resin – and begin building a new nest. A new, unmated queen flies from the mother nest to the developing new nest, usually accompanied by a host of workers. About a day or two after her arrival, she makes a mating flight, in the course of which she mates with several males from other colonies and returns to her nest. The workers, meanwhile, have been building brood cells, into which the queen begins laying eggs. During this founding phase of the new colony, workers continue flying between the two nests, carrying building materials from the old to the new. This continues for a variable period -- commonly up to some weeks, but up to several months in *Partamona* - after which the new colony becomes fully independent with a complement of about 10–30% of the workers from the mother colony. Because of this initial period of continued dependence on the mother colony, new colonies cannot be founded at a great distance from the mother nest, usually about 300m or less.

Note that, unlike in honey bees, it is a daughter queen that flies out with the swarm, while the mother queen remains behind in the mother nest. Absconding by the colony is almost unknown in stingless bees, correlated with the fact that in time the queen's abdomen becomes greatly distended with eggs *(physogastric*), rendering her unfit to fly.

The provisioning-and- oviposition process

A distinctive major feature of the social biology of stingless bees is the provisioning-and-oviposition process, or P-O-P. In common with most solitary bees, stingless bees practise *mass provisioning*, in which a full complement of brood food is placed along with the egg, after which the cell is sealed. In contrast, other social corbiculates feed the larva incrementally throughout its development (*progressive provisioning*). The P-O-P involves a stereotypical, species-characteristic series of steps culminating in a sealed cell with an egg and mass of brood food inside. The larva will grow and pupate in the cell without the aid of workers, finally cutting its own way out on reaching adulthood.

Defense of the colony

The absence of a functional stinger does not render these bees helpless in the face of natural enemies. Many species typically nest in hard-walled cavities that make the brood and food stores inaccessible to large predators (e.g. *Frieseomelitta, Nannotrigona* spp.). And those that build exposed nests typically surround these with a hard outer shell (e.g. *Partamona*). Against small predators – mainly ants – the bees are defended by the very restricted entrance and the constant presence of guard bees. In some (e.g. *Nannotrigona* nr. *chapadana*), the entrance tube is closed at night when the bees are inactive outside the nest.

Furthermore, bees that cannot sting can still bite, and some are provided with exocrine glands that can emit noxious defensive compounds. If one disturbs a colony of *P. nigrior* or *T. amalthea* the bees will usually fly out in a mass that becomes a furious nuisance in the hair and around the face. The strength of the response to a large intruder tends to correlate with colony size, so that species with large colonies tend to be more vigorously defensive.

From the colony's viewpoint, it is critically important to deny access not just to all predators but also to nest parasites (e.g. some flies) and *cleptoparasites*. These latter steal provisions if they can reach them. They may be members of other colonies of the same species, but there are also stingless bees specialised to overpower colonies of other species and plunder their nests. In this area these form the genus *Lestrimelitta*. These are robber bees. They do no foraging of their own at plants, nor do they initiate their own nests. Rather, they pillage colonies of other species for their food stores. They have strong mandibles and, when invading another's colony, simply overpower the residents, aided by chemical weapons. In attacking a colony of another species, they use not just physical force but also glandular compounds that confuse and intimidate. Raiding of a colony may be detected by a whiff of a citronella-like compound. Despite their physical power, *Lestrimelitta* seldom cause the downfall of the colonies they attack. This makes biological sense, as they do not eat other bees or their brood, and it is in the pillagers' interest that the aggrieved colony should recover for later robbing. When it comes time to found a new colony, *Lestrimelitta* usurps the nest of another species.

Foraging

Like other social bees, stingless bees (aside from *Lestrimelitta*) visit a broad variety of plant species in their search for flower resources; specialising on just a few species would hamper efforts to support their large colonies. Many also visit aggregating aphids and other sap-feeding hemipterans, from whom they obtain honeydew. As a strong general rule among social corbiculate bees, on a given foraging trip a worker largely or exclusively visits flowers of just one species, a habit known as flower constancy. This can be confirmed by watching foraging bees in the field. It is readily demonstrated in the laboratory by examining pollen loads that the bees bring back to the nest.

In their competition with other bees for the same resources, many stingless bees have a distinct advantage in their *food-source recruitment*. That is, a scout bee that has found an especially rich patch of flowers, for example, can communicate this to nestmates, affording them a head start in exploiting it. At the very least, the scout bee automatically communicates the patch's existence when returning to the nest. In addition, the scout bee can stimulate nestmates through a series of stereotyped moves and vibrations, effectively an indication of level of enthusiasm for the food source. This sort of stimulation is known in *Melipona* and *Nannotrigona*, but there is reason to believe that it is almost universal in stingless bees (Nieh 2004).

Some species go beyond this by providing cues regarding the location of the food source. These can be as effective as the well-known dance language of honey bees. In some species returning foragers recruit nestmates by laying an odour trail back from the food source in the form of scent droplets on vegetation along the way (Jarau 2009, Nieh 2004). Among local species, this is known from *C. capitata* and *T. amalthea*. This is much the same as the scent trails deposited by recruiters in many ants, which allow large numbers of nestmates rapidly to locate the new food source. Although none of the other local species or their close relatives are known to deposit odour trails, some species of *Lestrimelitta, Partamona* and *Plebeia* appear to have means of directing nestmates toward food sources.

Some of what foragers collect is fed immediately to nestmate larvae or adults, but some is stored in the nest. It is not practical to store nectar for long periods, as it tends to spoil. This explains why stingless bees – like other bees – concentrate and convert it into the much more durable honey. Unlike honey bees, most bees do not accumulate significant stores of honey. Among stingless bees, various members of the genus *Melipona* stand out as keeping substantial honey stores, so that they are the mainstay of *meliponiculture* (see further in this report).

Comparison of honeybees and stingless bees

Owing to the greater popularity of honeybees in Trinidad and Tobago, it is perhaps worth mentioning comparisons between honeybees and stingless bees. The following list (Table 2) is amended from the Food and Agriculture Organization of the United Nations' publication: Good beekeeping practices for sustainable apiculture (2021) as reported by Heard (2016).

Table 2. Comparisons between honeybees and stingless bees.

HONEYBEES	**STINGLESS BEES**
Belong to one genus - *Apis*	Belong to 60+ genera with approximately 500 species
The hexagonal comb is used to both rear young and store food.	The young are reared in specialised brood cells and food is stored in large pots.
Young are fed regularly.	Brood cells have high food provision.
The nest is built principally with wax.	Wax mixed with plant resins to form propolis is the main building material.
Tight temperature control is maintained in the nest.	Moderate capability to maintain nest temperature control.
New colony is founded by sudden swarming of many workers and the old queen.	Build new nest first then gradually move in with a new queen.

(Heard, 2016)

The FAO document (2021) goes on to state the following:

"Stingless bee propagation techniques are sustainable because the colonies are perennial. They can easily be mass-produced using simple methods. The colonies are self-sustaining because there are always new queens available in the colonies".

Hive Culture

As mentioned earlier, stingless bees are not nomadic but generally stay in a fixed place. The ideal situation is to maintain bees in their natural habitat, however, for bees which have established colonies within the built environment or within trees that are to be removed, boxing is advised to sustain the life of the colony.

Some stingless bees have a quite elaborate entrance to their hive, while for others, the entrance is quite simple. The photographs below in Figure 15 give an idea of the varied appearance, which may assist in identifying the species of bee.

Melipona favosa
(Moko Chiquita)

Frieseomelitta paupera
(Petite angel)

Partamona nigrior
(Petit Pegone)

Figure 15. Photographs showing the design of the hive entrance of some species of stingless bees.

Managing bees in nature means allowing the bees to thrive in their chosen habitats. Stingless bee colonies found in trees should ideally be left there to thrive. Where possible, conditions can be enhanced to support the colony, such as planting preferred plants that are known sources of nectar and pollen for the bee species or which supply resins which they need for construction of the hive.

It is worth remembering that native stingless bees are effective pollinators and that this role assists in food production and maintenance and expansion of vegetative cover. For instance, *Frieseomelitta paupera* (Petite angel) is the main pollinator of avocado. The decision to assist in managing these bees therefore contributes to sustaining this service. Additionally, some of the hive products of these bees are valuable and are a bonus benefit to their management by beekeepers.

For this reason, some species of stingless bees are more commonly managed than others. From communication with keepers of stingless bees in Trinidad and Tobago, the species which are more commonly kept are: *Frieseomelitta paupera* (Petite angel), *Melipona favosa* (Erik, Moko chiquita), *Melipona trinitatis* (Guanot, Moko grande) and *Trigona amalthea* (Pegone). One beekeeper has had a measure of success with *Partmona nigrior* (Petit Pegone). The guidelines document therefore makes reference to the managed species in sharing information on management of artificial habitats.

Keeping bees in logs

In the case of removal from a felled tree, the colony can initially be maintained in a log, which is carefully cut from the tree. The section housing the hive can be cut to a length of about 120 cm (4 feet).

Some beekeepers maintain the upright orientation in which the hive was found, standing the log on a solid surface like the bare ground. Other beekeepers may place the cut log in a horizontal orientation on a supportive shelf. In either case, care must be taken to orient the log in such a way that the entry to the hive is kept clear to allow access for the worker bees.

One beekeeper used a method for transitioning from the log to a boxed hive (Figure 16). A box suited for *Melipona trinitatis* measuring 25 cm x 25 cm x 60 cm (10 in x 10 in x 24 in) was used. A 15 cm (6 in) diameter hole was cut at the bottom of the box; the box was screwed onto the top of the cut log, with a small piece of sponge sandwiched between the two.

In such a set-up, the bees eventually built brood cells in the box, accessed through the floor of the box. The box can eventually be 'split' from the log (unscrewed and removed) when the brood is well-established inside.

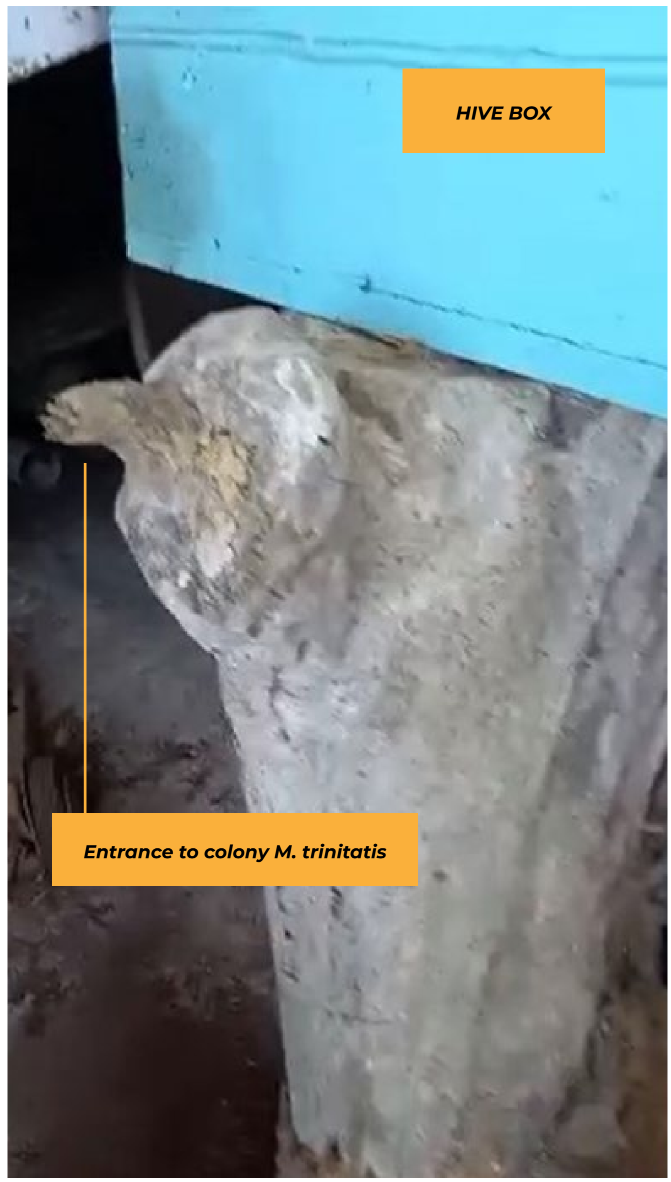


Figure 16. Hive box on log with Melipona sp. colony.

Keeping bees in hive boxes

Hive boxes used for stingless bees are different in structure from the hives used for management of honeybees. An online search will reveal a variety of designs across the globe, from clay pot designs used in indigenous communities in South America, to sophisticated designs used in Australia using a combination of wood and acrylic materials. Here in Trinidad and Tobago, the boxes used most commonly among stingless bee keepers employ a simple design, generally a rectangular box with a single entrance and a removable cover (Figure 17). Discussions with beekeepers have yielded the recommendation that boxes should be built of untreated wood, and the most common wood types used are cedar or teak. Some beekeepers recommend that the box is unpainted, however others have painted the boxes with no adverse impact on the bee colonies.

Figure 17. Photographs showing basic hive box designs for (a) Melipona sp and (b) Frieseomelitta paupera.

Hive box design by beekeepers in Trinidad and Tobago

Of the four local stingless bees which are more frequently managed by stingless bee beekeepers, broods will be in the form of stacked pancakes for *Melipona trinitatis* (Guanot, Moko grande), *Melipona favosa* (Erik, Moko chiquita), *Trigona amalthea* (Pegone) or like bunches of grapes for *Frieseomelitta paupera* (Petite angel). Setting up hive boxes requires consideration of the general hive habit of the respective bee species. It was noted by one beekeeper for instance, that *Frieseomelitta paupera* (Petite angel) tends to build its brood cells as far away from the hive entrance as possible, whereas *Melipona trinitatis* (Guanot, Moko grande) tends to build its brood close to the hive entrance. In bee management, consideration is also given for harvesting hive products and this factors into hive box design.

A hive box design was developed by the University of Utrecht (Sommeijer, 1999) as the Utrecht University – Tobago Hive or UTOB. The hive consists mainly of two sections, a brood chamber and a honey chamber, which rest on a rimmed, tray-like floor (Figure 18).

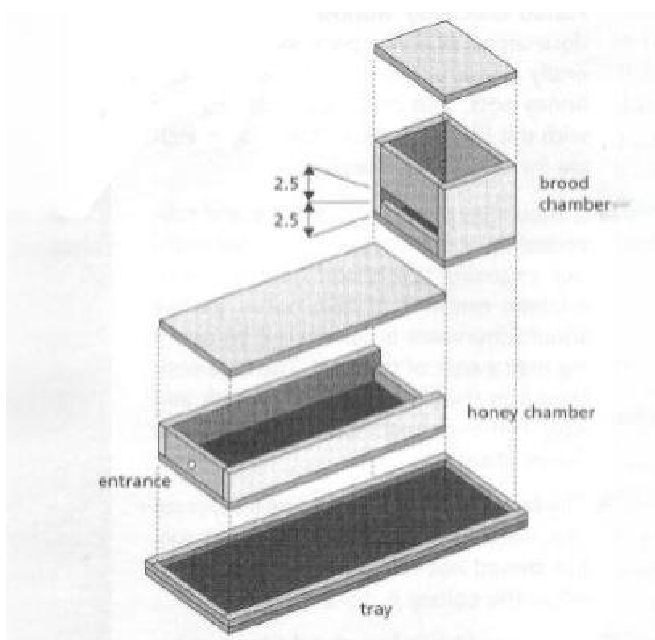


Figure 18. Diagram of UTOB hive box design. Source: Sommeijer, 1999.

It was tested in Tobago by local beekeepers for use with *Melipona favosa*, with variations of the design recommended for other species. The author also noted that even within species, some modifications of the dimensions of the hive box may be required, adjusting to the usual size of the brood nest.

Some local beekeepers have also offered hive box designs for different stingless bee species as given below (Table 3).

Table 3. Dimensions for various box designs for local stingless bee species from two beekeepers.

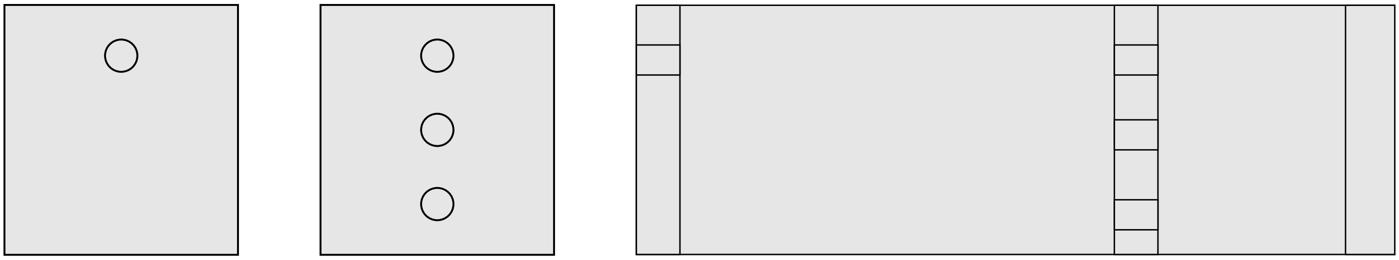
BEE SPECIES	HIVE BOX DIMENSIONS
Melipona favosa (Erik, Moko chiquita)	6 in x 6 in x 14 in (Beekeeper 1)
Frieseomelitta paupera (Petit angel)	8 in x 8 in x 14 in (Beekeeper 1)
	4 in x 4 in x 1-1.5 ft (Beekeeper 2)
Melipona trinitatis (Guanot/Moko grande)	8 in x 10 in x 2ft (Beekeeper 1)
	6 in x 1 ft x 1ft (Beekeeper 2)

Apart from this basic structure of the hive boxes, additional features are incorporated in the design. These features are described for different species and beekeepers on the following pages.

Design of boxes for *Frieseomelitta paupera*

For *Frieseomelitta paupera* (Petite angel), the hive box interior can be divided into two sections (Figure 19). At one end of the box, a hole is drilled to create an entryway for the bees. The colony is placed at the other end of the box, away from the entrance. The colony is walled off in a small chamber (one-third the length of the interior) by a piece of wood (4" x 4"). A few small holes should be drilled in this inner wall to allow passage of the bees and to improve ventilation in the hive. The bees will maintain the brood colony in the chamber and will place honey stores near to the entrance.

The bees will place honeypots outside of the chamber, allowing ease of harvesting with minimal disturbance. The space before the inner wall can be further subdivided into two sections, so that honey can be extracted from the section closest to the entrance and the honey which is closer to the wall near the brood can be left for use by the brood.



(a) (b) (c)

Figure 19. Diagrams showing (a) front view of hive box with entrance hole (b) front view of inner wall with holes and (c) side view of hive box showing inner wall and holes in inner wall and at entrance.

Design of boxes for *Melipona sp* and *Trigona sp.*

For the *Melipona sp.* (Guanot and Erik) and *Trigona amalthea* (Pegone) the hive box is a two-level design. A 1-inch thick, 12x12 pine board is needed for the base of the lower box, with 6-inch-tall walls on all sides. The top of the bottom box is open (Figure 20 a). The upper box also has 6-inch-high walls and is open at the top, however a 12x12 board is used to make a removable lid for the top box. The floor of the upper box is also made with a 12x12 board, in which a diamond-shaped hole is cut (Figure 20 b). Neat construction by a good joiner is required, since if the connections at the walls and floor are not properly made, the hive will be susceptible to pest entry.

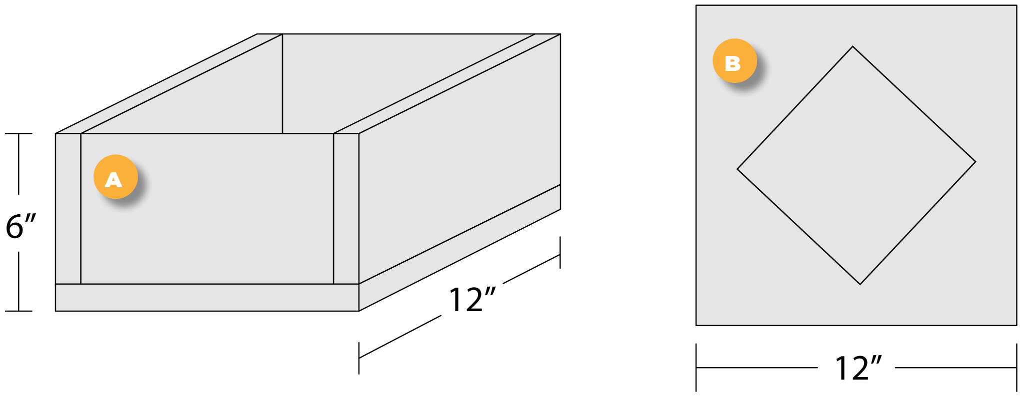


Figure 20. Diagrams of hive box design showing (a) lower box and (b) hole cut in floor of upper box.

The bees will build their stack of brood cells upwards and will place honey pots around the central brood tower as food sources. The brood tower will be extended upwards to the level of the top of the upper box, through the diamond-shaped hole in the floor of the upper box, getting support from this 'floor'. When conditions are correct (dry season, well-established hive), the hive may be split by taking the top box off with the upper half of the brood pancakes and placing this on an empty lower box; the lower box with the lower half of brood pancakes is then added below an empty box.

Another beekeeper uses a design with larger dimensions of 8 in (H) x 10 in (W) x 24 in (L) as well as an upper removable 'super'; the floor of the 'super' is completely open but has fishing line arranged in a grid, through which the colony can extend upwards (Figure 21). Notably, the super does not extend across the entire top of the lower box, but is about one-third the length (8 in) and is placed centrally, with two pieces of wood covering the remaining parts of the lower box. A feeding hole is also made at one end of the box in the "roof" of the lower structure.

Figure 21. Photographs of (a) hive box with 'super' and (b) floor of 'super' showing fishing line grid.

Another feature of the box design for the Melipona species is a special entryway for the hive. This design is recommended to lengthen the entryway and provide greater opportunity for defense of the hive (especially to phorid flies). Two pieces of wood, approximately 3" x 6" are cut. In one piece, a small hole is drilled through, about 1" from the bottom, to form an entrance hole. In the second piece, a hole saw is used to drill a series of four intersecting holes in the mid-region of the wood, with the lowermost hole coinciding with the location of the hole in the first piece of wood. These two pieces will be placed at the front of the hive. Right behind these pieces, a small hole will be drilled into the wall of the hive, coinciding with the uppermost hole of the second piece of wood. The diagram below (Figure 22) shows the appearance and sequence of wood pieces as described.

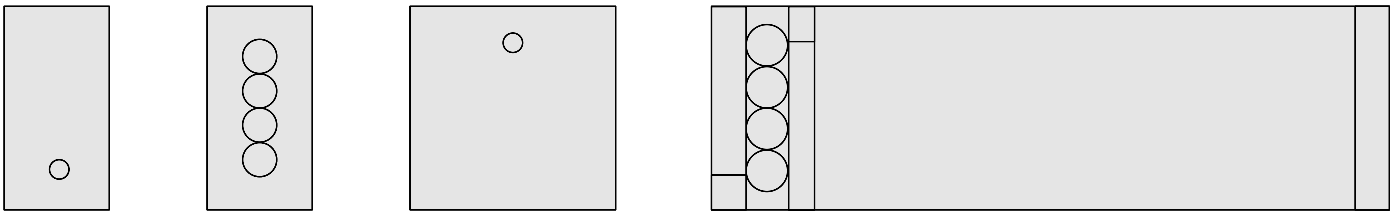


Figure 22. Diagrams showing front view of wood pieces (1 and 2) and hive box front wall (3) and side view of wood pieces and hive box wall in sequence (1/2/3).

One beekeeper has refined the appearance of the entryway further, by using a piece of PVC from plumbing supplies. Photographs of the two entryway designs are given below (Figure 23).

Figure 23. Photographs of (a) the wood structure and (b) the PVC covered entryway designs for Melipona sp. artificial habitats.

Transfer of colonies to hive boxes

When transferring wild hive to boxes, one beekeeper recommends that the following tools are used:

BOTTLE CAPS	**EAR WAX SPOON**	**FEATHER**
HIVE BOXES OF APPROPRIATE DESIGN	**HONEYBEE WAX BLOCK**	**STRAIGHT PIN**

For *Frieseomelitta paupera* (Petite angel), the brood structure cannot be easily separated. The queen has to be located first (recognizable by her distended abdomen). Using a feather, the queen should be gently transferred into a container to separate her from the rest of the bees. Then the complete brood can be taken out of the log and put into the appropriate hive box.

For *Melipona trinitatis* (Guanot), *Melipona favosa* (Erik) and *Trigona amalthea* (Pegone), only the brood 'pancakes' should be transferred to the box (Figure 24). Honey and pollen pots should not be transferred into the box, since, if the pots are damaged, they will leak and will attract pests. The pots can be transferred to a basin and then the honey and pollen can be extracted.

Figure 24. Melipona trinitatis (Guanot) brood cells after transfer to a hive box.

When moving one half of the brood to another box, remove small pieces of the wax from the original hive and roll into four small balls of similar size. Place the four wax balls on the floor of the new hive, equidistant to receive the portion of the brood tower. This creates a space that allows the bees to go below the brood pancakes to clean, removing cells of the brood that may have been damaged in handling.

About half the population of worker bees needs to be moved to the new box. Use a specially fashioned vacuum bottle, to extract the bees (Figure 25).

Figure 25. Bottle with siphon used to extract bees from log.

Food supply

The bees will need to be supplied with food in their new habitat. Instead of their natural honey, the brood is supplied with a small container of a simple syrup (50:50 water and sugar) to which stinging nettle can be added. One beekeeper places this mixture into a bottle cap which is then placed in the box. Another beekeeper pours the mixture into a small bottle, which is then inverted and placed into a feeding hole made in the 'roof' of the hive box, the mouth of the bottle being inserted into a ring of sponge (Figure 26 a).

Honey pots and pollen pots look alike, so pollen needs to be separated by meticulously going into the pots. The pollen can be removed with an ear wax spoon (Figure 26 b) and placed into bottle caps in a new hive box. Honeybee wax (which can be obtained from the pharmacy) is melted and a cap tightly packed with pollen is inverted and dipped in the molten wax (Figure 26 c). The top of the wax cap is then scored with a straight pin to help the bees discover the pollen, and the cap is put into the box.

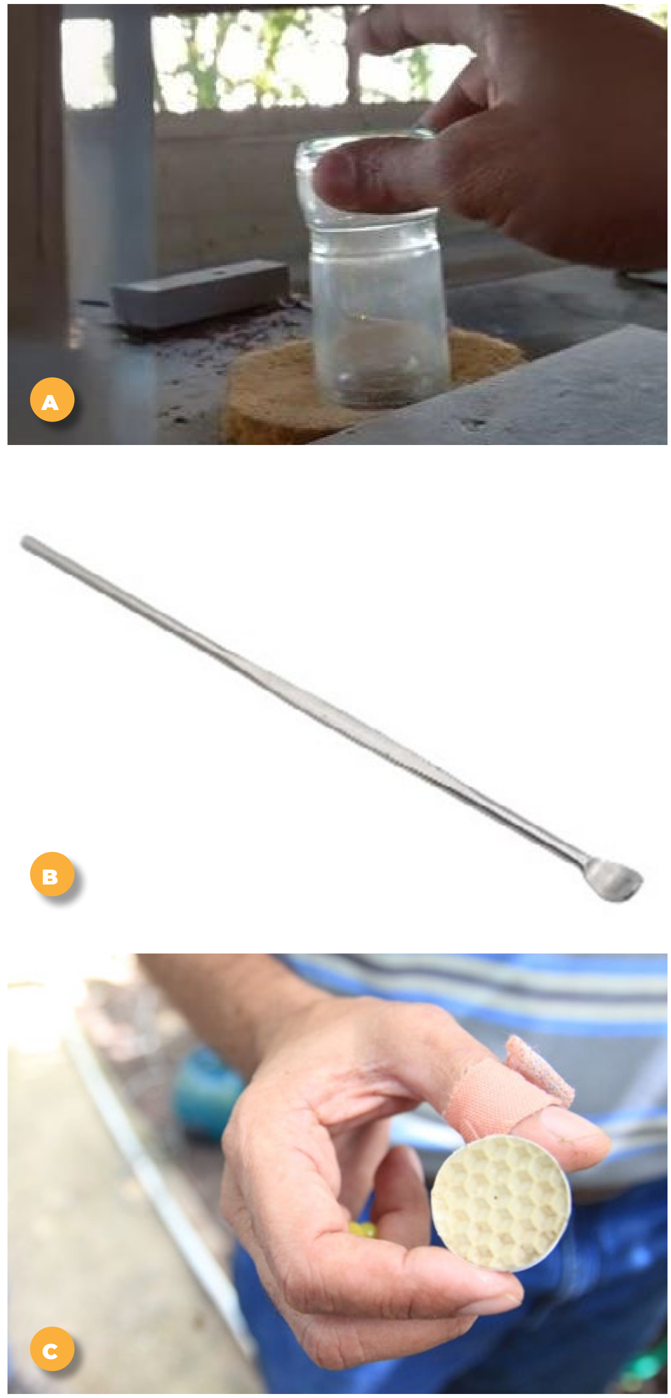


Figure 26. Tools used in stingless bee hive management (a) feeding bottle (b) ear wax spoon (c) wax capped store of pollen.

Pest management

Phorid flies are a main pest of the stingless bees; when they get into a hive, they lay eggs which hatch into maggots. One beekeeper uses flypaper strips affixed vertically and horizontally around the hive entrance to trap phorid flies (Figure 27 a). Another beekeeper creates a trap inside the box, using a small container with a screw cap. Holes are bored into the cap, small enough that a bee cannot get in (Figure 27 b) and the container is filled with apple cider vinegar (Bragg's or Heinz are preferred brands).

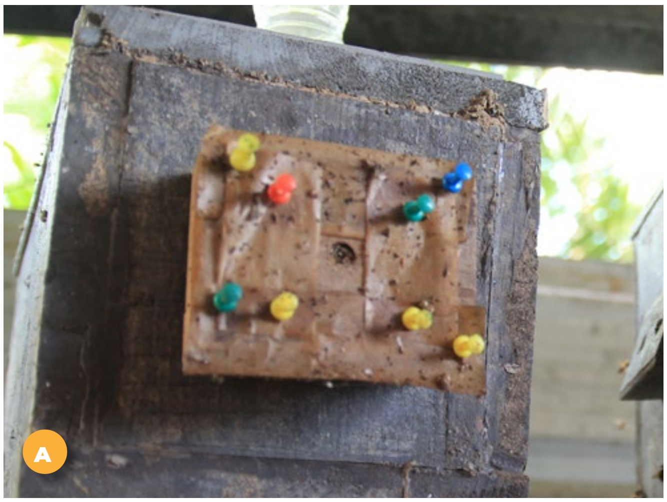


Figure 27. Traps for phorid flies: (a) flypaper at hive box entrance and (b) apple cider vinegar trap.

The sour scent of the apple cider vinegar attracts phorid flies as it mimics the scent of honey, pollen pots and damaged brood cells. When the phorid flies enter the container, they will be trapped and drown in the apple cider vinegar. The bees will, however, block the holes with resin as they do not like the scent of the contents; every 2-3 days therefore, the containers should be checked to clear the holes as necessary.

A second trap for phorid flies should be set up outside the hive. This trap can be constructed using a plastic soft drink/soda bottle. A funnel is created by cutting off the top part of the bottle and overturning it onto the lower half (Figure 28). Apple cider vinegar is poured into the lower half of the bottle. At the rim of the lower portion of the bottle, on which the funnel will rest, use red wax (from around Babybel cheese), beeswax mixed with plasticene or duct tape to seal.

One beekeeper noted that Crapposeed oil placed around the outside of the hive box entrance also deters phorid flies.

Figure 28. Example of phorid fly trap to be used outside the hive.

Photo from: **https://www.sciencebuddies.org/stem-activities/make-homemade-fly-trap?from=Pinterest**

Securing the hive box

After the brood, food reserves and pest traps have been put in place, the hive box needs to be secured. For the simple rectangular box design, one beekeeper recommends placing clear plastic over the box, before affixing the lid of the box. This will allow the keeper to examine the box daily without disturbing the hive. The layer of clear plastic is kept in place using wax (wax wrapper from BabyBel cheese is recommended). The wax is smeared along the top edge of the walls of the hive box using a putty knife; after smearing the wax, the plastic is lowered onto the wax and pressed down (Figure 29). The lid of the box is then placed over the plastic and secured to the sides of the hive box using masking tape or duct tape. For the hive box design which has a super placed above the centre of the box, the beekeeper uses masking tape at all the joints.

Figure 29. Photographs showing placement of (a) wax and (b) clear plastic over hive box.

Some beekeepers advise that hive boxes should not be painted however others have used paint on boxes with no negative impact on bees. Hive boxes can be kept indoors or outdoors, but if kept outdoors, ensure that the hives are covered to protect them from the elements (Figure 30).

Figure 30. Stingless bee hive boxes in the outdoors, covered by galvanized sheeting.

Splitting of hives

After a hive is well-established and is thriving in a box, it may be split to produce two hives (the original one and a new one). For bees that build the 'pancake' type of colony, a simple division of the brood is done, placing one half of the brood into the new hive box. The beekeeper may however opt to start with a hive box design which is made of two parts, to ease the division of the colony.

Hive box design for development of daughter hives

For species which have brood discs ("pancakes"), a modified OATH design is successfully used in maintaining colonies. OATH is the Original Australian Trigona Hive used for stingless bee culture (Figure 31). The design of the OATH is a two-level hive. The top half has an open floor and the lower half has an open roof and the two parts articulate at these areas.

One beekeeper uses a modification of the design - for the *Melipona sp*. (Guanot and Erik) and *Trigona amalthea* (Pegone) – which is also comprised of a two-level hive box. A 1-inch thick, 12x12 pine board is needed for the base of the lower box, with 6-inch-tall walls on all sides. The top of the bottom box is open. The upper box also has 6-inch-high walls and is open at the top, however a 12x12 board is used to make a removable lid for the top box. The floor of the upper box is also made with a 12x12 board, in which a diamond-shaped hole is cut (Figure 32).

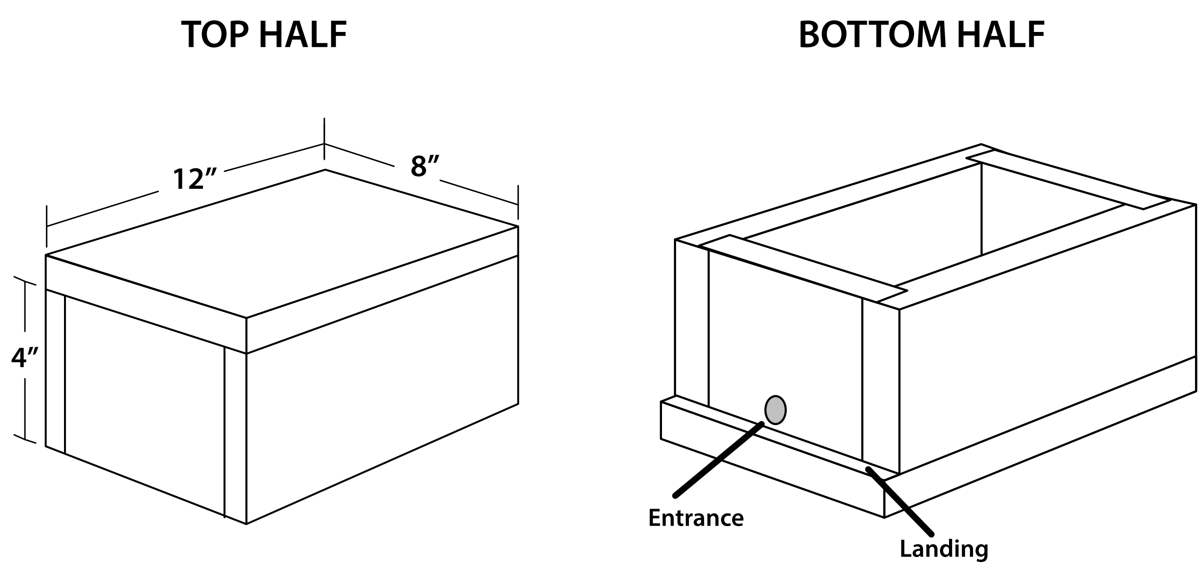


Figure 31. Diagram of an Original Australian Trigona Hive (OATH).

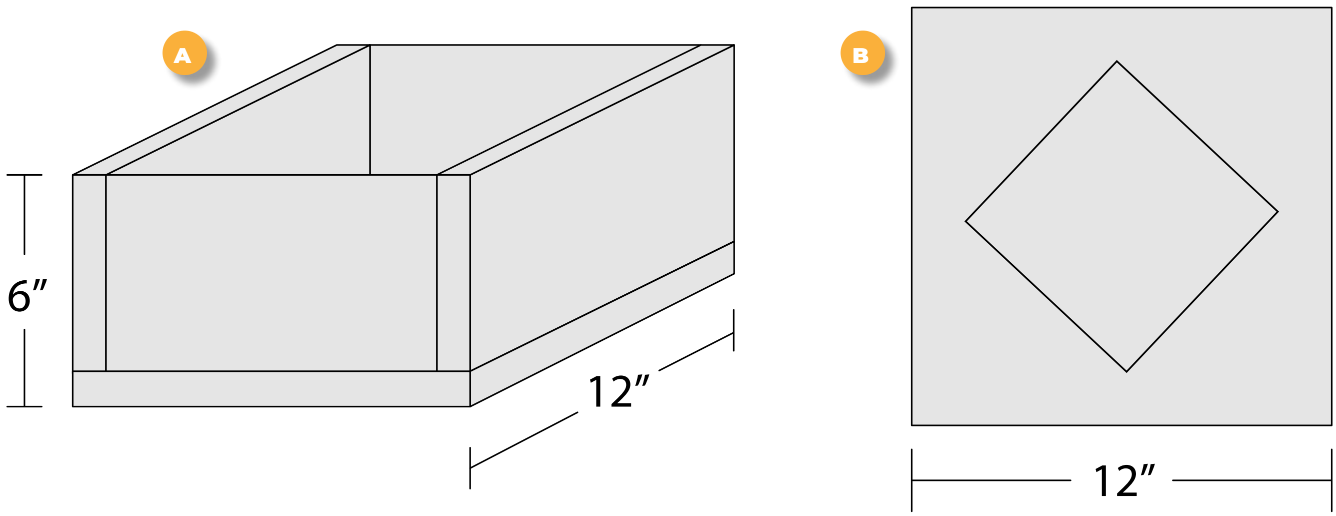


Figure 32. Diagram of modified OATH - (a) lower half and (b) floor of upper half of box.

The bees will build their stack of brood cells upwards and will place the honey pots around the central brood tower as food sources. The bees will continue to build a brood tower upwards to the level of the top of the upper box, through the diamond-shaped hole in the floor of the upper box, getting support from this 'floor'. When conditions are correct (dry season, well-established hive), the hive may be split by taking the top box off with the upper half of the brood pancakes and placing on an empty lower box and taking the lower box with the lower half of brood pancakes and adding it below an empty upper box.

Another version of this design is used by other beekeepers, as mentioned previously (Figure 18). The design has a larger lower box and a smaller (super) above which is detachable; this version was described earlier in the hive box design section. The design works in the same way, by removing the upper section when it is filled with the expanded colony to use this upper section of the colony to start a new hive.

As in setting up a hive, the following tools are needed for the hive splitting process:

- Apple Cider vinegar (Bragg's or Heinz)
- "Bee vacuum"
- Funnel created from plastic bottle
- Jam jar
- Plastic bowl or basin
- Syringe
- Isopropyl alcohol
- Putty knife
- Plastic container with cap
- Hive box
- Duct tape

***Frieseomelitta paupera* (Petite Angel)**

This species makes very few queen cells. Queen cells are also about the same size as worker cells and it is difficult to separate the brood as the brood cells can be destroyed easily. A technique used to create a new colony is by luring bees to a new box.

To create a lure, after honey harvesting, take the honey pots and extraneous bits of wax and place in isopropyl alcohol. Mix this well and then use the mixture to coat the inside of empty boxes. Place the lure-baited box(es) near to the hive with the thriving colony. In the dry season, a large cloud of bees may be observed; usually there is a chance of splitting into two colonies at this time, when the bees are attracted to the baited box. Additionally, if a bottle is placed over the hive and the wall of the hive is gently tapped; worker bees will come out and can be collected into the bottle.

***Melipona trinitatis* (Guanot), *Melipona favosa* (Erik), *Trigona amalthea* (Pegone)**

When the hive is opened, the brood cells, pollen pots and honey pots will fill the inside of the box. Brood cells can be separated from the honey and pollen pots by hand or with the use of a putty knife. The honey pots and pollen pots can be placed into a bowl and the contents extracted after the new hives are set up.

For these three bee species, queen cells are located on each 'pancake' of the brood cell structure. There may be one or more of these queen cells, which are always larger than the more numerous worker bee cells and they are always located at the edge of the brood structure.

Split the tower of brood pancakes into two. An icing knife can be used to separate the pancakes. Follow the steps outlined in transfer of hive to a box in the previous section, inclusive of addition of a food supply and inclusion of traps for control of Phorid flies.

Harvesting of hives

As mentioned previously, there are four species of stingless bees more commonly managed by beekeepers in Trinidad and Tobago and their choice for management includes consideration of the production of stingless bee honey which is a hive product with medicinal/therapeutic value. Some beekeepers refer to this as a 'type of honey' owing to the fact that by international standards, this stingless bee hive product cannot be formally classified as honey, since it has a higher moisture content than the honey produced by honeybees, the latter which is consumed/used as a food product.

In the hive, this stingless bee honey is stored in 'pots' and is used by the bees for nutrition alongside pollen. In management of stingless bees in artificial habitats, stingless bee honey is harvested by keepers, but some of the product is left in the hive to maintain the colony. When a new artificial hive is being established by the beekeeper, or when honey production is low in the hive, a simple syrup of 50:50 sugar and water is used to feed the bees until the colony is able to sustain itself.

'Honey' production volumes of stingless bees

According to one beekeeper, in terms of stingless bee honey production, a *Frieseomelitta paupera* (Petite angel) hive may produce about 80 ml of honey per year. *Melipona trinitatis* (Guanot, Moko grande) produces the second largest output of honey among the local species, about 1-2 litres per year. *Trigona amalthea* (Pegone) has the largest number of worker bees in its colony and produces the largest volume of stingless bee honey (more than 2 litres per year) among the local species.

Partamona nigrior (Petite pegone) produces a high-quality honey which is very clear and sweet, but management is challenging. The bees tend to fill a hive box and then the colony begins to decline in activity until only the queen is left. Honey production by *Nannotrigona testaceicornis* (Irai) is negligible and the honey produced by *Lestrimelitta limao* (Lemon cab) is toxic and should not be consumed.

Harvesting process

For harvesting of stingless bee honey from moved hives, you will need the following:

- Smoker
- Sieve
- Funnel
- Bowl/Basin
- Putty knife
- Syringe
- Storage jar
- Paint brush or feather

Figure 33. Melipona trinitatis bees on a honey pot.

While stingless bees are generally not aggressive *Trigona amalthe*a (Pegone) will defends its colony by biting. For this reason, when harvesting is planned, smoking and protection will be required. Clove leaves are useful for the smoker and termite nests are good for smoking in a coal pot.

Melipona trinitatis (Guanot) makes a wax tube on the interior of the hive box and the brood is made close to the entrance; honey and pollen pots are at the back. It is difficult to tell which pots hold honey (Figure 33) or pollen, therefore all the pots should be taken out during the harvesting process and put into a bowl/basin for individual extraction of the hive products.

The pots from *Melipona trinitatis* (Guanot) can be examined by breaking them individually in turn to examine the contents. The honey can be carefully removed from pots using a syringe (Figure 34).

The entire set of pots will need to be put through a sieve for *Frieseomelitta paupera* (Petite angel) as the pots are small and difficult to separate. The honey collected can be bottled and stored.

Pollen can be removed from the pollen pots with an ear spoon or other small scooping tool.

Figure 34. Extraction of honey from Melipona trinitatis boxed hive using a syringe.

Hive design to facilitate harvesting of stingless bee honey

Frieseomelitta paupera (Petite Angel) bees make the brood structure as far away from the entrance of the hive box as possible. The hive box design is longer than it is wide, as mentioned earlier. The beekeeper may choose to insert two subdividing panels (each with a central hole to allow movement of the bees and air) to create three chambers in the box. The bees will develop the brood structure in the chamber furthest from the entrance and will use the other two chambers to create honey pots. The beekeeper can choose to remove honey from pots nearest to the entrance and leave honey in the middle chamber for the benefit of the bees. In this case the hive box just needs to be tilted at the entrance end to drain the honey from the box.

Melipona sp. (Erik) hive box design can follow a Mayan log hive design. In the Mayan log hive, the bee colony is located at the middle of the length of the log and at the two ends of the log, a large stone or circular piece of wood is used with mud to cap the log. The bees – *Melipona sp* – locate the colony near the entrance of the hive (which is near the centre of the log) and build honey and pollen pots on either side of the brood structure – which will be near the capped ends of the log. In the artificial habitat, the hive box is slightly longer than it is wide, with the entrance hole made at the centre of the long side. Two walls are put in the interior, and the brood is at the centre between the two walls. Holes are placed in the walls to allow movement between brood chamber and other two areas. Bees will create stores of honey in the chambers located at either end of the hive box. Harvesting of honey can be done at one end only each time of harvest, alternating the side harvested on each occasion. This allows a store of honey to be left for use by the bees.

Hive products and the value chain

As mentioned in the previous section, the honey produced by some of the local species of stingless bees, in varying volumes, can be harvested as a hive product. This section gives some more background information on the use of this product, current and potential uses of other products of the hives of stingless bees and other aspects of the value chain as related to Meliponini culture.

Stingless bee honey

The type of honey produced by local stingless bees differs in several physical characteristics from honey produced by exotic honeybees. According to the FAO publication on good beekeeping practices (2021):

"Stingless bee honey has a higher moisture content, higher acidity, lower sugar composition and lower enzyme activity than Apis mellifera honey."

The honey produced by stingless bees is generally used as a medicinal product rather than a food product. This substance has been used traditionally in South America and Africa as a treatment of coughs, enteric diseases and fever and also to increase fertility (FAO, 2021; Adler et al., 2023). In Central and South America, the honey of some stingless bees has been used in treatment of wounds (Ramon Sierra et al., 2016).

In Trinidad and Tobago, honey from *Frieseomelitta paupera* (Petite angel) bees has been used as eyedrops in treatment of glaucoma (David Rostant, BES-Net TT video recording; see Resources). Local research on the properties of stingless bee honey is documented in a paper published by Browne et al. (2020) in which antimicrobial activity was noted in honey produced by *Frieseomelitta sp.* and *Melipona sp.* obtained from Tobago.

In terms of stingless bee honey trade in Trinidad and Tobago, one beekeeper sells the honey of *Frieseomelitta paupera* (Petite angel) at TTD 50 per 5 ml. Honey produced by stingless bees is therefore considered a high value product, though how widespread it is used locally is unknown.

Management of stingless bee colonies in hive boxes is greatly recommended when honey harvesting is a motivation as harvesting from wild hives is generally a destructive process.

Bee pollen

Bee pollen is produced as a mixture of flower pollen, bee secretions, honey, wax and enzymes. The bee pollen is used to feed the brood and is essential to the nutrition of the colony.

Bee pollen is however also harvested for use by humans, as several health benefits have been attributed to its use (Box 1). In Central America, pollen of stingless bees has been reported in use as an energiser and a nutritional supplement for children with anaemia, being eaten pure or mixed with banana or with honey (Adler et al., 2023).

Box 1. Pollen in pollen pot of *Melipona trinitatis*. Pollen of stingless bees has documented uses in Central America and this hive product may need to be explored locally.

Cerumen

Cerumen is composed of wax secreted by bees and sticky resins collected by the bees from plants. This is a product made exclusively by stingless bees (Ferreira *et al*., 2023) and is used in the construction of brood combs and the pots that store honey and pollen. Cerumen is recycled by the bees within the hive. Colouration and flexibility of cerumen varies, dependent on the relative proportions of wax and resin and can therefore be flexible or rigid, dark or light in colour (Shanahan *et al*., 2021).

Propolis

Propolis is formed from wax mixed with plant resins as well as soil or clay and forms a main building material, for sealing cracks and crevices in the hive. Propolis also yields a natural antibiotic, has anti-inflammatory properties (Al-Hatamleh *et al*., 2020) and is used in apitherapy. Propolis of stingless bees is said to have higher microbial activity than that of honeybees (*Apis* sp.).

The hive box and the hive colony as saleable products

Apart from the harvesting of hive products for personal use or for sale, the sale of hive boxes and/or colonies of stingless bees can be seen as a small or emerging market locally. Interest in Meliponini culture was expanded among attendees to workshops in the BES-Net TT project (2021-2024). The establishment of a social media network using the WhatsApp platform in 2023 saw active exchange of management tips and sharing of suppliers of hive boxes among established and potential stingless bee beekeepers, as well as established honeybee beekeepers.

One beekeeper of *Melipona favosa* (Guanot) has advanced the sale of hive colonies, with a main management focus on splitting of hives to produce new colonies rather than honey harvesting. The hive box and full colony retails at approximately TTD 3000. Another beekeeper has developed a side business of sale of hive boxes of various designs.

Education, Peer training and Apitourism

Boxed colonies of stingless bees also provide a good basis for public education on stingless bees and their management (Box 2). The BES-Net TT project advocates and supports the inclusion of stingless bee colonies in or near pollinator gardens and on farms. The bees supply pollination services and can form a prominent learning tool.

For those who are managing bees in this way, the colonies can provide opportunities for hosting of training workshops on stingless bee hive establishment and management. This can encourage more persons to be engaged in this form of stingless bee conservation. Training can allow for: increasing capacity to identify and/or recognise stingless bee species, how to box wild hives, management of hives and hive splitting and harvesting.

Established hives may also be a source of additional income through apitourism activities in which visitors can view hives and bees, sample and purchase hive products and tour supporting pollinator gardens as a unique tourism product.

Spin-off income streams are also envisioned for those supplying materials and tools for stingless bee beekeeping such as hive boxes, tutorials, value chain products and crop pollination services.

Box 2. Mr. Erle Rahaman-Noronha and boxed stingless bee colonies at Wa Samaki Ecosystems, Freeport. The bee colonies provide another area for key learning at a site where workshops on permaculture are delivered.

Meliponiculture as a livelihood activity

Meliponiculture, or stingless beekeeping, represents a sustainable and culturally significant livelihood activity in many parts of the world, particularly in tropical regions such as Latin America, Southeast Asia, and Africa. This practice can offer numerous benefits to our local communities, contributing to economic, environmental, and social well-being.

Economic Benefits

Income Generation: Stingless beekeeping can provide a substantial source of income through the sale of honey, propolis, bee bread and wax. The honey from stingless bees, often considered a premium product due to its unique flavour and medicinal properties, can fetch higher prices compared to regular honey. Propolis and bee bread can be considered value added products, which have significant market value due to their use in natural medicine and cosmetics.

Low Investment: Meliponiculture typically requires lower initial investment compared to traditional honey bee *(Apis mellifera)* farming. This makes it accessible for small-scale farmers, individual households and local community groups.

Environmental Benefits

Meliponiculture often aligns with traditional, sustainable land-use practices, helping to preserve forests and natural habitats. This is particularly important in locations where deforestation and habitat loss are critical issues. Stingless bees are excellent pollinators for a variety of crops, which can enhance agricultural productivity and biodiversity. This is crucial for the health of ecosystems and the maintenance of genetic diversity in plants. In this way, the practice provides beneficial pollinations services.

Social and Cultural Benefits

Stingless beekeeping undertaken as a community activity can strengthen community bonds as it often involves sharing of resources and knowledge and cooperative efforts. The activity can also provide educational opportunities for younger generations, particularly school children, to learn about social insects, ecology and sustainable agricultural practices.

Optimising the environment for bees

Stingless bees forage for the resources that are needed for their survival. These resources can broadly be listed as follows:

- Nectar, for their energy requirements
- Pollen for protein and other nutritional needs
- Resins and other plant materials for nest-building
- Water for cooling hives and for metabolic processes
- Soil and sand particles for nest building
- Twigs and plant materials for nest building.

When managing stingless bees in artificial habitats, it is therefore important to provide sources of these materials in the nearby surroundings.

Plant variety

Stingless bees will forage among the plants in their immediate habitat for nectar, and there are some plants that form a preference for particular species of stingless bees. Local stingless bees, it is believed, have co-evolved with local plants; for this reason, the BES-Net TT project has advocated for the use of local plants in pollinator gardens, above but not exclusive to the inclusion of exotic or naturalised plant species (Box 3).

A list of plants that attract stingless bees and other pollinators, researched by BES-Net TT is found in Appendix 2. The provision of diverse flora is recommended as well as plants which flower at different times of the year, to provide as continuous a supply of nectar and other needed resources for the bees.

Box 3. Common native plant species such as *Cosmos caudatus* attract several pollinator species including stingless bees. Establishment of pollinator gardens can assist in provision of needed resources and habitats for pollinator species.

Access to water

A supply of water, from natural sources or through infrastructure is needed for bees. Streams and rivers in the environment or watering stations such as pools or saucers of water in a garden will enable access to water. When providing watering stations, these should be shallow to avoid drowning. In pollinator garden designs, the incorporation of plants that can capture and temporarily hold water/rainwater – such as bromeliads or heliconias - is also useful.

Pesticide management

Indiscriminate use of pesticides is a key threat to the survival of stingless bees, and other pollinator species. Selecting less toxic pesticides and using environmentally friendly alternatives on farms will greatly assist. Pesticide application techniques that reduce excessive spraying and minimise pesticide drift by spraying close to the ground, will also be less impactful on bee populations. In Trinidad and Tobago, the recommendation is for use of Class III and Class IV pesticides in preference to those which belong to Class I and Class II. The class designation can easily be identified by colour codes at the base of the pesticide packaging (Table 4).

Table 4. Classification of pesticides as noted by colour codes on package. (Adapted from ETIS, 2005)

CLASS OF PESTICIDE	TOXICITY mg/kg BODY WEIGHT	WARNING (COLOUR BAND AT BASE OF LABEL)
Class I a	0 - 50	
Class I b	50 - 200	
Class II	200 - 500	
Class III	500 - 1000	
Class IV	>1000	

It is generally recommended that all pesticide use near bees (nesting and foraging spaces), especially stingless bees, is avoided due to their high sensitivity and the additional risk of contaminating hive products harvested.

Public education

Householders can assist in stingless bee conservation by using less 'bug sprays' in the home and switching to natural alternatives for pest control, such as garlic to deter weevils and lavender to repel mosquitoes. They may report stingless bee colonies found in the home (e.g. in brick wall, under the eaves of a roof) to stingless bee keepers (Trinbago Stingless Beekeepers Network, Facebook) for safe removal to hive boxes, rather than destroying them. If unable to determine if a colony is that of a stingless bee, the homeowner may contact the Apiaries Division, Ministry of Agriculture, Land and Fisheries. The BES-Net TT project developed some educational materials (teacher resources, You Tube videos) which are easily accessible and freely available for use in public education activities; these materials are available in the resources section of the project's webpage.

Monitoring programmes

Programmes that enable monitoring of stingless bees in the environment can provide key information about the health of populations of these organisms. Those engaged in keeping of bee colonies can document the health of colonies and changes/ declines and share this information with relevant local agencies.

In 2023, the BES-Net TT project undertook a survey of native bees at sites in Trinidad and Tobago to document species found on farms surrounding two protected areas (Box 4). Opportunities should be created for regular monitoring and sharing of information with a central agency (such as the Environmental Policy and Planning Division, Ministry of Planning and Development) so that any negative impacts on stingless bees (and other pollinator species) can be investigated.

Climate change, habitat destruction and invasive species are issues which may be impactful on stingless bees, and regular monitoring may provide information on these impacts and prompt actions to resolve them.

Box 4. Blue vane traps deployed during the BES-Net TT bee survey in Tobago in 2023. The conduct of such surveys enables supply of data on local biodiversity which can provide information on the health of the ecosystem.

Issues for the future

Growing interest in the conservation of pollinator species and specifically the management of stingless bees in Trinidad and Tobago augurs well for the protection of these small and often overlooked organisms.

In September 2023, the Government of Trinidad and Tobago signalled its commitment to taking action to conserve our pollinator species, by becoming the 32nd country member of Promote Pollinators, the Coalition of the Willing on Pollinators (Box 5). This organisation, which got its start in 2016, represents an alliance of countries that have expressed a commitment to taking action through articulated strategies to act on the global decline of pollinators and their habitats.

Box 5. Martijn Thijssen from Promote Pollinators, the Coalition of the Willing and Lena Dempewolf of the Environmental Policy and Planning Division, Ministry of Planning and Development display the signed agreement which indicates Trinidad and Tobago's membership in the Coalition.

As with all communication for environmental protection, continuous and consistent messaging will go a long way to sustain this interest and take action that is necessary to maintain these components of our local biodiversity.

The following are key actions that are recommended for continuance in this regard:

- Promotion of educational materials to build local capacity to recognise stingless bee species.
- Public education with specific groups to build knowledge and protection actions (especially among loggers, hunters).
- Compilation and promotion of verified information and guidelines on management of stingless bees.
- Address standards/code of best practices for hive management and honey production. Pioneering work undertaken in these areas are noted as follows:
  - The East African Community (composed of Burundi, Uganda, Kenya, Tanzania, Rwanda, and South Sudan) has developed a unified stingless bee honey standard (FAO 2021, page 90).
  - Malaysia has specifically developed the first SBH standard referred to as Malaysian standard (MS) 2683:2017 (Al-Hatamleh et al., 2020)
  - Work underway to develop a native bee honey standard in New Zealand (ABC Net, Australia, 2019)
- Promote and facilitate opportunities to conduct research.
  - Stingless bee species biology
  - Stingless bee honey analysis
  - Therapeutic value of honey – documentation of indigenous use and formal analysis

Resources

- Contact agencies/persons for hive removal, hive advice
  - The Trinbago Stingless Beekeepers Network Facebook page: https://www.facebook.com/groups/491945367571395/
  - Apiaries Division: https://agriculture.gov.tt/divisions-units/ran-contact-info-2/

- Video recordings from BES-Net TT project
  - Introduction to Stingless Bees - Professor Christopher K Starr (ret.) in Workshop 3 of BES-Net TT Workshop Series 2022. Video length: 39 min, 20 sec
  - Introduction to Stingless Bees - Mr. David Rostant, Stingless Bee Beekeeper. in Workshop 3 of BES-Net TT Workshop Series 2022. Video length: 44 min, 53 sec (Time code - 0:42:35 – 1:27:28)
  - Splitting and Harvesting of Stingless Bee Hives - Mr. David Rostant, Stingless Bee Beekeeper in Workshop 4 of BES-Net TT Workshop Series 2022. Video segment: 1 hour 3 min (Time code – 0:00:00-1:02:43)
  - Building Pollinator Habitats – Mr. David Rostant, Stingless Bee Beekeeper, In: Workshop 5 of BES-Net TT Workshop Series 2022. Video length: 52 minutes.
  - Stingless Bees in Trinidad and Tobago – Slide show. BES-Net TT resource. 5 min, 44 sec.
  - A Haven for Hives – Saving T&T's Stingless Bees. BES-Net TT resource. 4 min, 46 sec.
  - Stingless Bee Rescue in Trinidad and Tobago – Hive Transfer. BES-Net TT resource. 7 min, 43 sec.
  - Stingless Bee Hive Split. BES-Net TT resource. 5 min.

- 2023 BES-Net TT Bee Survey Fact Sheets
  - Fact Sheet 1: Key Lessons Learned
  - Fact Sheet 2: Survey Outcomes
  - Fact Sheet 3: Do you Know

- Websites to assist in organism identification
  - Brazilian Association for the Study of Bees (ABELHA) - https://abelha.org.br/abelhas-sem-ferrao-do-brasil/
  - Discover life - https://www.discoverlife.org/
  - iNaturalist - https://www.inaturalist.org/
  - Moure's catalogue of neotropical bee species - https://moure.cria.org.br/catalogue

Glossary

Apiculture	The activity or job of keeping bees, especially to produce honey. (Cambridge Dictionary)
Apitourism	A form of tourism connected with beekeeping as a traditional profession and with bee products in ecological, food and medicinal aspects. (Pal and Bhattacharya, 2018)
Bee bread	Fermented bee pollen, honey and bee saliva, which is used as a major protein source for bees. (Wan Iryani Wan Ismail et al., 2018)
Bee pollen	A natural mixture of bee secretions, honey, enzymes, wax, and flower pollen. (https://www.medicalnewstoday.com/articles/bee-pollen)
Bromeliads	Plants from the Bromeliaceae family that often capture and hold water, providing a water source for bees and potential in pollinator gardens.
Cerumen	A mixture of propolis with the wax secreted by bees before it is used in nest construction. (Al-Hatamleh et al., 2020)
Class III and Class pesticides	Categories of pesticides that are less toxic and recommended for use to IV minimize the impact on bee and potential pollinator populations.
Heliconias	Plants from the Heliconiaceae family, known for capturing rainwater and providing a water source for bees and potential pollinators.
Honey	A sweet, sticky, yellow substance made by bees and used as food. (Cambridge Dictionary) The sweet viscous fluid produced and stored by honeybees. (Beekeeping and Bee Products Act, Chap 67:53, Laws of Trinidad and Tobago) The nectar and saccharine exudations of plants which are gathered, modified, and stored in the comb by honey bees. (US regulations, 7 USC § 4602(7)) The natural sweet substance, produced by honeybees from the nectar of plants or from secretions of living parts of plants, or excretions of plant-sucking insects on the living parts of plants, which the bees collect, transform by combining with specific substances of their own, deposit, dehydrate, store and leave in honeycombs to ripen and mature.

	(Codex Alimentarius International Food Standards) The natural sweet substance produced by Apis mellifera bees from the nectar of plants or from secretions of living parts of plants or excretions of plant-sucking insects on the living parts of plants which the bees collect, transform by combining with specific substances of their own, deposit, dehydrate, store and leave in honeycombs to ripen and mature. (Honey (England) Regulations, 2015; European Union) Note: The EU definition states that honey is only honey according to the definition when it is produced by *Apis mellifera* honeybees.
Indigenous use	The traditional use of natural resources by local communities, such as the therapeutic use of stingless bee honey.
Meliponiculture	The practice of keeping and managing stingless bees, particularly for their honey and other products.
Nest homeostasis	The process by which bees maintain stable conditions in their nests, such as temperature and humidity.
Pollen	The powdery product synthesised by seed plants responsible for the production of the male gametes of the plant. (Biology Dictionary)
Pollinator gardens	Gardens designed to attract and support pollinators like bees, often featuring a variety of local plant species.
Propolis	A resin-like substance which is produced by bees by mixing salivary secretions, beeswax, pollen and resins harvested from botanical sources. (Al-Hatamleh et al., 2020). Propolis is used in the construction of honey and pollen pots.
Resins	Plant materials collected by bees and used for nest construction, often mixed with other substances like wax and saliva.
Stingless bee honey (SBH)	Honey produced by stingless bees, which has unique properties and is subject to specific standards in some regions.
Stingless bee hive management	The practices involved in the care and management of stingless bee hives, including hive establishment, maintenance, and harvesting.

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Appendices

Appendix 1.

Colour changes in *F. paupera* with age

Source: de Bruijn et al., 2015

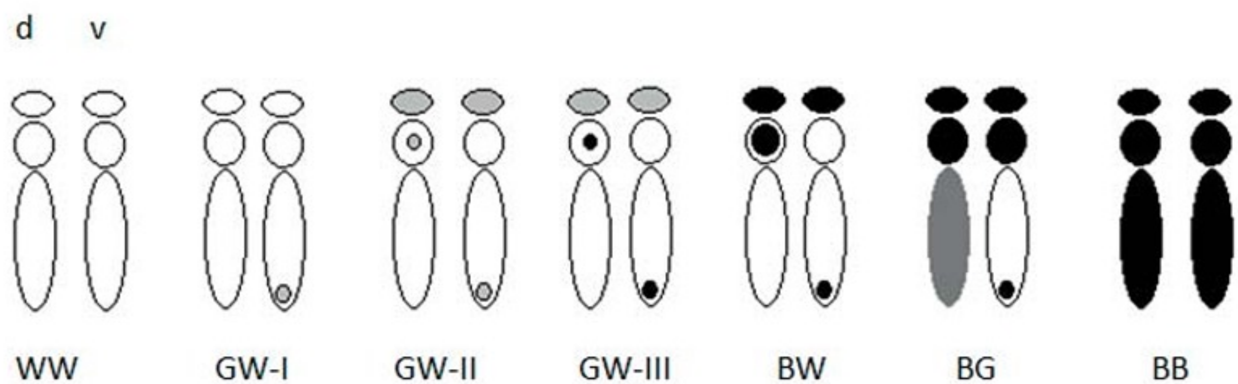
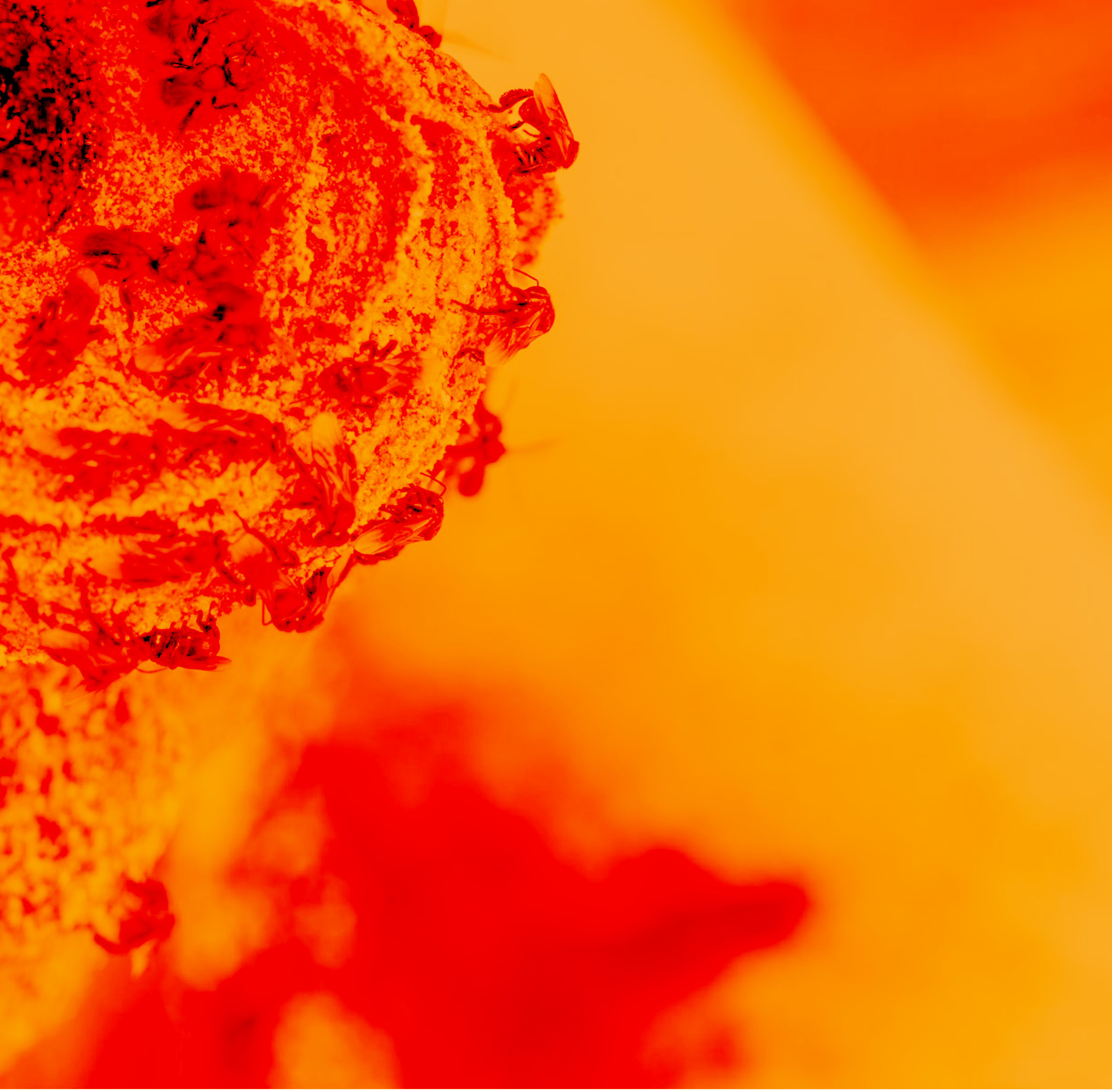


Figure 2. Pigmentation-scenario based on the distinct pigmentation-patterns for worker-bees in *Frieseomellita paupera* colonies (d, dorsal side; v, ventral side). WW: Just emerged worker bees, completely pale head, thorax and abdomen. The legs are half black/white. GW-I: Pale head and thorax, pale abdomen with brown tip on ventral caudal side. The legs are half black/white. GW-II: A brown head, a small pale brown plate on thorax (dorsal side) and a pale abdomen. The legs are half black/white. A small brown tip at the caudal end, ventral side of abdomen. GW-III: A grey head, a small black plate on thorax (dorsal side) and a pale abdomen. The legs are half black/white. A small black tip at the caudal end, ventral side of abdomen. BW: A black head, a big black plate on thorax (dorsal side) and a pale abdomen. The legs are half black/grey. A small black tip at the caudal end, ventral side of abdomen. BG: A black head, a completely black pigmented thorax. The abdomen is pale on the ventral side and grey/black on dorsal side. The legs are fully black pigmented. BB: A fully pigmented *Frieseomellita* worker-bee (completely black).

Appendix 2.

A list of plants which attract pollinators from various animal groups.

FAMILY	BOTANICAL NAME	COMMON NAME	POLLINATOR	HABIT	STATUS	NOTES
Acanthaceae	*Pachystachys coccinea*	Black stick	Birds	Shrub	Native	
Acanthaceae	*Ruellia tuberosa*	Minnie root	Bees, (stingless bees), insects	Shrub	Native	
Apocynaceae	*Asclepias curassavica*	MIlkweed	Butterflies	Shrub	Native	
Asteraceae	*Bidens pilosa*	Railway daisy	Bees, butterflies	Shrub	Native	
Asteraceae	*Cosmos spp.*	Cosmos	Bees, butterflies	Shrub	Native	*C. caudatus* (pink, is native)
Astercaeae	*Sphagneticola trilobata*	Graveyard daisy	Bees	Shrub	Native	
Bromeliaceae	*Achemea sp.*	Epiphytic			Native	Shade
Bromeliaceae	*Guzmania sp.*	Epiphytic			Native	Shade
Bromeliaceae	*Vriesea sp.*	Epiphytic			Native	Shade
Combretaceae	*Combretum fruticosum*	Orange flame tree	Bat, birds	Liana	Native	May be tricky to acquire
Convolvulaceae	*Ipomea sp.*	Vine	Native			
Convolvulaceae	*Merremia sp.*	Hairy woodrose	Bees, butterflies, flies,	Vine	Native	Consider *M. aegyptia*
Costaceae	*Costus sp.*	Spiral ginger	Birds, bees, insects	Shrub	Native	*C. scaber, C. arabicus, C. guanaiensis*
Costaceae	*Hellenia speciosa*	Wild cane	Bird	Shrub	Exotic	Syn. *Cheilocostus speciosus*, medicinal value
Fabaceae	*Lonchocarpus punctatus*	Savonette	Bat	Tree	Native	May be more suited to locations outside the main garden area
Fabaceae	*Mimosa pudica*	Shame charlottee	Insects	Shrub	Native	medicinal value
Gentiaceae	*Chelonanthus alatus*	Ground itch bush	Bats	Shrub	Native	
Heliconiaceae	*Heliconia sp.*	Heliconia	Birds	Shrub	Native	*H. hirsuta. H. spathocircinata, H. bihai*
Lamiaceae	*Salvia coccinea*	Scarlet Sage	Butterflies, hummingbirds	Shrub	Native	
Orchidaceae	*Orchids*	Range of pollinators	Epiphytic		Native	Local varieties preferred
Passifloraceae	*Passiflora foetida*	Jumbie Watermelon	Butterflies	Vine	Native	Consider other local species
Polygonaceae	*Antigonon leptopus*	Coralita	Bees	Vine	Exotic	
Polygonaceae	*Coccoloba uvifera*	Seaside grape	Bees	Tree	Native	Useful ornamental
Rubiaceae	*Ixora sp.*	Ixora	Birds, butterflies	Shrub	Exotic	
Rutaceae	*Citrus sp.*	Orange	Stingless bee (food source)	Tree	Exotic	For surrounding areas
Sapindaceae	*Cardiospermum halicacabum*	Bich grass	Bees, butterflies, various insects	Vine	Native	
Verbenaceae	*Lantana camara*	Kayakeet, Grater wood	Butterflies, bees	Shrub	Native	medicinal value
Verbenaceae	*Stachytarpheta jamaicensis*	Vervine	Butterflies	Shrub	Native	medicinal value



BIODIVERSITY AND ECOSYSTEM SERVICES NETWORK
TRINIDAD AND TOBAGO PROJECT

Guidelines for Sustainable Meliponini Management in Trinidad and Tobago

Government of the Republic of Trinidad and Tobago
Ministry of Planning, Economic Affairs and Development

BESNet
Biodiversity and Ecosystem Services Network

UNDP