Beekeeping with stingless bees: a new type of hive

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Stingless bees, like the honey bees of the genus *Apis*, live with many individuals in a nest where honey and pollen are stored. Although the amounts of honey are generally smaller than in the nests of honey bees, people have used stingless bee honey for many centuries. Comparatively little attention has been given to these bees in beekeeping development programmes. It is now realized that stingless bees are important resources for the production of a special type of honey and other products. A limiting factor in the production of stingless bee honey is the way in which domesticated colonies are housed. Because of the specific biology and the fundamentally different nest architecture, the technology developed for apiculture with *A. mellifera* and *A. cerana* does not apply to stingless beekeeping.

What are stingless bees?

Stingless bees (Apidae, Meliponinae) occur in all tropical regions of the world where they are abundant in species and numbers; hundreds of species have been described. Egg-laying queens are much larger than the workers and distinct forms of division of labour and task specialization occur among the members of stingless bee colonies. Whereas honey bees are progressive provisioners, stingless bees have a system of mass-provisioning their brood cells. During short periods, a restricted number of bees deposit the food in the cell, after which the queen lays an egg on top of the food. In all the stingless bee species, this system is characterized by a well-defined cycle: periods of cell-building behaviour alternate with short bouts of intensive cell-provisioning behaviour. Variations in this process are discussed elsewhere[7].

There is a large size variation within the Meliponinae. For instance, *Melipona fuliginosa*, the largest stingless bee, is more than 13 mm long, whereas a dwarf species like *Trigonisca duckei*, measures only about 2 mm. The size of the colonies varies from a few hundred individuals in some *Melipona* species to densely populated nests with tens of thousands bees in species of the genus *Trigona*. Because of their biodiversity and their great abundance in tropical forests, these bees are important for pollination in tropical ecosystems[4].

Nest architecture of stingless bees

The nests of stingless bees are more elaborate and complex than those of *Apis mellifera*. Nests of most species are built within protective cavities such as hollow trees or in the ground. Few species build their nests

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in exposed positions. The main building material is cerumen, a mixture of beeswax and plant resins. Extensive use is also made of batumen, a mixture of mud, plant resins, animal faeces etc. Pure plant resin is also commonly used and is collected in considerable quantities. The narrow nest entrance of *Melipona* and other genera allows the nest to be defended by one or only a few guards positioned in the mouth of the entrance tube which is often rather elaborate.

Within the nest the brood chamber is always clearly separated from the area of food storage. In principle, there are two cell types: brood cells and storage pots (fig. 1). Storage pots are in most species several times larger than the brood cells, and pots containing honey are generally intermixed with those that contain pollen. However, pots with honey are sometimes grouped at the periphery of the storage compartment, whereas pollen pots may be found near the brood chamber.

Most species arrange their brood cells in single-layered horizontal combs. The pile of horizontal combs is surrounded by a series of sheets of cerumen. This involucrum separates the brood chamber from the storage compartment. Brood cells in a cluster arrangement are not surrounded by an involucrum. This allows them to fit into irregularly shaped cavities. Species with intermediate arrangements of brood cells, e.g. irregular combs, are also found.

Meliponiculture

Before early settlers introduced the European honey bee to the Americas, stingless bees were the only colony-forming and honey-storing bees in the neotropics. Stingless bees are particularly diverse and abundant in tropical America, where their status as insect pollinators is dominant[4].

Because stingless bees are so abundant, honey and other products of these bees have been used intensively by Indian groups

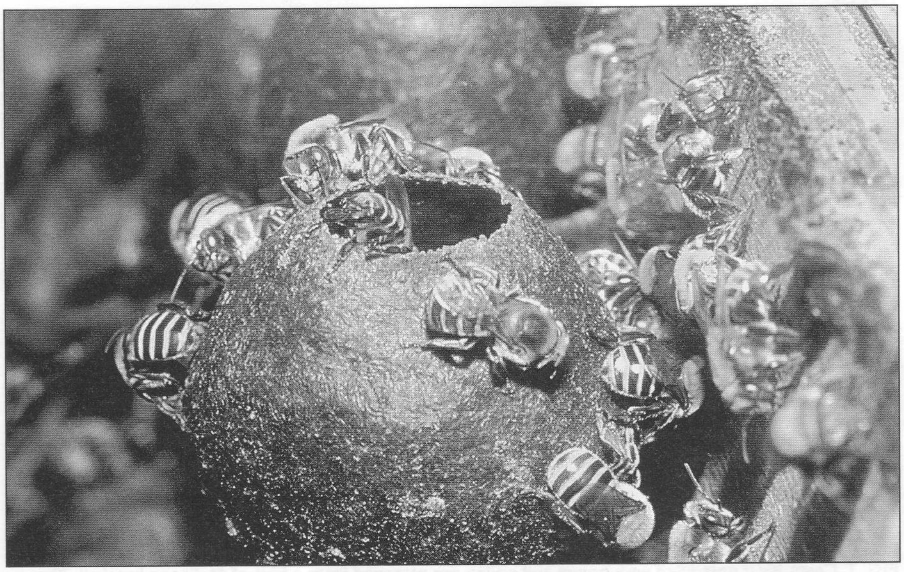

FIG. 1. Detail of honey pot into which bees discharge nectar; *Melipona beecheii*. Note the size of the pot.

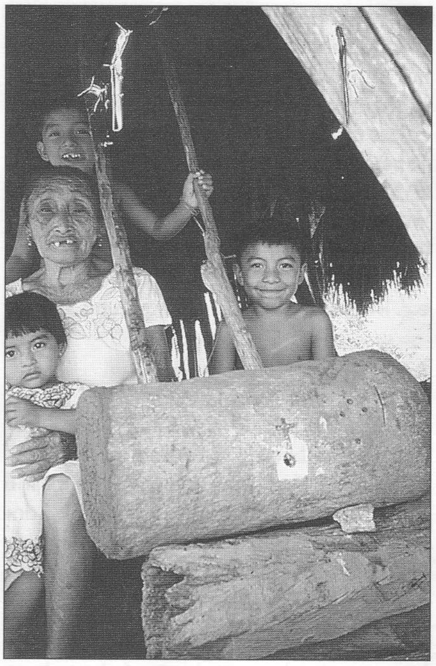

FIG. 2. Mexico: Maya Indians with stack of traditional hives of *Melipona beecheii* in Yucatan, Mexico.

from South and Central America. Anthropological information is available about traditions relating to the domestication of stingless bees by meso-American Indians (particularly the Maya). Meliponiculture was very important in this part of the world and interesting management procedures are described. South American Indians, e.g. in the Amazonian forest, also made important use of stingless bees. Traditionally, stingless bees are kept in hollow logs transferred directly from the forest. In some regions, particularly in the Yucatan peninsula, Mexico, logs are neatly cut and widened before a colony is transferred (fig. 2).

Recently, meliponiculture has again started to receive attention in Central America after a period of decline. One of the reasons for this renewed interest is the spread of Africanized honey bees[6]. As an interesting complementary form of small-scale beekeeping, local traditional meliponiculture is currently being studied and improved.

FIG. 3. Costa Rica: pots filled with honey and pollen are removed from a hive of *Melipona beecheii*. The honey is squeezed from the pots, after which the building material and the pollen are thrown away.

Honey harvest

Honey is frequently collected from natural colonies in the forest (honey hunting). This often leads to the destruction of the nests, and often to that of the tree as well. During the harvest, the honey is squeezed out of the storage pots. Since pots with pollen are often also found in the honey storage area, a considerable amount of pollen generally gets lost during harvest and the emptied nest material is thrown away (fig. 3). The nest cavity in a log-hive is sometimes difficult to reach as the log has only narrow openings at each end (fig. 4). Part of the brood may be destroyed when the honey is taken out, and colonies can suffer badly as a result of the harvest. Suction devices have been developed that are used to extract honey from pots in the log hives, without damaging the pots, and leaving the brood and pollen stores untouched.

Natural enemies of stingless bees

A major pest for stingless bees is the phorid fly (*Pseudohypocera* sp.) which can feed on stored pollen and on brood. Flies that have been able to invade the nest prefer to lay their very numerous eggs on the pollen in damaged pots. The maggots can rapidly destroy the complete nest. Stingless beekeepers need to seal parts of the hive, other than the main entrance, with mud to keep out these files.

Prospects for development

The development of traditional meliponiculture provides new opportunities for people in rural areas, women in particular, and it can improve the economics of many households. Many people who have opted out of beekeeping because of the highly defensive behaviour of Africanized honey bees may be persuaded to take up meliponiculture, particularly if floral resources are abundant.

FIG. 4. Guatemala: log with nest of *Melipona beecheii* suspended from a roof. After the stopper is removed from the hive the honey pots are clearly visible.

Improved and rationalized management of domesticated colonies, based on the biology of the bees, is necessary to increase honey production, although the amount of honey produced by stingless bees will always be much less than the amount produced by honey bees. It should be possible to improve many aspects of traditional meliponiculture, e.g. the housing of colonies, multiplication and harvest procedures. Furthermore, the antibiotic activity of stingless bee honeys[1] may lead to the use of these honeys in medicinal products. Certainly stingless bee honey, with its delicate taste, does fit very well in the present development of niche (export) markets for speciality honeys.

In Costa Rica, local people are keenly interested in participating in meliponiculture training programmes which have been set up by the Universidad Nacional and the Ministry of Agriculture in co-operation with the Bee Research Department of Utrecht University. It is important that the local people who want to take up meliponiculture are given reliable information about the development of individual bees, the production of queens and drones, colony reproduction cycles, nest construction and foraging behaviour.

In addition to these perspectives for rural development, two other applications of stingless bees should be mentioned. The fact that this diverse group of colony-living bees can be used for pollination in agro-ecosystems is very likely to encourage meliponiculture. Modern agriculture requires the use of various specific pollinators, e.g. in greenhouse crops. At present experiments in this field are being carried out in several countries. Because stingless bees rank as very important indigenous pollinators of neotropical and other tropical forests, they should be included more often in programmes for the conservation and management of natural resources.

Hives in current use and their limitations

Since the architecture of stingless bee nests is fundamentally different from that of *Apis* nests, a 'rational' hive for housing these bees has to be very different from the established honey bee hives. Several types of hives for stingless bees have been described. The 'Nogueiro-Neto' hive is well known. Prof. Paulo Nogueira-Neto started his long series of publications about stingless bee biology and about his type of stingless beehive 50 years ago[2,3]. The essential feature of the Nogueira-Neto hive is that the food pots are constructed in a shallow tray that ensures that the bees construct only one layer of pots in this chamber. More space can be provided by stacking additional trays neatly on top of each other. The hive allows for the unobstructed vertical development of the brood chamber. Upward space for the growth of the brood nest is created by the fact that each of the stacked trays, except the bottom one, lacks part of the drawer-floor. The principle of shallow drawers for pot construction has been adapted by other designers of stingless bee hives. Van Veen and coworkers recommended the use of a box with a tight-sealing lid for housing *Melipona beecheii*.

Up to now the published types of stingless bee hives that adapt the Nogueira-Neto shallow-tray principle have the disadvantage that they are composed of many loose parts (shallow trays stacked vertically) that have to be removed when the hive is opened for harvesting honey and for inspection. When these hives are opened (i.e. the trays are removed) for honey extraction the brood nest is exposed and the involucrum is often damaged in the process. The removal of the trays, whose walls surround the whole hive as in the Nogueira-Neto hive, generally damages the protective sealing of a relatively large part of the hive. It is difficult for the bees to seal so many cracks quickly, and this allows phorid flies to invade the hive. In some Nogueira-Neto-type hives, which have a deep section containing the brood with honey supers placed above it, the brood nest is not involved at all during harvesting, and a suction device can be used to harvest honey from the pots very rapidly causing minimal trouble to the colony.

The UTOB hive

The 'Utrecht University — Tobago Hive' (UTOB hive), developed in Tobago by Utrecht University, was designed to satisfy the following major criteria:

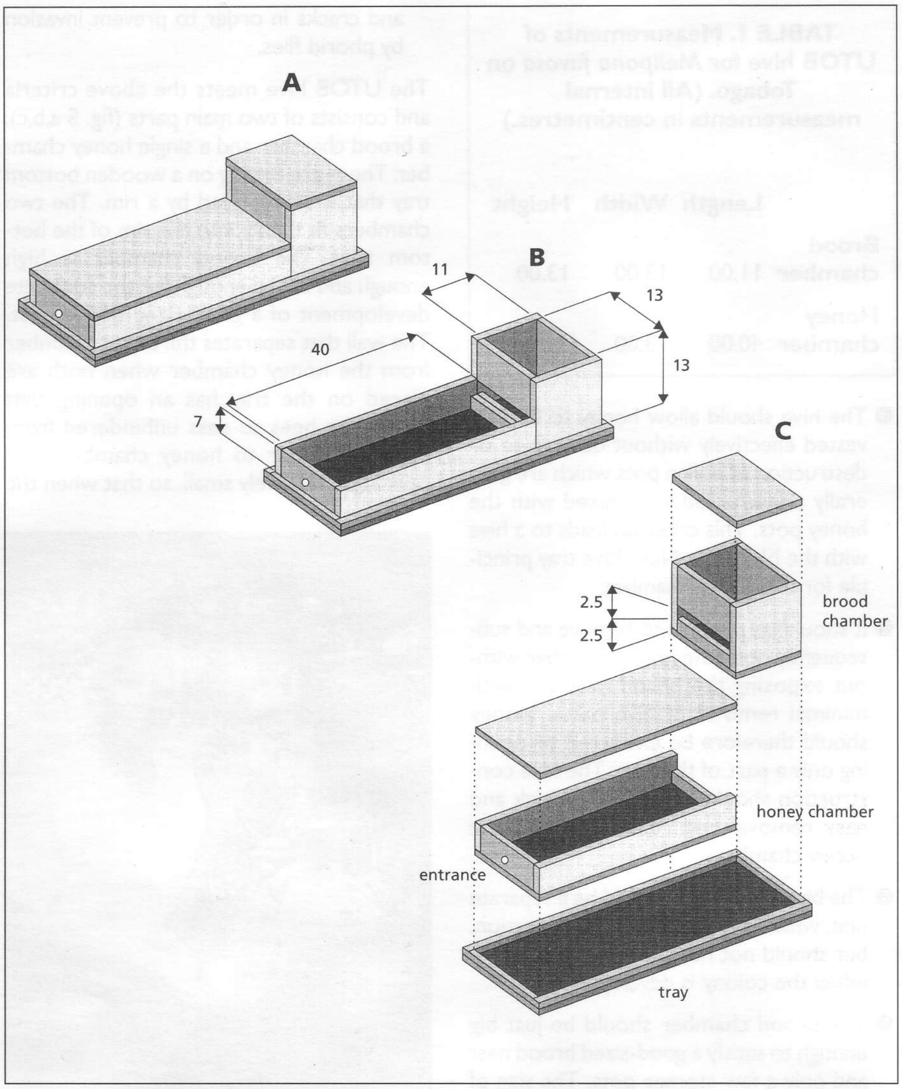

FIG. 5. Diagram of UTOB hive. A. UTOB hive, assembled with two compartments (brood chamber and honey chamber) resting on a wooden bottom tray that is surrounded by a rim (2 cm high). The two chambers fit tightly into the rim of the bottom tray. The hive entrance for the bees is on the side away from the brood nest.

B. UTOB hive with brood chamber and honey chamber in position on the basal tray and with lids from the chambers removed. The connecting walls separating brood chamber and honey chamber have an opening that allows the bees to pass unhindered between the chambers. Only this small opening to the brood chamber is exposed when the honey chamber is removed.

C. Exploded diagram of the UTOB hive.

TABLE 1. Measurements of UTOB hive for *Melipona favosa* on Tobago. (All internal measurements in centimetres.)

	Length	Width	Height
Brood chamber	11.00	13.00	13.00
Honey chamber	40.00	13.00	7.00

- The hive should allow honey to be harvested effectively without damage to or destruction of pollen pots which are generally constructed intermixed with the honey pots. This criterion leads to a hive with the Nogueira-Neto hive tray principle for the honey chamber.
- It should be possible to remove and subsequently open the honey chamber without exposing the brood nest and with minimal removal of hive parts. Honey should therefore be extracted by opening only a part of the hive. The hive construction should facilitate the quick and easy removal and replacement of the honey chamber.
- The brood chamber should be a separate unit, which can be opened for inspection, but should not need much manipulation when the colony is developing well.
- The brood chamber should be just big enough to satisfy a good-sized brood nest and only a few storage pots. The size of the brood chamber should force the bees to construct all other pots in the adjoining honey chamber.
- The connection between the honey chamber and the brood chamber should be such that the honey chamber can be disconnected easily. Removal and replacement should cause a minimum of damage and cracks in order to prevent invasion by phorid flies.

The UTOB hive meets the above criteria and consists of two main parts (fig. 5 a,b,c): a brood chamber and a single honey chamber. These are resting on a wooden bottom tray that is surrounded by a rim. The two chambers fit tightly into the rim of the bottom tray. The brood chamber is high enough and broad enough for the complete development of a good-sized brood nest. The wall that separates the brood chamber from the honey chamber when both are placed on the tray has an opening that allows the bees to pass unhindered from brood chamber to honey chamber. The opening is relatively small, so that when the

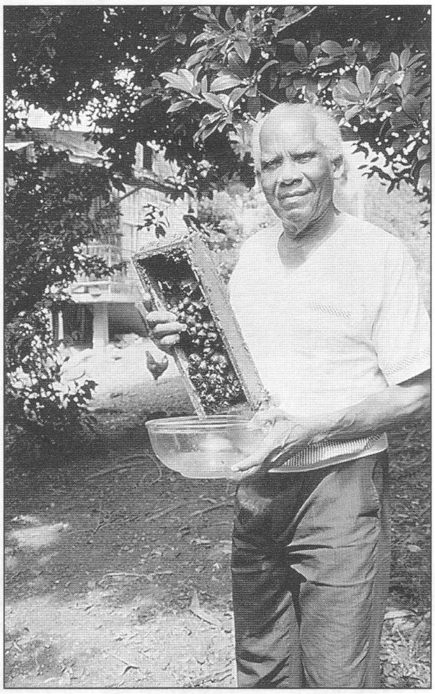

FIG. 6. Tobago: Honey chamber of UTOB hive can easily be taken off. Honey is drained from pots in honey chamber after the honey pots have been punctured at the top. Pollen pots can remain in position.

honey chamber is taken away from the tray, to be opened for honey extraction, only a small opening is made in the brood chamber.

The honey chamber is shallow but high enough to allow for the construction of a layer of pots one-and-a-half pots high. This will generally result in a monolayer of pots. Sometimes, when more pots are packed into the honey chamber, pots can be built at different levels, but not completely on top of each other. This means that all pots can be opened individually without the need of cutting pots away.

Honey can be harvested quickly by opening the top of the pots with a pointed knife. Draining honey from the honey pots is now very easy and a fast procedure because of the low viscosity of this honey (fig. 6). Pots that contain pollen are opened only to check their contents and can remain in position.

The flat honey chamber has a long rectangular shape and when in position on the tray, is tightly pressed against the brood chamber. The hive entrance is on the side away from the brood nest (fig. 7). From our studies on division of labour, we know that foraging bees rarely perform any other nest duties, so it is economic for foragers and nest bees in the hive to have their own compartments. In this way, foragers do not have to traverse large parts of the nest when depositing collected food in storage pots or when transferring food to nest mates.

The UTOB hive has been tested for more than three years on the island of Tobago (fig. 8). The size of the UTOB hives used were adapted to house *Melipona favosa*, a relatively small stingless bee with small colonies. The size of a hive for this species living in these local conditions is indicated in the illustrations. It should be stressed that because the different species of stingless bees vary in body size, they need hives that

FIG. 7. Tobago: Both compartments of the UTOB hive are open. Brood nest is well developed in the brood chamber and pots full of honey and pollen are arranged in the honey chamber.

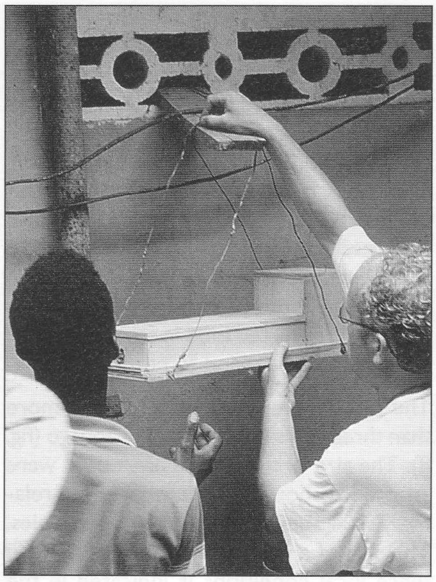

FIG. 8. Tobago: installation of UTOB hive.

are adapted to their specific needs. Even for the same species, it may be necessary to vary the size of brood chamber or honey chamber slightly so that it corresponds to the usual size of, e.g. the brood nest, in a specific area. This means that developing the right size of UTOB hive for a certain species of stingless bee in a certain area has to be based on local experience with the bees. More information on stingless beekeeping is to be found regularly in the *Pegone* newsletter which is published by the bee research department of Utrecht University[5].

Conclusions

The design of the UTOB hive allows for quick and efficient harvesting. It is very important that the honey storage compartment can be removed, opened and replaced without disturbing the brood nest and that honey can be collected without destroying or removing the honey pots. The pollen pots remain undamaged in their original position. The removal of the honey chamber is easy and leads only to minimal opening of the brood chamber. This leads to minimum disturbance in the brood nest and greatly reduces the risk of an invasion by phorid flies.

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