Stingless Bees

IMPORTANCE, MANAGEMENT AND UTILISATION

A Training Manual for Stingless Beekeeping

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This Manual

About this manual

This manual is put together to inform and encourage stingless beekeeping in every community. It focuses on the general biology, economic importance, culturing, hive product development and utilisation for pollination services. It also provides a step by step approach to efficient and sustainable stingless beekeeping. The manual has been designed to appeal to all categories of persons such as beekeepers, farmers, extension workers, students, scientists, NGOs, policy makers and the general public. Topics covered in this manual are based on current scientific and indigenous knowledge.

How to use this manual

The manual consist of two parts. Part one provides general information about stingless bees; whiles part two helps you discover how to efficiently and successfully keep stingless bees. In order to derive maximum benefits from this manual you need to first study the contents of part one to provide the needed background knowledge.

Forward

I deem it an honour and privilege to write a Forward on this excellent Training Manual for Stingless Beekeeping.

Bees, on the whole, are of great service to mankind. They do not only assist in the provision of an essential ecosystem service of pollination of flowering plants that results in increases in food production, but also provide hive products such as honey, Beebread, propolis and beeswax.

Current trends in our farming systems and wanton destruction of the environment point to a declining population of colonies of the most commonly featured bee, *Apis melifera* or the 'Stinging Bee'.

It is a welcome relief that the search for alternative to augment pollinators especially in managed pollination service have unearthed Stingless Bees as a viable, less fearsome and easy-to-manage alternative group.

This Training Manual is intended to be a beginning outline for experienced instructors teaching Stingless Beekeeping courses to future trainers, extension staff, students of agricultural institutes, colleges and universities, plantation fruit tree crop managers, and small and medium scale farmers.

Learning about new technologies is a slow, personal and social process. To accelerate this process, special training methodologies must be applied which are based on past experiences and have proved successful.

The Training Manual for Stingless Beekeeping is the result of many years of teaching/training experiences of the authors at the tertiary levels. It has the aim of filling an existing gap namely the lack of a suitable publication adapted to socio-economic conditions of the country and capable of assisting in the training of large numbers of extension staff, trainers and producers of seeds, vegetables and fruits that depend on pollination.

It is very well written and illustrated with appropriate diagrams and pictures well keyed in the text. The style is succinct, lucid and the language is well understood by all.

The contents are well thought out and presented in a logical order. Activities and instructions are clearly spelt out. Each activity begins appropriately with an outline on the impacts to be attained at the end of the course.

To the authors, I say, thank you for a good job done. To the trainees and practitioners, I say, it is an excellent hands-on training manual; and to all lovers of nature, I say, it is a good read.

Professor A.G. Carson
School of Agriculture, University of Cape Coast, Cape Coast. GHANA.

PART ONE

GENERAL INFORMATION ON STINGLESS BEES

Introduction

Pollination is an essential ecosystem service that results in the increase in food security and improvement of livelihoods. Many animals including bees are the main pollinators providing this service. Bees play a very important role in the pollination of flowering plants resulting in quantity and quality of fruits and seeds. They are known to pollinate about 70 -80% of flowering plants. Until now, most of the managed pollination service has been through the use of the honeybee, *Apis melifera*. Of late, the populations of *A. melifera* colonies have been declining at a fast rate resulting in low yields of crops. Some of the main causes of this decline can be attributed to the following: man's misapplication of insecticides which kill colonies and/or contaminate their hives; diseases; pests such as the trachea mites (varroa); logging; bush fires and habitat destruction. These problems also affect bee pollinators within natural landscapes such as forests resulting in the decline of plant species and animals that depend on fruit and seeds for survival.

It has therefore become necessary to search for a suitable alternative that can be used for managed pollination in both agricultural and natural landscapes. This search seems to have landed on Stingless bees, which have been in existence within tropical and subtropical ecosystems since creation. Stingless bees are also very important for their role in primary health care through production of medicinal hive products such as honey, propolis and Beebread.

Like honey bees, they live together in cavities with a queen, workers (females) and drones (males). A few species build and live in exposed nests usually attached to a tree branch or stem. Stingless bees comprise many species of which over 300 have been identified in Brazil. A few of these have been successfully cultured for their hive products and for pollination. Stingless bees can be found in tropical regions of the world including Central and Southern America, Australia and Africa. In Africa, 26 species have been identified and out of this 9 have so far been found in Ghana.

The development of stingless bees for sustaining human livelihood is new and almost non-existence despite their presence in Ghana. The current status of stingless bees in the country can therefore be described as follows:

- Stingless beekeeping and resource centres with Ghana are on-going.
- Education and sensitisation has started.

- Survey to identify all stingless bee species in the country has began.
- Scientific research on various aspects of stingless bees biology is on-going.
- Development for pollination and hive products is on-going.

Habitat destruction and forest fragmentation through logging and other forest clearing practices seem to threaten stingless bees in the country. Bush fires, wild honey hunting and misapplication of pesticides also destroy colonies. There is therefore the need to rescue and conserve stingless bees in order for them to continue providing the essential ecosystem services that maintain ecosystems and improve biodiversity.

This first book intends to provide current information on stingless bees in Ghana and how they can be cultured for the benefit of beekeepers, crop farmers and anybody who may need it.

Morphology of Stingless Bees

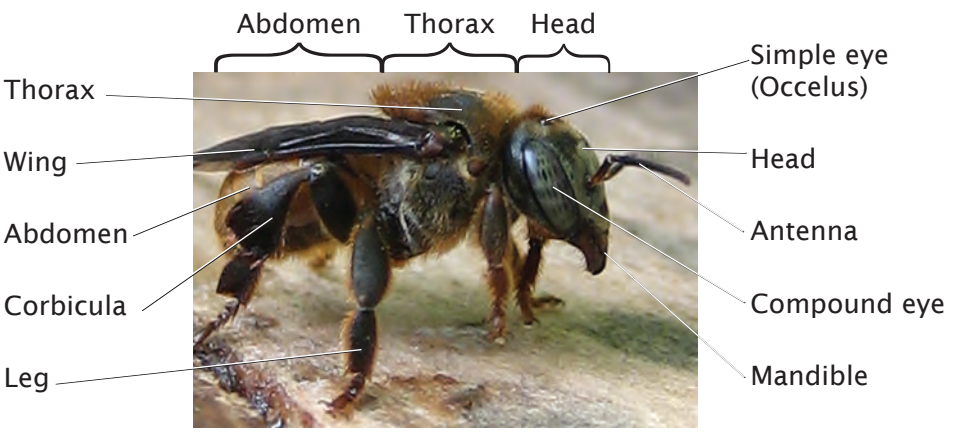


Figure 1.0.1 External morphology of a worker stingless bee (*Meliponula bocandei)*

Stingless bees like other bees, are members of the class Insecta, and family Apidae. Bees are either social (living in groups) or solitary (living as individuals). The external morphology of Stingless bees is in three body parts: Head, Thorax and Abdomen. Important features present on the head include the antennae, compound and simple eyes (occelli) and mandibles. Two pairs of wings and three pairs of legs are attached to the thorax. The hind legs of most stingless bee workers have a modified structure, corbicular (pollen

basket) for collecting and transporting pollen and other materials. The third body part is the abdomen which has a non-functional 'stinging' apparatus. It must be noted that most parts of the external body of stingless bees are covered with hairs.

Chapter 1

The Biology of Stingless Bees

1.1 Ecology

Specific Objectives

At the end of this unit trainees should be able to:

1. Mention the major climatic and vegetation areas of the world where stingless bees can be found.
2. Explain the interactions that occur between stingless bees and other organisms in their habitats.
3. List the abiotic factors that influence the behaviour of stingless bees in their habitats.
4. Describe places where stingless bees build their nests.
5. List the different kinds of materials used by the bees in nest development.

Like any other living organisms, stingless bees live and interact with the natural environment including the living and nonliving elements within their habitats.

Stingless bees and their habitats

Stingless bees live in tropical and subtropical areas around the world. These areas include: Africa, Australia, Central and South America. Stingless bees are believed to be native to Africa.

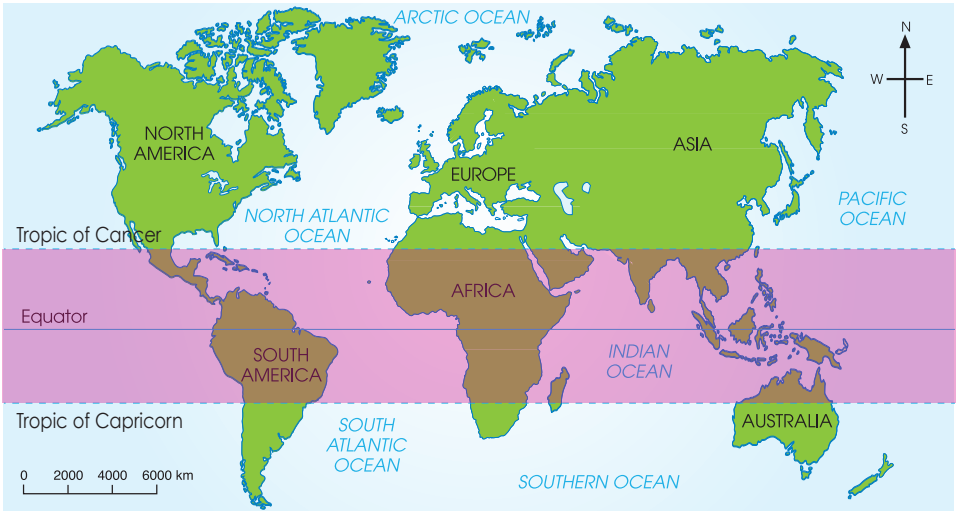


Figure 1.1.1 Stingless bee zone of the world

Various species have their preferred habitats and climatic conditions. Some species are present in the rain forest, savanna and also transitions between forest and savanna vegetation zones.

Stingless bees and their forage resources

Stingless bees forage to collect resources needed for their daily survival and these include:

1. Nectar for energy requirements.
2. Pollen for protein and other nutritional needs.
3. Water for cooling hives and for metabolic processes.
4. Resins and other plant materials for nest-building.
5. Soil and sand particles for nest building.
6. Twigs and plant materials for nest building.

Stingless bees and other living organisms.

Within their habitats and ecosystems stingless bees interact with both living and nonliving things and are influenced by the physical factors in their environments.

Some animals have been found and recorded predating on stingless bees. These include: ants, spiders, toads, lizards, birds and monkeys. There are also some beetles which live around or within their hives. One of the serious enemies is the Phorid fly whose larvae destroy the entire colony. There are also wax moths of various species that attack the colony of stingless bees. Some stingless bees act as robbers and tend to rob the resource of other stingless bees thereby resulting in absconding of colonies. Lizards and spiders have been found feeding on stingless bee foragers returning to their nests.

Monkeys are known to steal honey from stingless bees' nests. Man is one of their serious enemies. Apart from 'stealing' their hive products, man sets fire to nest and colonies through their farming practices and also cut and split their nests through logging and lumbering leading to their habitat destruction. Man also sprays hazardous pesticides in the environment and on crops which kill stingless bees or contaminate their forage sources.

Stingless bees also visit plants to collect pollen, nectar, resins, water and wax. Sometimes the bees bite on the leaves and buds to create wounds from which they collect the resources they need.

Stingless bees and nonliving factors

Stingless bees prefer to live in environments that are safe and suitable for their survival. They are however influenced by physical environmental factors that affect their micro-climate. For example, there is an optimum temperature range and relative humidity that various species prefer. Most stingless bees prefer warm temperatures and are very active on sunny days and less active on cold and cloudy periods. Stingless bees remain in their nests when it is raining and at night. Some stingless bees may prefer higher elevation than others. It is important to note and collect information on physical factors wherever a particular species is located.

1.2 Nesting Sites and Nesting Materials

Specific Objectives

At the end of this unit trainees should be able to:

1. List the location or nesting sites of stingless bees.
2. List the various materials used in stingless bee nest construction.

a. Nesting Sites

Many stingless bee species nest in cavities. These cavities could be found in the following:

- Stem and branches of living trees including bamboo.
- Dead logs (either standing or lying on the ground).
- Old and abandoned ant hills.
- Cracks in walls of houses.
- Cavities in unused panel doors of buildings (accessed by cracks and key holes).
- However one species of stingless bee *(Dactylurina staudingeri)* builds its own nest in the form of a ball attached to a stem or branch of a tree.

Figure 1.1.2 Nests of some stingless bee species (a. *Dactylurina staudingeri, b. Meliponula ferruginea*, and c. *Hypotrigona sp.*)

b. Materials for Nest Building

Stingless bees make use of various natural materials for nest building. Once a cavity is located workers of a colony will use gums, resins, and wax to construct a nest. In some stingless bee species, sand and mud may be added to propolis and wax for nest building.

1.3 Life Cycle and Reproduction

Specific Objectives

At the end of this unit trainees should be able to:

1. Name the three members of the caste in a stingless bee colony.
2. Describe a generalised life cycle of stingless bees and illustrate this with a diagram.
3. Describe and outline the role of the caste (queen, drone and worker).
4. Describe the swarming process as a means of reproduction of stingless bee colonies.

All stingless bees like other honeybees are social and live together in colonies. The social organisation within a colony is made up of a single queen, a few hundreds of drones and several thousands of workers.

The Life Cycle of Stingless bees

The queen mates with a single drone from a different colony and stores all the sperms she needs for egg fertilisation during her life. This is done in flight. She returns to her nest and begins to lay two types of eggs. Fertilised eggs are laid and will develop into worker or queen larvae. Unfertilised eggs develop into drone larvae. Larvae that must develop into queens are fed and provisioned entirely on royal jelly.

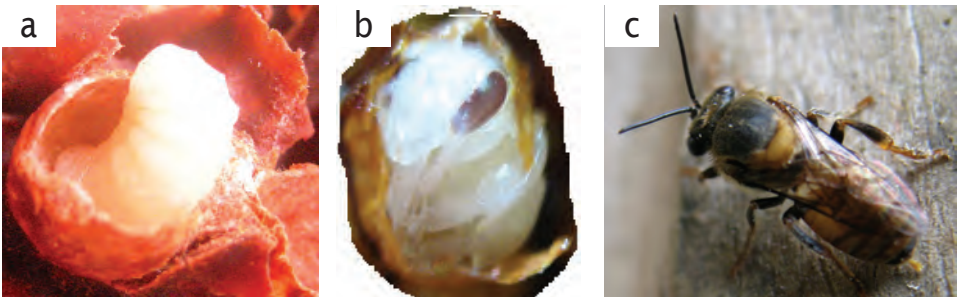


Figure 1.1.3 Developmental stages of stingless bees (a. larva, b. pupa and c. adult)

a. The Queen

The queen is the mother of all members of a colony and controls the day-to-day organisation and activities of the nest. This is done by releasing chemical substances called pheromones. By releasing different pheromones from her body, members of the colony interpret and act accordingly. One example is a pheromone which suppresses the laying ability of all workers of the nest.

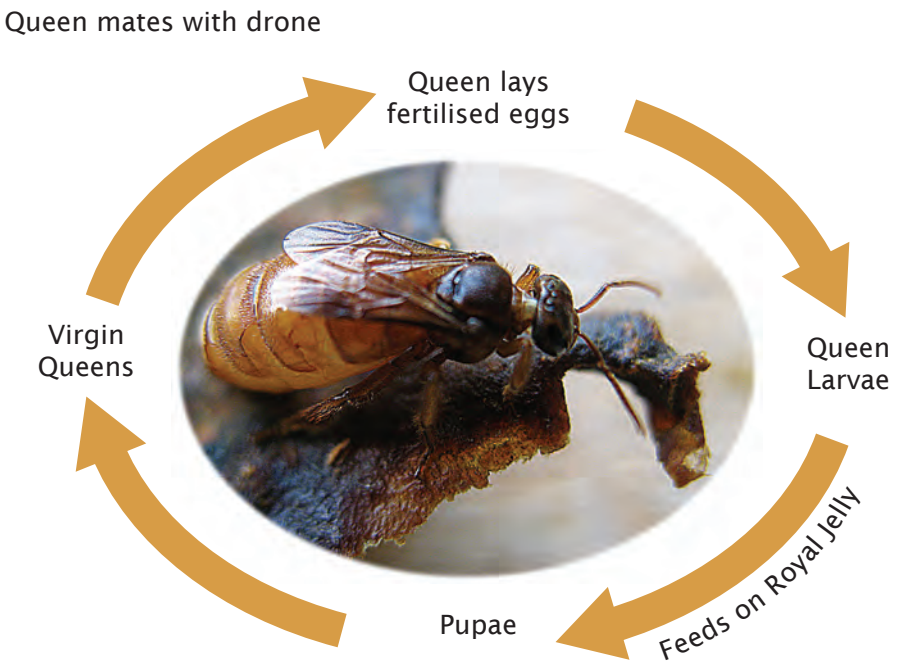


Figure 1.1.4 Generalised life cycle of the stingless bee queen

b. The Workers

Workers are the female components of a colony apart from the queen, and develop from larvae hatched from fertilised eggs. The larvae are initially fed with royal jelly for a few days and then given worker jelly until the pupal stage when the cells are sealed. Adults emerge as workers and perform most of the activities of the nest such as foraging, house cleaning, defence and larval feeding.

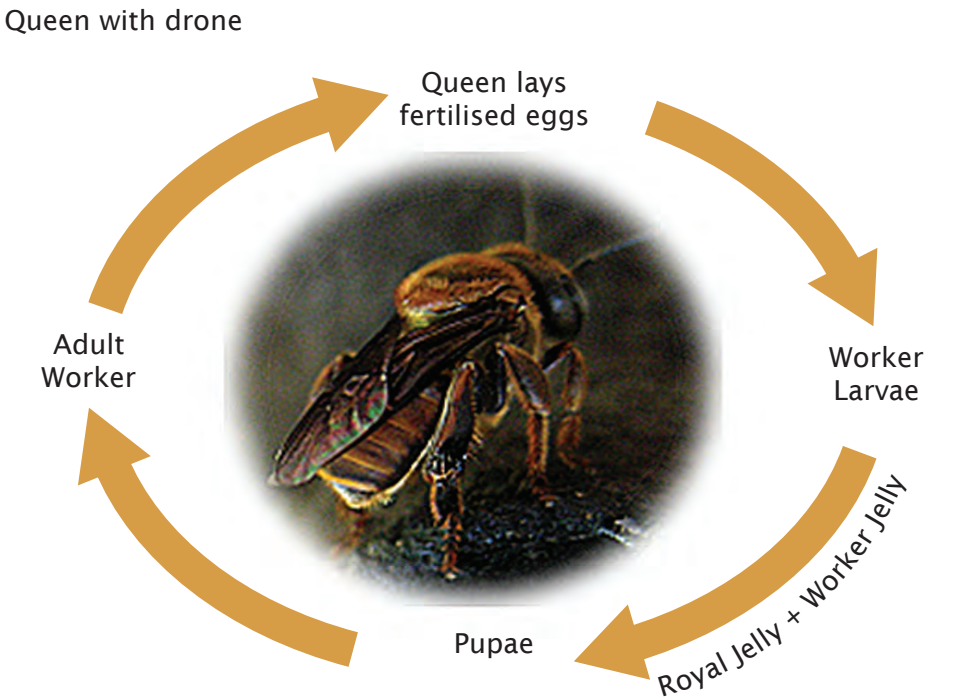


Figure 1.1.5 Generalised life cycle of worker stingless bee

c. The Drones

Drones are the male components of the colony and very important in colony reproduction. This is achieved by mating with virgin queens from other colonies. They are developed from unfertilised eggs. Drone larvae are fed with larval food just like workers. Drones can be seen as light coloured within the nest.

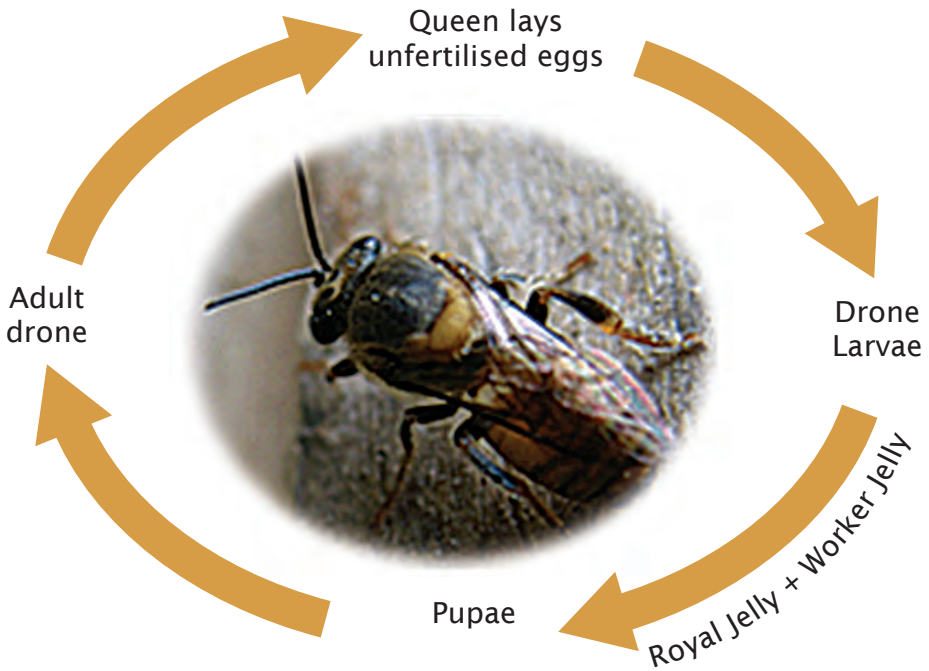


Figure 1.1.6 Generalised life cycle of drone stingless bee

1.4 Swarming (Colony Reproduction)

When forage resources are abundant stingless bee colonies increase in numbers. Colonies with abundant resources divide to form new colonies. These new colonies move out and build new nests in new locations. This phenomenon is referred to as swarming. This normally occurs in the dry season.

1.5 Colony Behaviour

Foraging

Specific Objectives

At the end of this unit trainees should be able to:

1. List all the resources the stingless bees collect.
2. Describe how stingless bees forage.
3. State when stingless bees go out to forage.
4. Outline various forage sites.

During foraging, stingless bees collect pollen, nectar, oils, water, resins, mud and sand particles.

Most stingless bee species communicate locations of forage sources by secreting chemical scents (pheromones) and through the use of the sun's direction. When the foraging workers encounter any forage, they will collect and return to their nest to recruit other workers to the forage source. During the trip, workers stop and mark specific spots with pheromones in order to direct the other workers to the forage source.

Workers begin foraging activities as early as dawn and end by dusk depending upon weather conditions and availability of forage. Peak foraging times coincide with the dry season when forage is in abundance.

Depending on the species, stingless bees will forage within 2 kilometers from their nests. Foragers may be found on flowers of various plants, on grasses and also near water bodies. Some bees collect resins from tree trunks and branches as well as on buds of flowers and leaves.

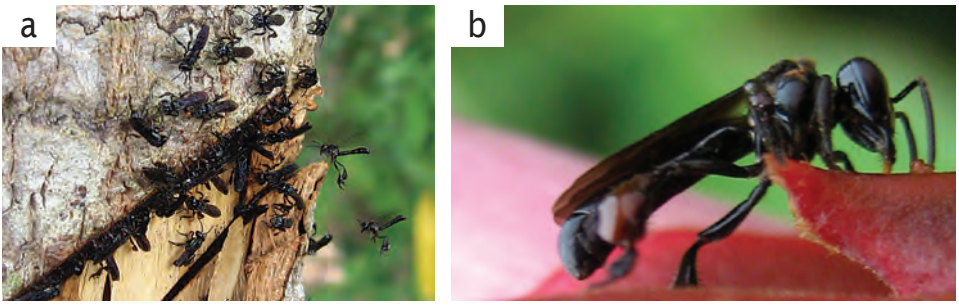


Figure 1.1.7 *D. staudingeri* collecting resins from (a) wounded tree trunk and (b) petals

Nest activities and organisation

Specific Objectives

At the end of this unit trainees should be able to:

1. List the structures that are found in the nest of stingless bees.
2. Describe the arrangement of the structures in a typical nest.
3. Outline the activities of all the members of a stingless bee colony.

a. Nest Structure

The internal arrangement of a stingless bee nest will show the following structures:

1. The passage way – This is an extension of the nest entrance, linking the outside world to the nest. Next to the entrance and in many other locations inside the nest there are deposits of resin, used frequently by the bees.
2. The brood section -- Most species of stingless bees use cerumen (a mixture of wax and plant resin) in the construction of the brood cells and storage pots; others use pure wax. The brood section is enveloped by multiple layers of membranes of cerumen which is called the involucrum and is important for temperature control in the nest. Brood cells are arranged horizontally in most species or in a cluster, however in others such as *Dactylurina*, cells are vertically

arranged. Layers of brood cells are suspended and separated by connectives and pillars.

3. Storage Section – The oval shaped storage pots for honey and Bee-bread (pollen) are built with cerumen.
4. Open spaces – These are spaces left out in the nest for the deposit of resins, propolis and other materials used by the colony for nest building and security.
5. Nest volume – Stingless bees build nest according to colony size. Where a cavity is too large for a colony the nest is temporary closed up at both ends using layers of membranes of batumen (composition of resin, mud and wax).

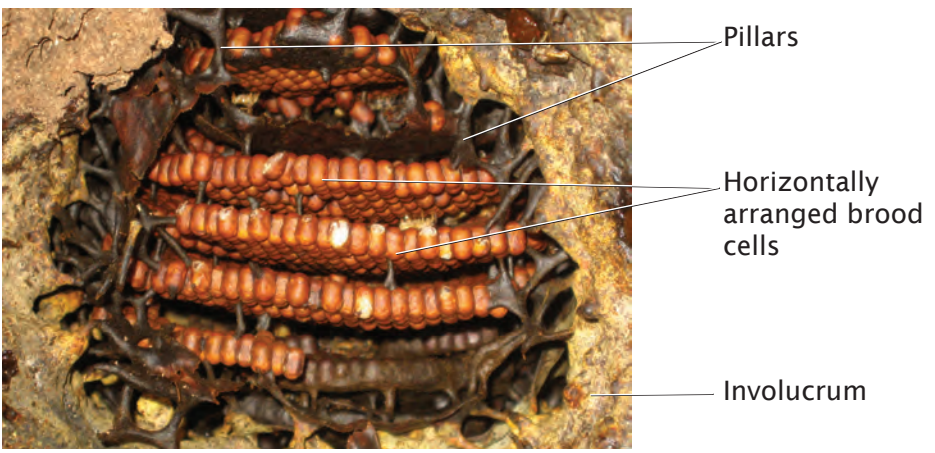


Figure 1.1.8 Part of *M. bocandei* nest internal structure showing the brood section

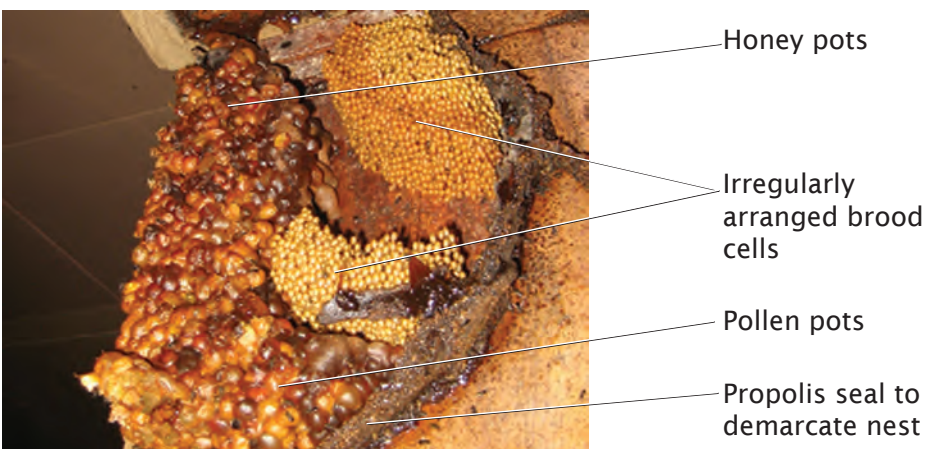


Figure 1.1.9 Arrangements of nest contents of *Hypotrigona ruspolii*

b. Activities in the nest

Egg-laying – The queen is responsible in the laying of eggs that hatch to maintain nest populations. However all the other activities in the nest are carried out by the workers which include the following:

1. Storage pot construction.
2. Honey and pollen processing and packing.
3. House cleaning and maintenance.
4. Larval feeding and provisioning.
5. Queen grooming and feeding.
6. Colony security.
7. Mating is the role of the drones and the queen.

Colony Defence

Specific Objectives

At the end of this unit trainees should be able to:

1. List various threats to stingless bee colonies.
2. Outline various strategies used by stingless bees for colony defence.

Even though stingless bees do not have the ability to employ stinging as a means of defence, they are equipped with various means of defending their colonies from intruders.

Stingless bees need to defend their colonies against threats. Threats to stingless bee colonies may include the following:

- Predators: lizards, birds, toads, spiders, and ants.
- Intruders: robber bees, hive beetles, wax moths, flies, other animals and man.

In order to prevent predators and intruders from interfering with colonies, all stingless bee species will guard nest entrances with a few to many workers.

Figure 1.1.10 Workers guarding nest entrances of (a) *Meliponula* sp., (b). *Hypotrigona ruspolii* and (c) *Dactylurina standingeri*

In the night, workers on guard retreat into the nest and use propolis to close their nest entrances. This behaviour prevents ants, beetles and other animals from entering the nest. The propolis seal at the entrance is removed in the morning and new ones replaced every evening. Some species of stingless bees use sticky plant materials such as resins to prevent intruders from entering their nests. Where intruders or predators manage to enter nests, large volumes of resins and propolis are used to entomb them alive till they die. Some stingless bee species construct a long and winding tunnel to the outside of the nest to aid colony defence.

Any disturbance of the nests of some species of stingless bee such as *Dactylurina* and *Hypotrigona* will signal several workers of their colony to attack the perceived intruder. In their attack, workers try to enter vital areas such as the eyes, nose, ears, and mouth causing discomfort to the intruder. Biting is another means some stingless bees employ to wade off intruders when their nest is disturbed. The bees bite may cause painful and long-lasting skin lesions serving as a deterrent to a potential enemy.

Inter-colony relationship

Specific Objective

At the end of this unit trainees should be able to:

1. Outline and describe how two colonies of the same species may relate.

Worker bees sometimes miss their way and may enter the nest of another colony. Because each nest is unique, and especially in what is described as 'colony scent' members are easily recognised if they enter a different colony. They are either accepted if they carry food or regarded as robbers and rejected. In some situations workers of a colony specialise as robbers and raid others of their entire stores. When this happens members of the nest that is robbed may leave and settle elsewhere.

Chapter 2

Economic Importance of Stingless Bees

Stingless bees are important in a number of ways. These include; their role in plant reproduction through pollination, production of medicinal honey and other hive products as well as their value in aesthetics. Stingless bees can be used in research as well as for ecotourism.

2.1 Pollination

Specific Objectives

At the end of this unit trainees should be able to:

1. Explain the basic concept of pollination.
2. State the role of stingless bees in crop and plant pollination.
3. Outline the benefits of stingless bees in pollination.

Pollination is the transfer of the male sex cells (pollen grains) from the anther to female receptacle (stigma) of the same flower or different flower of the same species of plant. Through pollination, fertilisation occurs and fruits and seeds are formed.

1. Stingless bees visit flowers of plants including crops and forest trees as well as shrubs and herbs to collect nectar, pollen, wax, resins, oils and other plant substances. In so doing, they effect the transfer of pollen grains onto stigmas resulting in pollination of these plants which lead to fertilisation and eventually fruit and seed production. The frequency of their visit to the flowers and efficiency (ability to deposit pollen collected on body of bees on stigmatic heads) in effecting pollination result in high quality and quantity yields of fruits and seeds.
2. Many animals have been implicated as pollinators. Bees in general carry out most of the pollination services. However, as a result of their small sise and large diversity, stingless bees are found to be

one of the most effective and efficient pollinators especially of forest trees. As buzz pollinators, they are able to vibrate the flower to expel pollen from anthers.

3. Fruits and seeds can be processed as food and medicines. These are also fed on by animals (herbivores). Some fruits and seeds fall onto the ground and enrich the soil with nutrients; others germinate and serve as genetic resources to grow other plants especially forest trees. Trees in forests can be harvested for timber products. Other trees serve as medicinal herbs and ornamentals.
4. Stingless bees can be employed in pollination of greenhouse plants/ crops in both temperate and tropical regions.

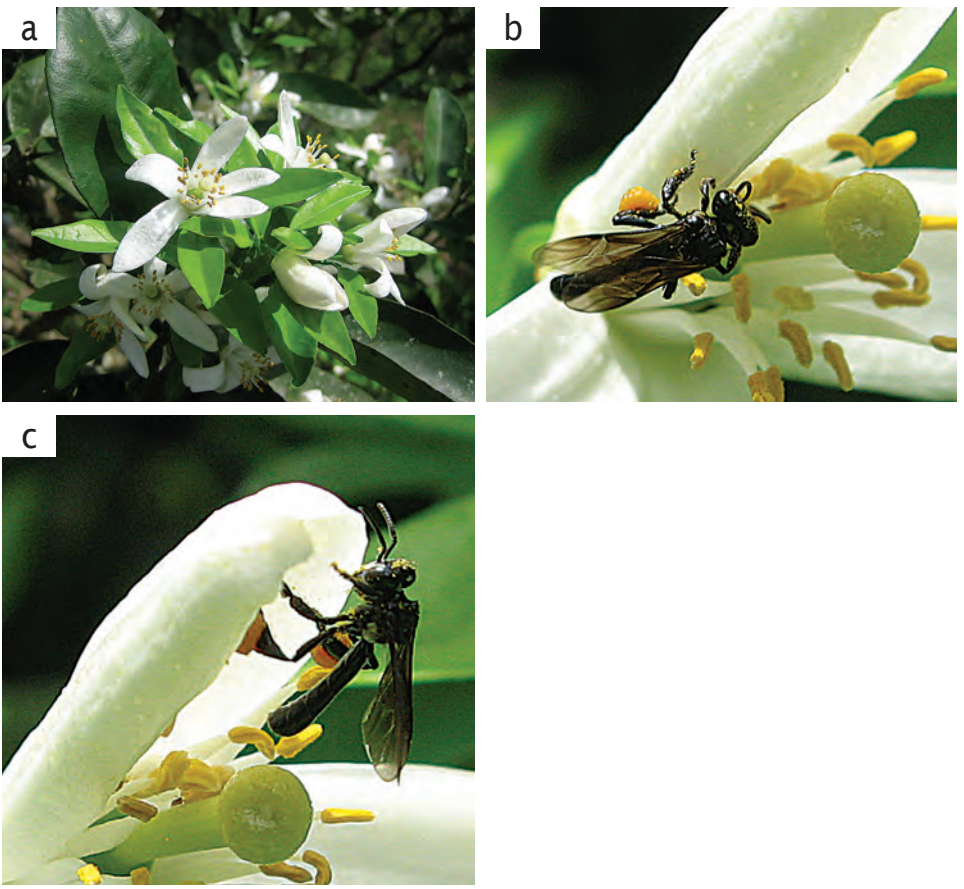


Figure 1.2.1 Demonstration of pollination (a. Orange flowers, b & c *Dactylurina* on orange flowers)

2.2 Hive Products

Specific Objectives

At the end of this unit trainees should be able to:

1. List and describe the products obtained from the hive of stingless bees.
2. Describe the uses of the products to the bee colony and also to man.
3. Describe the production of a nucleus colony and its uses to the beekeeper.

Stingless bees are also important to man in the production of honey, propolis, wax and pollen or Beebread. These hive products have unique medicinal properties and can be of great benefit for health promotion. Baby colonies known as nucleus colonies may also be raised and sold to beekeepers and farmers.

Honey

Stingless bees produce honey from nectar of flowering plants. It is stored in pots that are made of wax cerumen. Honey is mainly made up of glucose and fructose but contains minerals, vitamin and other nutrients. It is the main energy source for the bees and can serve as energy booster for humans. Stingless bee honey can be used as components of bread, cookies and biscuits and also in the production of alcoholic and non alcoholic drinks. Stingless bee honey is popular for its antioxidant and antibiotic properties, hence its effectiveness in healing wound and fighting both internal and external infections.

Pollen

Pollen grains are collected from flowers by stingless bee workers and stored as Beebread in pots within the nest. Large quantities of Beebread can be harvested by the beekeeper. Pollen can also be harvested as balls from the forager's pollen basket. This is done with a pollen trap fitted at the nest

entrance. Pollen is rich in proteins, vitamins and minerals and provides these nutrients to the bees. Pollen may be packaged and used as food supplements and also added to infant food. It is also used in many cosmetic preparations.

Fugure 1.2.2 *D. staudingeri* with pollen on hind legs

Propolis

Stingless bees collect resins, gums and other plant exudates to produce propolis. It is used to secure the nest against external intruders; all openings and cracks are sealed with propolis. Propolis can be harvested from the hive by scrapping with a hive tool or knife. Propolis has been scientifically tested and proven to be effective against many health disorders. It is a natural antibiotic that is effective in healing wounds and infections in the body. Ulcers (internal and external), skin infection and rashes are known to be treated with propolis. Regular intake of propolis is known to regulate blood pressure and also boosts the body's immune system.

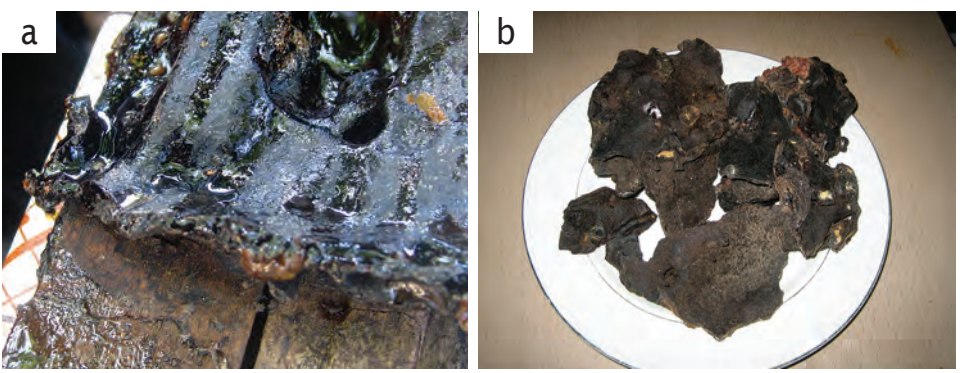


Figure 1.2.3 Stingless bee propolis (a)store within hive and (b) harvested on a plate.

Beeswax

Glands in the abdomen of worker bees secrete wax that is used for the construction of pots. These pots are used for food storage as well as for brood development. After extracting honey or Beebread, the storage pots can be rendered into wax by hot water extraction. Stingless beeswax can be used in cosmetics products to boost the skin and body health. Body and facial creams as well as lip balms can be prepared from beeswax. In addition to these health products, industrial items such as textiles, polishes (wood, floor, leather) and candles can be produced from beeswax. In the pharmaceuticals, industrials beeswax is used to coat tablets and capsules.

Nucleus Colonies

Many species of stingless bees have been found to continuously produce many queen cells. This means that at any time conditions are favourable, a colony may have many queen cells in the nest. The beekeeper can take advantage of this colony behaviour and raise baby colonies from the queen cells. When a number of workers and queen cells are placed in a small hive, a young colony (nucleus colony) can developed. This nucleus colony can be used for multiplication of a beekeeper's stock or could be sold to other beekeepers.

2.3 Aesthetic Value

Specific Objective

At the end of this unit trainees should be able to:

1. Outline various means by which stingless bees can bring happiness and relief to human kind.

Aesthetics is another area where the economic importance of stingless bees can be derived. This will involve the making of artefacts of stingless bees such as jewellery and souvenirs to bring happiness and relieve to mankind.

Different materials including wood, metals, plastics and wax can be used to mold stingless bee images and used for jewelry such as necklace, earrings, bangles, rings, key holders etc.

Various art works depicting stingless bee images can be made of wood and other materials. Paintings, and colour photos can be printed on cups, plates, mugs and T-Shirts and sold as souvenirs.

Stingless bees may be interesting to keep at home and office to serve as source of happiness and relief to people.

2.4 Research and Training

Specific Objectives

At the end of this unit trainees should be able to:

1. Outline and explain the importance of stingless bees in research and for training.
2. List some research areas where stingless bees can be used.
3. Outline some channels of training in stingless bees.

Stingless bee colonies interact with the environment in many ways. Human activities that negatively affect environmental health such as bad farming practices, air and soil pollution will also affect stingless bees. Stingless bee colonies can therefore be used as indicators of environmental change. Research in plant pollination, animal societal behaviour and other ecological studies can be conducted using stingless bee colonies.

The outcomes of research can be extended to the general public particularly farmers, extension agents and students. This can be done through farmer field schools, workshops, open days, radio and TV programmes, website publications, use of pamphlets and brochures as well as other publications (print and electronic).

2.5 Tourism

Specific Objectives

At the end of this unit trainees should be able to:

1. Outline and describe the use of stingless bees in ecotourism.
2. List various aspects of stingless bees that can attract tourists.

The curiosities that surround bees that do not sting and the fact that hive products from stingless bees have exceptional medicinal properties offer great opportunities for tourism. A natural forest environment with nests and different designs of bee hives will attract people who would want to try out some of the bee products. Little artefacts, T-shirts, and other attractive items could be picked up as souvenirs by visitors.

Chapter 3

Culturing of Stingless Bees

3.1 Equipment for Culturing

Specific Objectives

At the end of this unit trainees should be able to:

1. List equipment used in culturing stingless bees.
2. List the materials used in hive construction.
3. List factors to be considered in designing and building stingless bee hives.

The equipment used in stingless beekeeping are few compared to that of *Apis melifera*. Protective clothing such as bee suit and smoker may not be required. Apart from an appropriate beehive that offer protection to the stingless bee colony, the other essential equipment required may include the following:

1. Hive Tool
2. Hammer
3. Chisel
4. Hand saw
5. Torch light
6. Straining/ sieve material
7. Harvesting Containers with airtight covers

Materials for Artificial Nests Construction (Stingless Beehive)

Locally available materials and receptacles may be used for the construction of stingless bee hives. These may require modifications in one way or the other for the bee colony to accept to develop a nest. Materials for hive construction include:

1. sawn timber and planks
2. bamboo
3. burnt clay pots
4. gourds and calabash
5. shells of coconut, snails and other hard fruits
6. hollow logs
7. plastic bottles and gallons

Figure 1.3.1 Various local materials that can be used for hive construction

Hive Design and Construction

The following factors must be taken into consideration when designing and constructing a stingless beehive:

1. Volume of the natural nest:

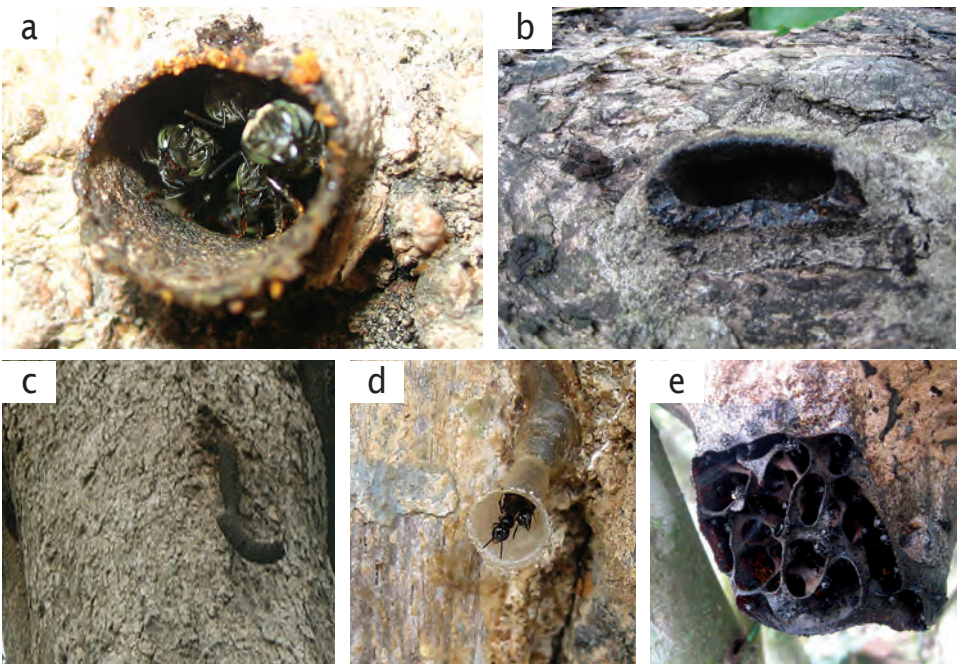
The hive volume should be related to that of the natural nest. The hive should have sufficient space to enable the colony store food and also raise their young ones.

2. Orientation of hive:

A designed hive could be orientated in a way that will enable stingless bees to arrange nest contents either vertically or horizontally depending on the species.

3. Position of the nest entrance

The position of the nest entrances could be placed towards one end or more central relative to the cavity. It has been observed that the brood section of a colony is found close to the nest entrance. The entrance of a beehive should therefore be positioned for easy colony management. Some species construct characteristically long tunnels as entrance holes between the nest cavity and the outside. This must be considered when making hives for such species.



Fugure 1.3.2 Shapes of stingless bee nest entrances (a-c. *Meliponula* sp., d. *Hypotrigona ruspolii* and e. *Dactylurina staudingeri*)

3.2 Identification of Wild Nests

Specific Objectives

At the end of this unit trainees should be able to:

1. Locate foraging stingless bees on flowers in habitats where they are present.
2. Identify wild nests of different stingless bees.

Wild nests are the natural nests of stingless bee colonies found in their habitats or ecosystems. Various stingless bee species construct nests that are unique with peculiar architecture. The presence of particular stingless bee species in a locality may be noticed by first checking on flowers of various plant species within the habitat for foragers.

How to identify wild nests of stingless bees

The following steps can be used to identify wild nests:

Steps

1. Search for stingless bee species on flowers in agricultural fields, orchards, forests and woodlands.
2. If *Dactylurina* is to found, concentrate your search on branches of trees for the brown or black ball-shaped nest.
3. If *Hypotrigona*, look for the transparent entrance tubes on walls, bamboo stems or logs.
4. If *Meliponula*, search for entrance holes on trunks of trees and fallen logs.

a. Hypotrigona ruspolii wild nest identification

Steps

1. *Hypotrigona*, are common in villages with mud – walled and thatch houses and also in abandoned homes.
2. Their presence in a locality is normally recognised by small bees coming around your face trying enter your eyes, ears and nose. They may land on your body to collect sweat.
3. Survey and inspect wall of mud houses, door and window frames of abandoned buildings
4. It is common to find a protruding transparent to translucent entrance tube sticking out of the walls or nests with a few bees guarding the entrances.
5. When disturbed, workers come out in their numbers and try to enter eyes, ears and nose and even attempt to bite intruders.

b. Hypotrigona gribodoi wild nest identification

Steps

1. *H. gribodoi* appears to be the smallest bee species and are rare to find. They build exposed nests which overlap each other in clusters on barks of very tall tree trunks and branches.
2. Each nest constitutes a colony of bees.
3. They also take sweat and disturb faces, eyes and ears.
4. They are difficult to see and one may need binoculars to search tall trees for wild nests.

c. Meliponula wild nest identification

Steps

1. Four species of *Meliponula* bees have been found in Ghana to date. There are slight differences in their nest architectures.
2. Three of them are cavity nesting in logs or tree trunks and one of them is ground nesting.
3. The cavity nesting bees can be separated by their body colours, (brown and black); sizes and behaviours.
4. The brown *Meliponula* bees have their entrances shaped like a slit without entrance tube. The black ones have entrance tubes which can be very long and coiled in some cases and very short and stout in others.
5. Again, one needs to painfully search trunks of trees or fallen logs to see entrance holes and observe bees flying in and out.
6. It is common to find one or more bees guarding the entrance. The black bees are very shy and withdraw into the nest when there is any movement near their entrances.
7. If you listen carefully you will hear buzzing sound within their nests.

3.3 Collection of Wild Nests

Specific Objectives

At the end of this unit trainees should be able to:

1. List the various methods of collecting wild nests of different stingless bee species.
2. Outline the steps to follow in collecting various stingless bee species.
3. Relocate the wild nests successfully and comfortably without any threat to the bees.

Stingless bee colonies are relatively easy to collect compared to Honey bees because they do not sting due to dysfunctional stings. Some of them however give painful bites and can be nuisance to collectors. They pour out in large numbers and enter any available hole such as eyes, nose, and ears. Some of them enter into hairs making the victim very uncomfortable. Where necessary a bee veil must be worn over the face.

Methods of Wild nest collection

Two main methods can be used to collect wild nest. These are:

1. **Using trap nests**

   Trap nests are temporal collecting container that can be used to bait and trap swarms of bee colonies.

2. **Whole nest collection**

   The whole colony is collected in their natural hive and relocated into meliponiaries or colonies are transferred into artificial hives.

a. Trap nests

It should be noted that the use of trap nests are still under investigations in Ghana but successful trials have been made in Brazil and Australia.

Traps can be made with various materials which may include: wooden boxes, cavities in logs, internodes of bamboo trees, calabashes, coconut shells, pots and plastic bottles of various sizes and shapes. These materials can be baited with stingless bee wax and propolis tincture. These may take a while for colonies to occupy since stingless bees take longer times to swarm unlike honey bees. It must be known that in stingless bees, worker bees spend many weeks gradually constructing a new nest inside a nearby hollow tree. It is when the nest is nearly finished that a young, newly mated queen moves in with some worker bees to complete the new nest.

It would therefore be necessary to carry out monthly inspection of trap nests to check their state and provide some care until they are colonised. Once nests are colonised, they can be relocated and transferred into more permanent hives.

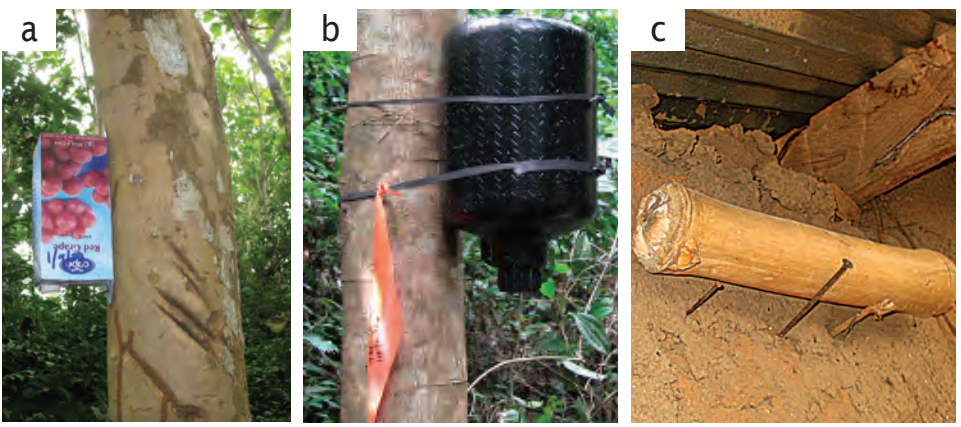


Figure 1.3.3 Trap nests for stingless bees attached to tree stems in the forest (a) empty fruit juice container (b) plastic gallon (c) bamboo internode

The size and volume as well as the entrance hole must correlate to the colony sizes of the stingless bee species involved. So far trap nests have been designed for only *Hypotrigona* and *Meliponula*.

Steps

1. Plastic containers of various sizes are obtained from the market.
2. To avoid light inside the container, they are sprayed with dark paints on the outside.
3. Holes are drilled on the lids to fit the targeted bee species.

4. The lids are removed and coated with melted wax and a tincture of propolis and alcohol are used to rinse the container. These serve as baits. The lids are then replaced.
5. The traps are now ready and are taken to the forest or suspected habitats for placement.
6. Using binding wire, traps are tied to trees with the lid facing downwards.
7. Monthly inspection is recommended to check on the state of the traps and give the necessary attention.
8. Remember to collect records on the nests to include GPS information, locality, and date of set up and the name of person putting up the trap.
9. Remove the trap when colonised at night when foragers would have all returned by closing the entrance with a stick.
10. Note and record the date trap nest was colonised.
11. Relocate the new colony safely and carefully especially if they need to be transported over long distances and days.
12. Help bees to settle as quickly and comfortable as possible. Make sure predators do not have access to them.
13. Provide ready food and water.

The materials for trap nesting can be replicated using various materials available in Ghana provided the materials do not allow light and excessive heat into the hive.

b. Whole wild nest collection.

There are various steps to follow in collecting whole wild nests from their habitats. As much as possible it will be good to use trap nests. But in case of rescue from disaster, it is necessary to collect whole nests for relocation. It must be noted that some stingless bees inhabit very large economic trees which might require felling the tree and cutting the nest out. These may cause lots of costs and damage to valuable property. For instance, if the tree is found within plantations or farm lands or close to a valuable property. It is also possible to collect whole nest without felling trees. This will be discussed later. Depending on the species one might need to wear a veil to protect the face from bites and disturbances.

Steps

a. Dactylurina staudingeri

1 Once wild nest have been located, one needs to decide the convenience of collection.

2 Make sure the area is cleared and free from obstacles.

3 Nests located low to the ground are easier to work with.

4 With opened 'fertiliser sack', the nest is quickly wrapped around and tied at both ends to prevent bees from flying out and disturbing.

5 The branch of the tree on which the nest is located is cut using a hand saw. As much as possible avoid the use of a cutlass since it will disturb and cause the nest to split posing danger to the colony.

6 Carry the nest wrapped in the sack to the new location before untying it. Preferably this should be done in the evening towards dusk. It is important to place the nest at the same orientation it was before collection.

7 Make sure records are taken on the GPS location, locality and collector's name and date of collection.

b. Hypotrigona ruspolii

1 Once nests have been located, use common tools to scoop entire colony into hives leaving out the hive products.

2 Collect and record data on the colony.

3 If possible allow the foragers to return to new hive before relocating.

4 Transport bees and relocate them carefully and safely.

c. Meliponula sp.

1 Decide if trees containing wild colonies need to be felled or not.

2 Using chain saw machines, the tree can be felled or the nest can be removed by using the chain saw to make an oval opening around the nest area. The oval-shaped opening prevents the tree form breaking off at the point of cut.

3 Lots of reasoning and experience play major role in determining the colony size within the log.

4 If the tree harbouring the nest needs to be felled, begin by cutting a big chunk and then narrowing it gradually making sure the nest is not cut.

5 If the log happens to be too big to carry, try to reduce the size by slicing portions off with care so that the nest is not sliced off.

6 Once the right size is obtained, the foraging workers should be allowed to return to the log. It is important to keep the log in the same orientation as before.

7 The suitable time for nest collection is in the evening when all foragers have returned to the nest.

8 Using a piece of stick, wood or clay, the entrance is close or sealed before the nest is relocated.

9 It is very important to keep the orientation of the nest as before. This will prevent eggs from drowning within cells resulting in casualties and colony absconding.

10 On the other hand only the nest can be removed. This is done by carefully using the chain saw to cut an oval opening around the nest.

11 The front portion of the wood covering the nest can then be removed with the help of a chisel/hive tool.

12 Once the nest is exposed, either the entire brood or part of the brood can be carefully removed and placed into a hive with the workers and the queen in the same orientation as found in the nest.

13 The oval cover can be replaced to enclose the remaining brood and sealed with clay. This will enable returning foragers to help build up the remaining colony.

14 The hive can then be relocated gently and safely.

15 Collected data must be recorded on each colony.

3.4 Colony Transfer into Bee hives and nest placement

Specific Objectives

At the end of this unit trainees should be able to:

1. Outline the precautions for successful transfer into a beehive.
2. Outline the processes for effective establishment of a stingless bee colony.
3. List the conditions for nest placement.

It is very important to re-establish a stingless bee colony into a well constructed beehive. A well designed and constructed beehive will enable the colony to develop properly and store good volumes of honey and pollen. These stored foods in addition to other hive products could be harvested by the beekeeper without much difficulty. Colonies can also be managed more easily in bee hives rather than in their natural logs.

Precautions for transfer

Timing

Colonies should be transferred during the early parts of the beekeeping season (beginning of the dry season). This is the time when food and other resources are abundant in the environment to help colonies establish and grow quickly.

Nest Security

Stingless bees are very good at securing their nest against outside intruders. Some intruders such as flies and beetles take advantage of an unsecured nest and invade colonies which may result in death. Constructed hives should therefore be prepared in such a way that all openings and gaps are closed or plunged with appropriate materials. This will enable colonies to re-establish quickly and grow.

Invasion of pest during transfer

The beekeeper should carry out the transfer operation as quickly as practicable in order not to offer the opportunity for pests to invade the nest. This will mean that all necessary equipment and materials should be put in place prior to the opening of the natural nest.

Invasion of pest after transfer

When the transfer operation is over the beekeeper should make sure that the site of the new hive is free of pest especially ants. Hive stands and hanging ropes should be effectively protected from ants and other pests. Dirty engine oil in cans and grease on ropes can be used to stop the invasion of the new nest by ants and other crawling insects.

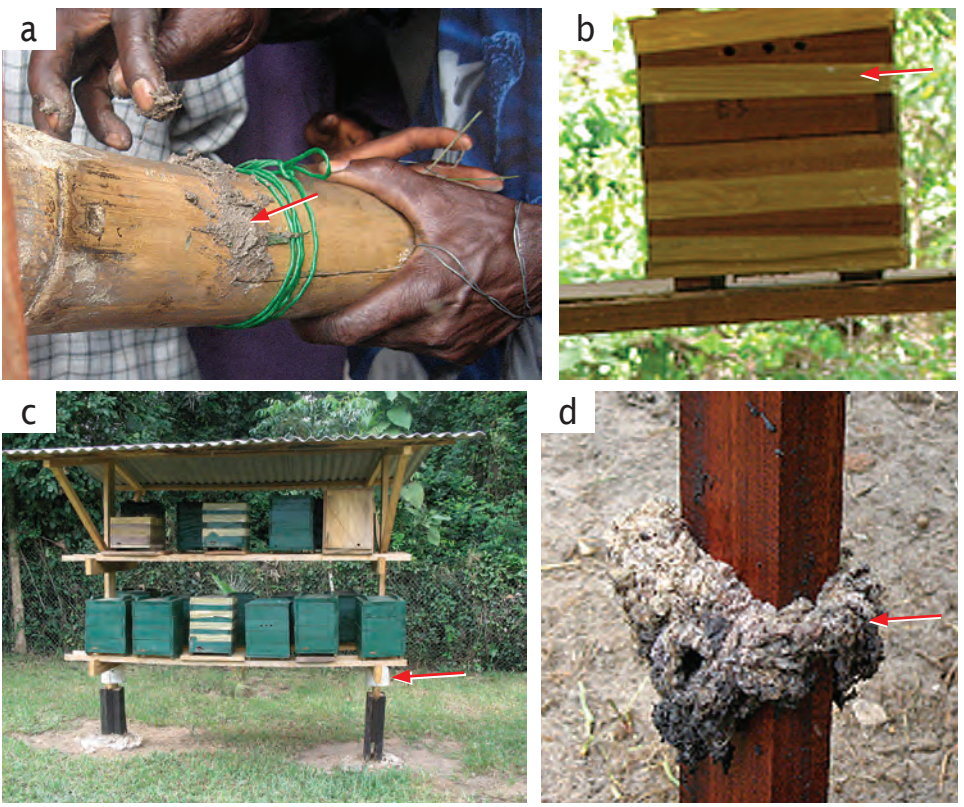


Figure 1.3.4 Various means of protecting hives (a. clay, b. cellotape, c. plastic lizard gard and dirty oil as well as d. foam soaked with dirty oil - arrowed)

The Transfer Operation

The following steps could be taken to move a colony from its natural nest cavity into a constructed beehive:

1. Clean the beehive and set it up near the natural nest.
2. By means of appropriate tools such as a hand saw, cutlass, chisel, hammer open the nest with care. Try as much as possible to leave the nest contents intact. Avoid crushing or killing the bees.
3. Remove the whole brood section of the nest and place this inside the new beehive close to the entrance.
4. Close the new hive and secure it well. Use appropriate material such as clay, or cellotape to seal all openings except the entrance.
5. Replace the old nest with the new hive to allow returning foragers to colonise.
6. The food (pollen and honey pots) content of the natural nest must not be added to the new hive but processed and used by the bee-keeper. This will prevent contamination and possible pest infections in the new hive. Eggs and adult hive pests especially hive beetles may be present in the pollen and honey storage pots of the natural nest.
7. Sugar syrup (sugar:water = 1:1) can be prepared for feeding the new colony.
8. Remove the old empty nest away from the site to avoid attracting hive pests.
9. Monitor the re-establishment of the new hive externally and check nest for ants and other pests.

Nest placement

A good site selected for the placement of stingless bee nests (natural & artificial) should protect the colonies from elements of the weather as well as enemies of the bees. In addition to these the beekeeper should consider the following factors:

1. Availability of abundant forage resources in the form of flowering plants.

2. Availability of water source especially during the long dry season.
3. Accessibility – area must be reached easily by the beekeeper.
4. Adequately shaded with good air circulation.
5. Well drained land, avoiding damp and water-logged areas.

Possible site for hive placement

Stingless bee colonies pose no problems to people and can be kept close to human habitation such as the following:

1. ***Near homes*** – at the backyard, on corridors or verandas of houses.
2. ***On the farm*** – near fruit orchards and vegetables farms.

3.5 Colony multiplication

Specific Objectives

At the end of this unit trainees should be able to:

1. Describe the various means of multiplying stingless bee colonies to include:
   a. Baiting for swarms through the use of trap nests.
   b. Division of established colonies.
   c. Nucleus colony production.

a. Baiting for swarms.

Different kinds of hives can be used as trap nests to attract swarms of stingless bees. Well established colonies will divide naturally during the dry season when food resources are abundant. These swarms may relocate and settle in any receptacle that they find suitable. Different receptacles designed from different material are made attractive to swarms by cleaning and baiting with attractants such as propolis and wax. Herbs that are attracted to stingless bees such as mints and lemon grass can also be used as baiting material.

The hives are set in the forest on the trunk of trees during the early parts of the dry season. The baiting hives should be visited regularly and checked for the expected occupants (swarm). Unexpected occupants such as ants and other insects should be removed and fresh bait applied.

b. Colony division

Well established stingless bee colonies (at least one year old) can be split into two by the beekeeper as a means to multiply his or her stock. This activity should be carried out at the right time in the season and with great care. Both old and new nests should have abundant forage resources as obtained during the dry season to grow and establish. Securing both old and new nest should be a critical consideration by the beekeeper. All holes and opening that will allow intruders into the nests should be sealed.

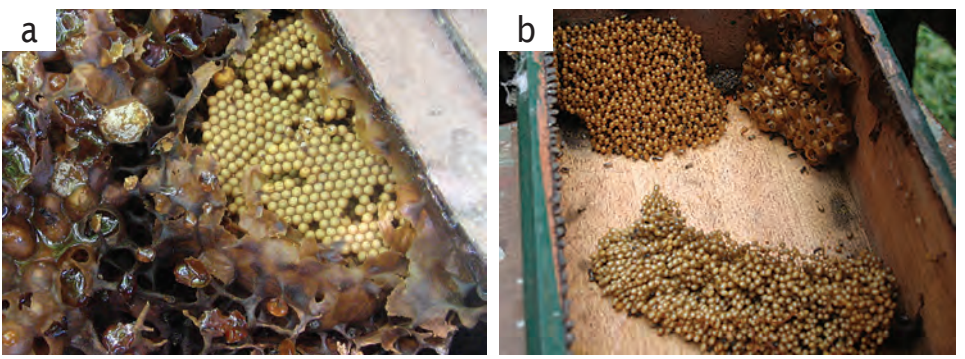


Figure 1.3.5 Brood sections of a. *Meliponula* sp. and b. *Hypotrigona ruspolii* nests

Procedure

1. Place the new hive close to the established nest.
2. Open up the old nest and get to the brood section.
3. Remove the involucrum and pillars around the brood cells.
4. In horizontally arranged brood cells as found in the *Meliponula* sp. use a knife to divide the brood section into two horizontally. In species with vertical brood arrangement, the brood section should be cut vertically. A brood section that is arranged in a cluster as in *Hypotrigona ruspolii,* part of the brood could be taken.

5. Place half of the brood section into the new hive and sweep about half as many bees into the new hive.
6. It is possible to find queen cells (larger than other brood cells) in the brood areas of the nest. Remove some of these if any into the new nest.
7. Close the hives firmly and move the old nest about 50 m away from its position. Place the new nest at the position of the old nest. This will allow some foragers from the old colony to bring in food and other resources.
8. Monitor the progress of both old and new colonies.
9. Where the hive is made of supers, separate the brood supers and replace each with fresh brood super.

Note that we did not remove any food from the old nest into the new one. This is to avoid infection of the new nest before it is securely protected.

c. Production of Nucleus Colonies

Because queen cells are present in stingless bee nests, most of the times nucleus colonies can be produced.

Procedure

1. Construct small bee hives and use them as nucleus boxes.
2. Open a nest and find queen cells in the brood section.
3. Pick some brood cells including a potential queen cell and place in a nucleus box.
4. Use a soft brush to sweep some worker bees into the nucleus box.
5. Close and secure the new nest very well.
6. Feed the baby colony with honey/sugar syrup to enable it grow.
7. Monitor the development of the baby colony by careful inspection.

d. Artificial Feeding colonies within hives

Figure 1.3.6 Supplementary feeding of a baby colony with sugar syrup

3.6 Management

It is vital to put in place sound and effective management practices in order to derive maximum benefits from stingless bees.

Specific Objectives

At the end of this unit trainees should be able to:

1. State the importance of management for colony growth.
2. List challenges that colonies might face.
3. Outline management strategies to overcome the challenges that confront stingless bee colonies.

A well managed colony will:

1. Have good records for improved management.
2. Grow and produce lots of hive products that will generate good income.
3. Have reduced pests and disease problems.
4. Have reduced stress from external factors.

Stingless bee colonies are prone to many challenges including the following:

1. Extreme weather conditions.
2. Pests, diseases and weeds.
3. Bushfires.
4. Chemical pesticides.
5. Pollution from charcoal burning.
6. Lack of forage and water.

Colonies should be protected from the direct impact of the elements of the weather such as rainfall and sunshine. These can be done by placing hives under sheltered areas such as shade trees and sheds.

Some pests have been found to attack stingless bees. Regular monitoring should be done to help colonies in such circumstances. Appropriate bee hives should be provided to keep colonies. Placement of hives should done in such a way to prevent pests such as ants, lizards, spiders and other intruders having access to nests (Refer to session 3.4). Meliponiaries should be kept clean of weeds.

Bush and charcoal burning could produce intense heat and smoke which could kill colonies. Colonies are best kept at places where these activities are limited.

Pesticides are number one killers of stingless bee colonies. When foragers visit crops that have been sprayed with pesticides, they either get killed or collect contaminated forage which may poison other hive members and thereby destroying the colonies. If possible colonies should be sited at places where pesticide contamination is minimal. On the other hand, if colonies are placed near agro-ecosystems, where regular spraying is carried out, frequent monitoring should be required so as to reach an agreement with potential sprayers. For example, hives could be locked-up before spraying.

During the dry season, water could be scarce within the forage range of stingless bees. In times of food scarcity such as in the rainy season or lack of vegetation as a result of bush fires, bees will need supplementary feeding. This could be provided through growing of plants that stingless bees feed on near the meliponiary or providing artificial feeding.

Figure 1.3.7 Designs on hive stands(a-c) to prevent ants, lizard and other intruders access to bee hives

3.7 Harvesting of Hive Products

Specific Objectives

At the end of this unit trainees should be able to:

1. Outline the various steps of harvesting stingless beehive products.
2. List the necessary precautions to take during harvesting and storage of products.

The main hive products of stingless bees that can be harvested include: honey, propolis, pollen, Beebread and wax. The following steps could be adopted in harvesting specific products. The following equipment must be made available for harvesting products:

1. Clean and dry containers with covers.
2. Hive tool.
3. Punching stick.

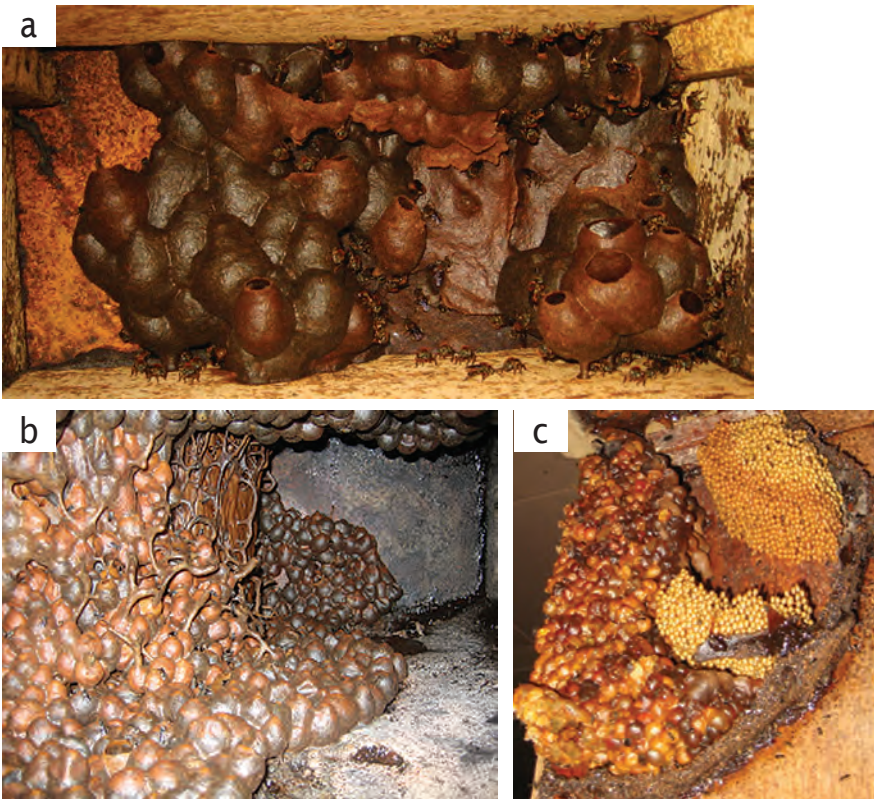


Figure 1.3.8 Inside stingless bee hives showing pots of honey, pollen (Beebread) and propolis (a. honey pots, b. honey pots and propolis and c. entire nest with pollen, honey pots and brood)

Steps

Honey

1. Open hive and locate the honey section made up of sealed pots that are stacked together.
2. Remove the honey section of the hive.
3. Puncture/open the top of the honey pots with the punching stick.
4. Tilt the hive so that honey can flow out into a container.
5. Make sure all the honey in punctured pots have been emptied.
6. Replace the honey section(s) and seal the spaces with cellotape.
7. Cover the container with its lid to secure the honey.

8. Alternatively, whole pots can be scraped with the hive tool into containers. These pots can also be punctured and strained to release the honey.
9. It is best to leave the honey pots intact for the bees to refill quickly.

Pollen

1. Pure pollen can be collected at the entrance by means of a pollen trap.
2. At the end of day, little balls of pollen in the traps are collected and stored in containers.

Beebread

1. By means of the hive tool collect pots containing Beebread located near the brood section or pollen section of the hive.
2. Put them into separate containers and cover.

Propolis

1. In the case of propolis, use the flat side of the hive tool to scrape the product from the floor and corners of the hive.
2. Put these into separate containers and cover.
3. Put back the cover of the hive ensuring that bees are not killed or crushed.
4. Secure the hive by closing all openings with clay or cellotape.

Beeswax

The workers use secreted wax for building pots. To harvest wax from the colony, both the honey and pollen pots could be collected from the hive and put into separate containers. Beeswax can be processed from empty pots as described below.

Precaution for Product Harvesting

1. Harvest products from healthy and mature colonies.
2. Ideally, harvesting should be done in the dry season when forage is in abundance.

3. To avoid hive and product contamination, all harvesting equipment and containers must be clean.
4. Precautions should be taken to prevent intruders such as pests and robbing bees.
5. During harvesting some amount of hive products should be left in the hive to sustain the colony.
6. As much as possible, the brood section of the colony must be left undisturbed.

Processing of Hive Products

Honey

1. The harvested honey in the containers may have impurities such as dead bees and debris from the hive as well as some pieces of wax.
2. Clean honey can therefore be obtained by straining with sieve.
3. Further cleaning can be done using a cheese cloth or a piece of nylon cloth.
4. Stingless bee honey contain high moisture and must be pasteurised before storage otherwise, it must be kept in the freezer
5. Pack honey into airtight glass or plastic containers (jars, bottles and gallons).
6. Store at cool places or in freezers.

In these forms the honey is ready for storage, for food and medicine or for sale. At this stage the honey can further be processed into secondary value-added products.

Pollen

1. Pollen can be processed by drying using specially designed dryers in order to reduce moisture which could cause it to be mouldy.
2. The dried pollen can be packed in airtight containers.

The Pollen in this form can be processed into secondary value-added products or stored for food and medicine or for sale.

Beebread

1. Beebread can be released from pots by breaking the wax covering.
2. It can be packed into airtight containers and stored in freezers.
3. Alternatively, it can be dried by specially designed dryers and packed into airtight containers.

The Beebread in this form can be processed into secondary value-added products or stored for food and medicine or for sale.

Beeswax

1. Collect and wash broken pots free of remnant honey and Beebread.
2. Extract wax using boiling water.
3. Collect melted wax from the surface of hot water into moulds.
4. Allow to cool and solidify.

The beeswax in this form can be processed into secondary value-added products, stored or for sale.

Chapter 4

Product Development, Marketing and Value Addition

4.1 Product Processing, Utilisation and Value Addition

Specific Objectives

At the end of this unit trainees should be able to:

1. Outline the various steps in the processing of the hive products.
2. List and describe items of high value that can be produced with stingless bee products.
3. Explain the concept of value addition in product marketing.

Products from the stingless bee are unique and should be marketed as special items. Beekeepers can take advantage of the established fact that products of stingless bees have superior health promoting properties. The three primary products can be packaged and sold directly to consumers or users. There are other several possibilities available to the beekeeper to improve the already high value products from stingless bees. One of such possibility is to use the hive products as components of other items. Some examples of items whose values can be increased by the addition of stingless bee products include:

1. ***Bakery*** – bread, biscuit, cakes with honey.
2. ***Cosmetics*** – face and body creams, lipsticks, ointments with beeswax.
3. ***Infant food*** – various cereal preparations with pollen.
4. ***Fruit juice*** – orange, mango, guava etc., sweetened with honey.

Secondary Products

On the other hand some of the stingless beehive products could be turned into valuable secondary items to improve their value. A few examples are as follows:

- **Honey** can be made into wine, vinegar, confectionary products, etc.
- **Beeswax** into face and body creams, shoe and wood polishes, candles, etc.

4.2 Marketing of hive products

Specific Objective

At the end of this unit trainees should be able to:

1. Discuss the various strategies that can be adapted to effectively market hive products from stingless bees.

Considerations for Market Development

Marketing is a critical consideration in production. Effective marketing brings in good profit which is the desired reward for all the efforts put into production. A good marketing strategy can therefore be adopted to develop a niche market for stingless bee products. Important considerations include:

1. Identify the potential customers and reach out to them
2. Reaching out to them in a good way is to strive hard to:
   - satisfy their wants and
   - sustain their demand all the time.
3. Satisfying their wants also entails:
   - harvesting quality products from the hive and
   - packaging in an acceptable way to attract and meet the needs of consumers.

Who is your potential customer?

It is important for the beekeeper to explore his/her area and beyond for potential buyers of items produced from stingless bees. The beekeeper should take advantage of the fact that people's health is paramount and create

awareness of the availability of his/her good products. A catchy sign post, a small advert in the local newspaper or radio, write-ups on notice boards and announcements at meetings will draw customers to your products.

Satisfying the wants of consumers

The beekeeper will sell and continue to improve sales if he/she consistently supply top value products to consumers. This is only possible through the following:

1. Product Quality

Ensure that only top quality products are harvested from the beehive. The honey should be mature; this means the pots must be sealed or closed. These should be harvested and processed under good hygienic conditions and with proper equipment

2. Packaging

Good packaging is required to present the bee product to the consumer in an attractive way. An appropriate packaging material will also maintain the quality of the product during its shelf life. Glass and food grade plastic containers (bottles, pots, jars, and gallons) are available and could be used for packaging.

PART TWO

THE PRACTICE OF STINGLESS BEEKEEPING

Chapter 5

Wild Nests of Stingless Bees

5.1 Locating wild nests

Activity 5.1

To search and observe natural nests of various species of stingless bees in the field

What will be needed for this activity

Notebooks, pens, pencils, camera.

How to carry out this activity

The trainer will guide trainees to:

1. Visit the following nearby places where natural nests of stingless bees have been located previously:
   a. Forests and forest groves,
   b. farm lands
   c. abandoned buildings and mud walled houses
2. Observe the nest environment for the occurrence of:
   a. pests and predators of bees
   b. forage sources
3. Observe the nests critically, taking notes of the following:
   a. nesting material used,
   b. orientation and nature of nest
   c. nest entrance,
   d. height of nest above ground level

5.2 Characteristics of Nests and Nest entrances

Activity 5.2

To observe the internal structure of stingless bee nests

What will be needed for this activity

An observation hive of *Meliponula* sp., *Hypotrigona,* hand lenses, notebooks, pens, pencils, hive tool.

How to carry out this activity

The trainer will guide the trainees to:

1. Open the nest and critically examine the arrangement of the internal structures (brood, honey, pollen sections).
2. Search within the nest to locate the queen and other members of the colony.
3. Distinguish between the queen, workers, and the drones.
4. Observe the storage pots, the brood section and other features of the nest.
5. Observe the features of the passage way and the nest entrance critically.
6. Write their observations in their notebooks.

5.3 Capturing and Collection of Wild Nests

Activity 5.3a

List the various methods of collecting wild nests of different stingless bee species

What you will need for this activity

Notebooks, pens, pencils, white board and markers of different colours.

How to carry out this activity

The trainer will guide trainees to:

1. Form smaller groups of 5 people.
2. Brainstorm to come out with a list of methods and strategies that can be used to collect wild colonies of the various species of stingless bees in each group.
3. Bring the groups together and let each group present their findings.
4. Discuss the group findings and compare with existing methods and steps of colony collection.
5. Come out with best collection methods.

Activity 5.3b

The use of trap nests for capturing stingless bee colonies

What will be needed for this activity

Notebooks, pens, pencils, markers, white board, sample trap nests, baiting materials, binding wire and general tools.

How to carry out this activity

The trainer will guide trainees to:

1. Brainstorm and come out with the suitable times and places to set traps.
2. Discuss various materials and their designs suitable for trapping stingless bee colonies.
3. Discuss baiting materials and their uses in trapping.
4. Set up traps in the field.
5. Discuss management procedures for efficient trapping.

5.4 Transporting

Activity 5.4

Outline and describe the steps that must be taken to transport captured stingless bee nests from the forest to a meliponiaries (bee site)

What will be needed for this activity

Notebooks, pens, pencils, white board and markers of different colours.

How to carry out this activity

The trainer will guide trainees to:

1. Discuss the appropriate time of transporting a colony.
2. Discuss measures for securing and making colony ready for transport.
3. Discuss the proper orientation of the nest during packing in a vehicle and during carriage.
4. Outline the various means by which a captured nest could be brought to the bee site.

5.5 Relocating

Activity 5.5

Outline the steps for successful relocation of wild nests

What will be needed for this activity

Notebooks, pens, pencils, white board and markers of different colours.

How to carry out this activity

The trainer will guide trainees to:

1. Form smaller group of 5 people.
2. Discuss preparations that need to be made at the new location to receive colonies.

Chapter 6

Keeping Stingless Bees

6.1 Types and designs of hives

Different types of hive could be designed depending on the material and species of stingless bees available. In some case only slight modification of the existing natural nest is necessary. For example, bamboo internodes, logs or gourds.

Activity 6.1

To assemble various materials for hive construction.

What will be needed for this activity

1. Notebooks, pens, pencils, markers and white board.
2. Hive building materials (sawn timber, bamboo, burnt clay pots, gourds and calabash, shells of coconut, snails and other hard fruits, hollow logs, plastic bottles and gallons).
3. Wood working tools (saws, hammer, chisels drill with bits, cutlass).
4. Nails of all sizes.

How to carry out this activity

The trainer will guide the trainees to:

1. Observe the different materials and describe various possible designs for bee hives.
2. Make sketches of designs of bee hives on the white board.
3. Assign trainees into small groups and allocate a set of construction materials and tools.
4. Design and construct a beehive for a given stingless bee species using appropriate tools.
5. Present their constructed bee hives for assessment and criticisms by all.

6.2 Transfer into hives

Once established, stingless bee colonies are very sensitive to disturbance and care must be taken when transferring to new hives.

Activity 6.2

To discuss the necessary precautions and steps that must be taken for a successful stingless bee colony transfer

What will be needed for this activity

Notebooks, pens, pencils, white board and markers, natural nest of stingless bee species, hive tool, chisel, soft brush, beehive.

How to carry out this activity

The trainer will guide the trainees to:

1. List the critical considerations for transferring a colony from its natural nest into a beehive in terms of:
    a. Cleanliness of the hive and equipment.
    b. Importance of the brood section.
    c. Securing the hive from intruders.
    d. Exposure to invaders.
    e. Damage to bees and brood.
2. Clean the beehive and make it ready for the transfer.
3. Place the beehive next to the natural nest.
4. Open the nest to remove the brood section into the beehive.
5. Use the brush to sweep all the bees into the beehive.
6. Close the hive and secure it by plugging all openings with clay or cello tape.
7. Place the beehive at the position of the natural nest.
8. Carry away the empty nest and also the food storage pots.

6.3 Establishing Sites for Hives

It is possible to have a variety of sites depending on the locality and the purpose of keeping stingless bees. For example, stingless bee sites could be under a shed; in the veranda, porch, under shade trees, in a forest grove and in a purposely established garden.

Activity 6.3

To discuss the factors necessary for establishing a good site for stingless beekeeping

What will be needed for this activity

Notebooks, pens, pencils, white board and markers, demonstration bee sites.

How to carry out this activity

The trainer will guide the trainees to:

1. List various places where stingless bee colonies can be kept and discuss the reasons for selection of sites.
2. Outline the various steps in preparing a site for hive placement.
3. Discuss the appropriate hive placement ways at the site with respect to:
    a. Orientation.
    b. Distance between hives.
    c. Position of hives.
    d. General security of bees.

6.4 Taking Care of the Sites

Stingless bees like any other useful living organism may also need care to establish and grow. Good management practices including record-keeping is necessary in stingless beekeeping.

Activity 6.4

To discuss good management practices at stingless bee sites.

What you will need for this activity

Field note books, pens or pencils, stingless bee demonstration site.

How to carry out this activity

The trainer will guide the trainees to:

1. Identify the foraging needs of the bees and discuss how these needs can be provided.
2. Discuss how the elements of the weather can affect the bees and the various methods of protecting them.
3. List the various pests that attack stingless bees and discuss methods of restraining them.
4. Discuss possible human interferences at the bee sites and outline ways to prevent these.
5. Discuss the value of record-keeping and how to design simple record-keeping formats.

Chapter 7

Hive Products of Stingless Bees

7.1 Types of products

Activity 7.1

To list and discuss the importance of hive products to man and the bees

What will be needed for this activity

Notebooks, pens, pencils, markers and white board, the various hive products.

How to carry out this activity

The trainer will guide the trainees to:

1. Form smaller group of 5 people.
2. Assign the various products to each group.
3. Discuss the importance of the assigned products (honey; Beebread, propolis) thoroughly to include the indigenous uses in health delivery.
4. Discuss nucleus colony as a hive product.
5. Leaders of the groups to write reports to be presented to all.

7.2 Product harvesting

Activity 7.2

To discuss the step by step procedures for harvesting various Bee products. And also to undertake practical harvesting of products with trainees.

What will be needed for this activity

Notebooks, pens, pencils, markers and white board, hive tool, bee colonies, brush and containers.

How to carry out this activity

The trainer will guide the trainees to:

1. Discuss preparations needed for harvesting the various products.
2. Outline the precautions needed for harvesting.
3. Discuss the various steps for harvesting the products (honey, pollen, beebread, propolis, and wax).
4. Form smaller groups of 5 people each.
5. Undertake step by step practical sessions in harvesting each of the products.

7.3 Processing, packaging and storage

Activity 7.3

To help trainees to appreciate processes involved in processing, packaging and storage of quality hive products.

What will be needed for this activity

Notebooks, pens, pencils, markers and white board, sieves and airtight containers.

How to carry out this activity

The trainer will guide the trainees to:

1 Discuss precautions for processing, packaging and storage of hive products.

2 Discuss the various steps for processing, packaging and storage of each product.

3 Form smaller groups of 5 people.

4 Undertake step by step practical sessions in processing, packaging and storage of various hive products.

7.4 Marketing

Activity 7.4

Outline and discuss marketing strategies for stingless bee products

What will be needed for this activity

Notebooks, pens, pencils, white board, markers, well packaged products and pieces of published adverts.

How to carry out this activity

The trainer will guide the trainees to:

1. Discuss how to achieve quality products that will meet customers' needs.
2. Discuss various means of advertising the products.
3. Discuss pricing of products to make them affordable to consumers considering the input costs and profit margin.

7.5 Value addition

To help trainees achieve improved income through value addition of hive products.

What will be needed for this activity

Notebooks, pens, pencils, white board, markers and some value-added products.

How to carry out this activity

The trainer will guide the trainees to:

1. Identify and describe value added products in the market.
2. Distinguish between a secondary hive product and other items that contain bee products.
3. Discuss secondary and value-added products that can be developed from hive products.
4. Compare the value of the primary and value-added hive products.

Chapter 8

Pollination Service by Stingless Bees

In the selection of the pollinator species, it is important to know what stingless bee species will pollinate specific crops.

8.1 Use of Permanent hives for Pollination

Activity 8.1

To outline and describe steps in the use of permanent bee colonies in providing pollination services in an orchard or a vegetable farm.

What will be needed for this activity

Notebooks, pens, pencils, white board and markers.

How to carry out this activity

The trainer will guide the trainees to:

1. Outline and discuss the steps to follow in setting up bee sites in and around an orchard/ vegetable farm that requires bee pollination.
2. Outline and discuss necessary provisions for the bee colonies to enable them carry out effective pollination of the target crop.
3. Discuss precautions that must be taken by the farmer to ensure that foragers visit the target crop during flowering.
4. Discuss measures that must be taken by the farmer to maintain the colonies before, during and after the flowering season of the target crop.
5. List and discuss other farm management practices that may affect the well being of colonies during the pollination period.

8.2 Use of Mobile hives for Pollination

Activity 8.2

To outline and describe steps in the use of mobile bee colonies in providing pollination services in an orchard/ vegetable farm

What will be needed for this activity

Notebooks, pens, pencils, white board and markers, sample mobile hives.

How to carry out this activity

The trainer will guide the trainees to:

1. Review the steps in establishing and maintaining a meliponiary with colonies that will be used in providing pollination on farms.
2. Outline steps to follow to prepare and move bee colonies to a farm that requires pollination.
3. Review precautions in the transporting of colonies to the target farm.
4. Discuss the most appropriate time to send colonies to the target farm.
5. Discuss routine management practices to be carried out to ensure the well being of colonies that have been moved from their original site.
6. Discuss the appropriate time to collect, transport and settle colonies at their original site.
7. List and discuss other farm management practices that may affect the well being of colonies during the pollination period.

8.3 Use of Trap Nests for Pollination

Activity 8.3

To outline and describe steps in using trap nests to provide pollination services in an orchard/ vegetable farm

What will be needed for this activity

Notebooks, pens, pencils, white board markers and samples of trap nests.

How to carry out this activity

The trainer will guide the trainees to:

1. Review the setting up of trap nests as a means of obtaining colonies.
2. Discuss and design various patterns to distribute trap nests in the orchard/vegetable farm for the colonies to provide effective pollination of the crop.
3. Discuss the appropriate time to prepare and set up the trap nests on the farm.
4. Outline and discuss management practices required for trap nests as well as for colonies that establish in them.
5. List and discuss other farm management practices that may affect the well being of colonies in the trap nests.

Chapter 9

Aesthetic Value of Stingless Bees

9.1 Aesthetic Value

Like many other organisms, stingless bees can be utilised to bring about happiness and satisfaction to human beings.

Activity 9.1

To help trainees to discover the aesthetic values of stingless bees to include artefacts, art works as well as keeping them for companionship, beauty, happiness and satisfaction

What will be needed for this activity

Notebooks, pens, pencils, white board and markers, jewels and souvenirs such as key holders, postcards, T-shirts, mugs and decorative hives.

How to carry out this activity

The trainer will guide the trainees to:

1. Form smaller groups of 5 people.
2. Identify things in the environment that can bring happiness and satisfaction to people such as jewels, souvenirs and artworks.
3. Distribute some of the items of aesthetic value to trainees and let them brainstorm how these were arrived at.
4. Make a list of methods used in the production of these items to include molds of metal, wood, plastics, wax or clay.
5. Put all groups together to discuss and outline the various ways by which stingless bees can be used to bring happiness and satisfaction to human kind.

Chapter 10

Conclusion

10.1 Conservation of Stingless Bees

This book has brought to light the enormous importance of stingless bees to man and his environment. These include the provision of pollination service for fruit and seed production; utilisation of hive products in primary health care; their use in research, aesthetics and eco-tourism. Unfortunately, some economic activities of man in addition to pest and diseases impact negatively on the survival and sustenance of stingless bees. This situation calls for collaborative efforts to conserve stingless bees in order to sustainably provide the valuable ecosystem services (good health, clean environment, development of forest and natural products, and food security).

10.2 Public contribution towards conservation of stingless bees.

The general public is therefore encouraged to consider one or more of the following as their contributions toward the conservation of these valuable insects.

1 Showing interest and learning about stingless bees.

2 Keeping or culturing stingless bees.

3 Planting trees and other flowering plants that provide shelter and forage for the bees.

4 Campaigning against bush fires

5 Judicious utilisation of agro-chemicals including pesticides and herbicides

6 Establishing stingless bee clubs or environmental societies in schools and institutions.

7 Incorporating landscape management into towns and country planning.

8 Establishing of more Forest reserves, National Parks and Horticultural gardens.

9 Conserving river bank vegetations as habitats for stingless bees.

10 Encouraging communities to protect and conserve natural vegetation and forest groves as sanctuaries for stingless bees.

11 Encouraging pollinator-friendly agriculture

12 Encouraging research and utilisation of hive products.

13 Establish processing plants for hive products development.

14 Encourage the use of hive products as food supplement for good health.

15 Encourage the use of hive products as medicines in primary health care.

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Stingless Beekeeping Manual–
Partnership for greatness

The Stingless beekeeping manual is the effort of team work by Dr. Peter Kwapong and his then graduate students with financial support from Marin Community Foundation through the CSfund of California, USA.

Dr. Peter Kwapong is a senior lecturer of Entomology at the University of Cape Coast, Ghana; Dr. Kwame Aidoo, is a professional beekeeper and consultant; Dr. Rofela Combey is a bee taxonomist whiles Ms. Afia Karikari is a trained pollination entomologist.

Falling on experiences of research and training in stingless bees since 2005, the team decided to write this manual as a guide to help farmers and beekeepers in stingless beekeeping. Dr. Kwapong and his team, through rigorous research and training established the International Stingless Bee Centre (ISBC) within the secondary forest adjoining the Kakum National Park at Abrafo in the Central Region of Ghana. The ISBC is a centre of excellence and sanctuary for Stingless Bees. Activities at the centre include: Training, Research, Consultancy, Product Development and Sales as well as Eco-tourism. ISBC is a place to visit and enjoy the wonders of God.

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