



MAKE A SOLITARY BEE HOTEL

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What are solitary bees?

Golden honeycomb in bee hives usually comes to mind when we think of bees, however most bees (possibly up to 90%) don't live in big groups, in fact they live alone as solitary bees. The bees we usually think of, that live in large hives, are called 'eusocial bees' and they are bees that all benefit from living within a large network. Similar to the way people live in communities where the work of each person can contribute to the success of the community, eusocial bees form a community where different bees perform different tasks for the whole group's success. The Queen bee lays all the eggs, but is taken care of by the worker bees. The worker bees, depending on their age feed young bees, take care of the hive, find food, and produce honey, while the drone bees will mate with the queen. The Indian honeybee (*Apis cerana floria*), the red dwarf honeybee (*Apis florea*/ Danduwal bee), Indian stingless bee (*Tetragonula irridipennis*/ Kaneiyawa), and giant honeybee (*Apis dorsata* /bambara) are all examples of common eusocial bees in Sri Lanka.



*Plate 1. One large species of solitary bee, the giant carpenter bee *Xylocopa fenestrata*, foraging on a Zinnia flower. (a.k.a in Sinhala "Ambalan Paluwa") (photograph was taken from Dilmah conservations organic farm at MJF centre, Moratuwa)*

Most bees, however, don't live in big communities, they live mainly by themselves and each one takes care of their young. All these solitary bees share a common habit of living alone, but there are many different types. They come in different shapes, sizes, and colors, and have unique behaviors like cutting leaves, drilling through wood, and drinking the sweat of other animals. Honey-bees are very famous for pollinating (which is the transfer of pollen from one flower to another to allow a plant to reproduce) but solitary bees are often more effective pollinators than honey-bees. These lone bees visit many flowers and plants that are sometimes miles away. These bees do not produce honey and wax the way that the eusocial bees do, but instead many of them make 'bee bread' which is a mixture of the nectar and pollen they collect from flowers, that is stuck together and gets mixed with bacteria and fungus to form a fermented meal for their young. The nests that they make to shelter their young are made of a variety of materials, and in a variety of places, from under the ground to the insides of plant stems.

Scientific classification of the solitary bees

Common name	Class	Order	Suborder	Superfamily	Families
Bees	Insecta	Hymenoptera	Apocrita	Apoidea	Apoidea
					Colletidae
					Halictidae
					Megachilidae

Bees, ants, and wasps all belong to the order 'Hymenoptera' which is a collection of species that biologists decided to group together based on their similar features and evolutionary histories. This 'order' comprises of around 150,000 different species of which 20,000 are bees. This incredibly diverse group of 20,000 species can be divided into seven families, many of which contain various solitary bee species.

Why are they important?

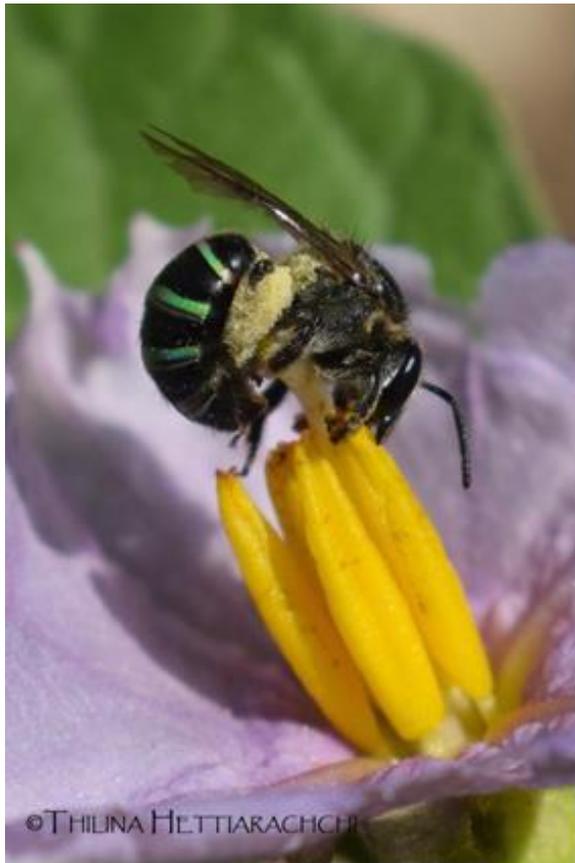


Plate 2. One of solitary bee (Hoplonomia westwoodi) using buzz pollination or it is called sonication (photograph was taken from Dilmah conservations organic farm at MJF Centre, Moratuwa)

Solitary bees don't produce honey so why are they important to people? The answer to that begins with pollination. Most of the plants we use for food require pollination to reproduce, and $\frac{2}{3}$ of global crops are pollinated with the help of insects. Solitary bees are one of these vitally important insect pollinators.

Pollination is the first step in the sexual reproduction of plants. It is, transfer of pollen from anthers or the male organs of flowers to the female receiving organ or the stigma. When insects go from one flower to another to find a meal, they are picking up and transferring pollen which starts the process of developing fruits and seeds.

Flower pollinators

Insects - Eusocial bees & solitary bees, most butterflies, most moths, some ants, some flies, some wasps, some beetles, and some thrips, and non-insects - some bats, some birds, some mammals, and even some lizards

All bees are known pollinators but the crew of solitary bees are experts in pollination, that are usually more efficient than honeybees. Their pollinating activity results in what is known as 'ecosystem services' which means that apart from allowing crop plants to reproduce, they also help all the other plants, animals, and environmental quality of their surroundings. They pollinate numerous plants that provide homes and food to many other animals and because some solitary bees nest in the ground they also help oxygen penetrate and enrich the soil.

Very importantly, because they travel great distances going from plant to plant, they ensure the mixing of plants with different genes, and genetic diversity is essential to plants being able to survive through different future circumstances because it creates many variants of the same plant.

Buzz pollination or sonication is the process where a bee attaches itself to a flower and then rapidly vibrates its body which causes the entire flower to vibrate, loosening its pollen and making it flow out of openings in the anthers. Brinjal, tomato, bell peppers and chilies, and other plants in the family Solanaceae need this special type of pollination to bear fruit. Honeybees do not 'buzz pollinate' but many solitary bees are experts!

Can we find them in Sri Lanka?

Sri Lanka is home to 150 species of bees in 39 genera and four families (genera, singular: genus, and family are different scientific groupings of organisms). Of these species, 21 can only be found in Sri Lanka, in other words they are 'endemic' (Michener, 2000; Karunaratne et al, 2006 & 2017) which is remarkable for a country that only has a total land area of 65,510km². In addition to bees, Sri Lanka has a very high level of biodiversity in a relatively small area.



Plate 3. One species of solitary bee foraging on Hyptis suaveolens. (photograph was taken from Wariyapola)

Habitat

Some solitary bee species use the abandoned tunnels left behind by beetles or weevils, and similar holes, made in dead or dying standing trees, while others create their own tunnel-like nests in the soft area (pith) of wooden stems (e.g. Carpenter bees, *Xylocopa* spp. - shown on plate 1). The remaining solitary bees mostly make their nests by digging tunnels into well-drained soil that has little to no vegetation on it.

A Few Common Examples

Apidae

The family Apidae is the largest family of bees and it includes a wide variety of species that includes all eusocial bees, carpenter bees, and some cuckoo bees.

Carpenter bees

These are typically large, and shiny black in color. As their name implies, they are the carpenters of the bee world. Female bees excavate tunnels in wood in which they build their nest, hence the name 'carpenter' bee. There two genera of carpenter bees in Sri Lanka; the giant carpenter bees (Genus: *Xylocopa* - see plate 1), of which Sri Lanka has 13 species, and the dwarf carpenter bees (Genus: *Ceratina* - see plate 4), of which we have six species. As pollinators, carpenter bees are generalists, which means they may be found foraging and pollinating a number of different plant species.

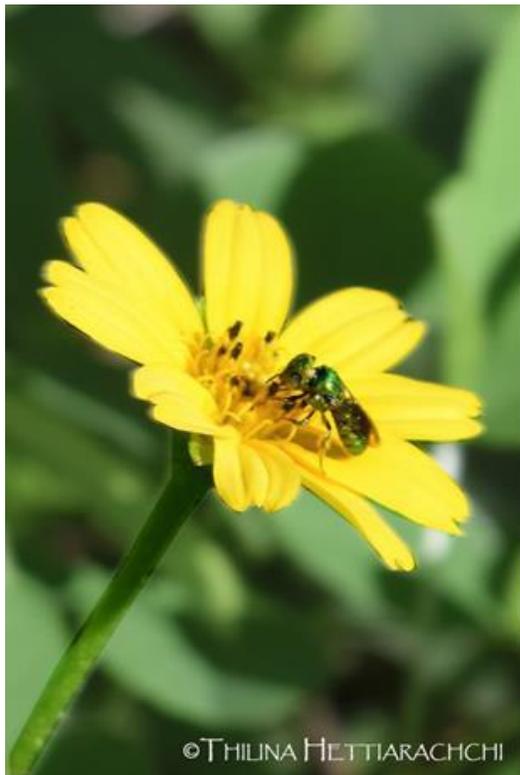


Plate 4. (Top) *Thyreus* spp., the most common cuckoo bee genus in Sri Lanka resting on a leaf. Males of many bees and wasps spend the night in this way, gripping stems or leaves with their mandibles alone. (photograph was taken from Wariyapola area)

Plate 5. (Left) The dwarf carpenter bees *Ceratina binghami*, one of most colorful bee species in the Sri Lanka on Singapore daisy, *Sphagneticola trilobata* flower. (photograph was taken from Kandy area)

Cuckoo Bees

These bees can be considered the thieves of the bee world because, instead of building their own nests and gathering their own food to feed their young with, they invade the nests of other bees and lay their eggs on these other bees' food stores. This is very similar to the behavior of cuckoo birds like the Asian Koel (which is known in Sinhala as the 'Koha' or 'Malkoha') who lay their eggs in the nests of other birds that then raise the Koels young. Just like the Koel forces other birds to feed her babies, the cuckoo bees' take the food gathered by other bees to feed their own offspring. These bees have lost their pollen baskets (called 'Corbicula') and much of the hair on their body and legs, which are adaptations to allow bees to collect pollen, because they do not need to collect pollen to feed their young. Instead, these bees only visit flowers to drink the nectar themselves, while other bees feed their young. 25 species of Cuckoo bees have been recorded in Sri Lanka.

Blue-Banded Bees

These bees look striking, with iridescent blue stripes on a glossy black abdomen (the 'stomach' section, or last section of an insect's body), and a furry golden thorax (the 'chest' section, just after the head). These bees have bulging eyes, long tongues that allow them to drink from long flowers, and grow to 11-12mm. They make their nests in soft mortar, mud-bricks, or in the sheltered parts of soft sandstone banks, and although they are solitary bees, the females build nests together in the same area while males roost together at night. These bees are experts in 'buzz-pollination' and since honey bees are unable to buzz pollinate, many plants that require buzz pollination rely on these bees for their reproduction.



Plate 6. A group of male blue-banded bees, Amegillia cingulata roost together (photograph was taken at Wariyapola)

Megachilidae

The family Megachilidae comprises of leaf-cutter bees and mason bees. They are unique because instead of carrying pollen on the 'Corbicula' (pollen sacs) on the back legs of most bees, they carry it on the underside of their abdomens. They are commonly known as hole-nester bees because they use tunnels in stems or holes in dead wood, made by beetles and other insects .

Leaf-cutter bees

Leaf-cutter bees are small to medium sized bees with stout bodies, dark coloration and bands. They nest inside naturally occurring cavities (like hollow twigs, or in the ground) and build cells (individual sections of their nest) with pieces of leaves. Female leaf-cutter bees will build multiple egg chambers per nest hole and in every one of them they deposit an egg with a little bit

of foraged pollen, nectar and saliva for the further development of the larvae. They lay a single egg in each cell but will construct a few cells in one chamber.



Plate 7. Leaf cutter bee, Megachile sp. in flight. These plant is a naturalized exotic weed, Hyptis suaveolens found in intermediate and dry zone in Sri Lanka. It has great affinity with solitary bees because it is attracted numbers of solitary bee species. (photograph was taken at Wariyapola).

Their nests will consist of one long hollow tube divided into individually sealed cells (sealed with pieces of leaves), where the egg that will hatch last is laid at the deepest part of the tube. One by one the eggs will hatch and emerge from their cell inside the nest chamber. They especially like plants in the family fabaceae (e.g. rose). Their presence in your garden can be confirmed by finding neatly cut circular pieces on leaves.

The damage to leaves, however, is minor in comparison to the services they provide the ecosystem as they are very important and productive pollinators of an array of wildflowers, fruit and vegetables.

Mason bees

Mason bees are named for their habit of using mud to construct their nest in hollow stems.

Steps toward Conservation

Bees are so important to our global ecosystems that we call them 'keystone species' because of how devastating it would be to the structure of an ecosystem if they were to disappear. Unfortunately, the general public are not very aware of their importance, so as a great first step you can talk about bees! Make more people aware and study more about them yourself.

Threats to solitary bees

The pressures that these insects face come mainly as a consequence of human activity. The overuse of pesticides is devastating to bees. It has caused the loss of many pollinators including bees, butterflies, numerous other animals, and ironically it has also killed many of the natural predators of pests. Unfortunately, farmers use pesticides they think are different, because they are sold by different companies under different names, but are actually the same chemical which results in spreading pesticides far above their recommended doses. This is also done deliberately sometimes to quickly kill pests. The sad result is that pollinators that could help the crop are killed, as well as many natural enemies of the pests which could have naturally lessened the pest problem. Foraging pollinators can absorb toxic pesticides through their integument (their outer layer), through drinking nectar that has mixed with the pesticide, and by collecting pollen that has been pesticide contaminated. Herbicide use can also lessen the availability of wild flowers that pollinators rely on for food. Apart from these chemicals, the pollution from vehicle and industrial emissions, light pollution, and certain agricultural practices such as monocultures (which effectively remove every other plant but the crop) make the habitat of these bees uninhabitable. Now unfortunately the speed at which climate change is taking place is causing mismatches and imbalances between the life cycles of plants and bees which have evolved together over many thousands of years.

“These insects, so essential to our agriculture and indeed to our landscape as we know it, deserve something better from us than the senseless destruction of their habitats”

– Rachel Carson, *Silent Spring*

The flowering of plants has begun to come earlier and the synchrony of plants and pollinators is changing. Both through urbanization and the increasing need for more agricultural land, we are systematically destroying our woodlands, grasslands, forests, fields and hedgerows – all the natural habitats of pollinators. As a result of urbanization, they do not have enough quality food sources due to the increase of flowerless landscapes and pollution. They have experienced heavy habitat loss and fragmentation. The lack of awareness on the importance of these pollinators also leads to many people removing them from their home spaces when the bees manage to find a little habitable area. In some parts of the world the presence of natural pollinators has been reduced so much that pollination must be carried out manually by farmers. Another threat to the native bees in Sri Lanka is the introduction of exotic bee species which grow much faster than the other bee species and force them out of their habitats. One example is the buff tailed bumblebee (*Bombus terrestris*) which was introduced to Sri Lanka to pollinate strawberries in greenhouses but ended up being put on the invasive species list because of how potentially destructive they became (Marambe, Silva, Wijesundara, & Atapattu, 2014) In addition to invasive animals, invasive plants also pose a threat to bees as they can outcompete the natural food sources of the bees.



*Plate 8. This is one species of wasp foraging on flowers of *Duranta erecta*, but people mistakenly identify them as bees. Some wasps also consider as pollinators. There is a possibility introduce them as well into your bee hotel.*

What can you DO?

So, a switch to environmental friendly farming system like organic farming is the first logical step. In organic agriculture, we rely mainly on ecological processes, biodiversity and cycles adapted to local conditions rather than the use of inputs with negative consequences. Simply, we grow crops without using harmful pesticides which supports both biodiversity and bees.

By promoting mixed farming systems rather than monoculturing (growing only one crop in a large land area) we can increase the food and habitat availability for bees. If people can practice integrated pest controlling methods rather than being dependent on controlling insects by using only pesticides pesticide use can be drastically reduced.

Plant a pollinator garden



Plate 9. Halictid bee (Most probably; *Lasioglossum* sp.) foraging on a flower of Curry leaves plant, *Murraya koenigii*

Plate 10. Species of male Halictid bee called *Hoplonomia westwoodi* resting on the Bacil leaf, *Ocimum basilicum* (photograph was taken at Dilmah conservations organic farm in MJF Centre, Moratuwa)

One of the more encouraging aspects of pollinator conservation is the ability to grow pollinator friendly landscapes. You can attract these invaluable creatures into your garden by filling it with vibrant and bee-friendly plants. You can attract even more pollinators to your home yard by include a range of plants that bloom at different times, in order to provide nectar and pollen throughout the year. All flowering plants are not necessarily a good food source for bees. Some bees specialize in visiting particular types of flowers. Some flowering plants like *Cosmos* spp., *Barleria* spp., *Salvia* spp. (sage), *Zinnia* plants, and *Solanum laxum* (potato vine) attract bees, and some naturalized exotic weeds and exotic flowering plants that are rich in both pollens & nectar such as *Hyptis suaveolens*, *Vernonia cinerea* (“Monara-kudumbiya”), *Ipomea mauritiana*, *Tephrosia* spp. (‘Kathuru-pila, Pila’), and *Sesamum radiatum* show special attractiveness to a

number of bees. (Karunaratne et al ,2005). Some crops which grow on farms like basil (*Ocimum basilicum*), Sesame (*Sesamum indicum*), eggplants, chilies, capsicum, tomato, pumpkin, cucumber, and gourds are also loved by bees when they are flowering. Flowers of some plants like starfruit/'Kamaranga' (*Averrhoa carambola*), Grevillea, Curry (*Murraya koenigii*), *Duranta erecta*, 'Wara' (*Calotropis gigantea*) are also good foraging plants for bees.

They need places to nest

Providing shelter for bees is also one of the best methods for their conservation. They need places to nest, which vary depending on the species. Most solitary bees make their nests in soil, and most ground-nesting bees need bare patches ground where the soil is not compacted (they need loose soil to be able to dig). So, we can make suitable nesting sites by clearing vegetation to create a patch, or by digging a pit and filling it with sand. A chosen site must be well drained, often places on a slope and open sunny places are ideal.

Leave some clumps of grass or other low growing plants to reduce erosion. Do not trample and disturb their nesting site once it is created. While others nest individually in naturally occurring narrow tunnels in dead tree trunks left behind by wood boring insects, they can be encouraged to nest locally by providing a "BEE HOTEL".

How to make a SOLITARY BEE HOTEL

The easiest way to make a bee hotel is the bundle of sticks model. This involves collecting hollow sticks such as small bamboo sticks and reeds of various diameters (it is important that there is a variety of diameters), bundling them up and keeping the bundle outside where you can see bees. These reeds or bamboo stems should be into segments just behind the nodes, so only one end of the segment is open. Make sure cover these bundle from rains and heavy sunlight.

To make a slightly more solid solitary bee hotel, first of all you need frame or wooden box. The box should be a minimum of 20 cm deep and open only from the front end. Make a single pitch or double pitch roof to deflect rain. You can choose your ideal height and width based on the availability of wooden blocks and bamboo stems or reeds.

Then you have to make nesting blocks, that can be made from pieces of wood of different shapes and sizes, to load into the frame. Make sure that the wood you use for these blocks is not treated wood (treated wood contains chemicals harmful to the bees). These blocks can be made from variety of common wood. Once you have a collection of dried stems and untreated wood pieces, just make sure they are 18-20cm long.



Figure 1. Bamboo stems are at least around 20cm and cut stems into segments just behind the nodes, so open in one end and closed at the other.



Figure 2. Bamboo stems with different diameters can be tied into a bundle and make a simplest type of bee hotel or these stems can be loaded into the wood frame in the solitary bee hotel.

Nesting blocks mimic the holes in the trees that cavity-nesting bees will use in the wild. To attract as many species of bees as possible drill holes of varying sizes into the wooden blocks. Be sure not to drill all the way through the block as the holes must have a stopping point. Drill-bits ranging from 2 mm to 10 mm in diameter are ideal. The depth of the holes that you make depends ultimately on the length of your drill bits, but most drill bits are fairly short anyway. When you select stems be wary of taking hard woods because drilling the holes will make you very tired. Load your logs and stem pieces into the frame, making sure that the open ends of the hollow parts face outwards, and are smooth. You can fill the empty spaces between wooden blocks with bamboo stems or hollow reeds.



Figure 3. make a frame/or wooden box first. The box should be a minimum of 20cm deep and open only from the front



Figure 4 different size of stems cut into 20 cm logs

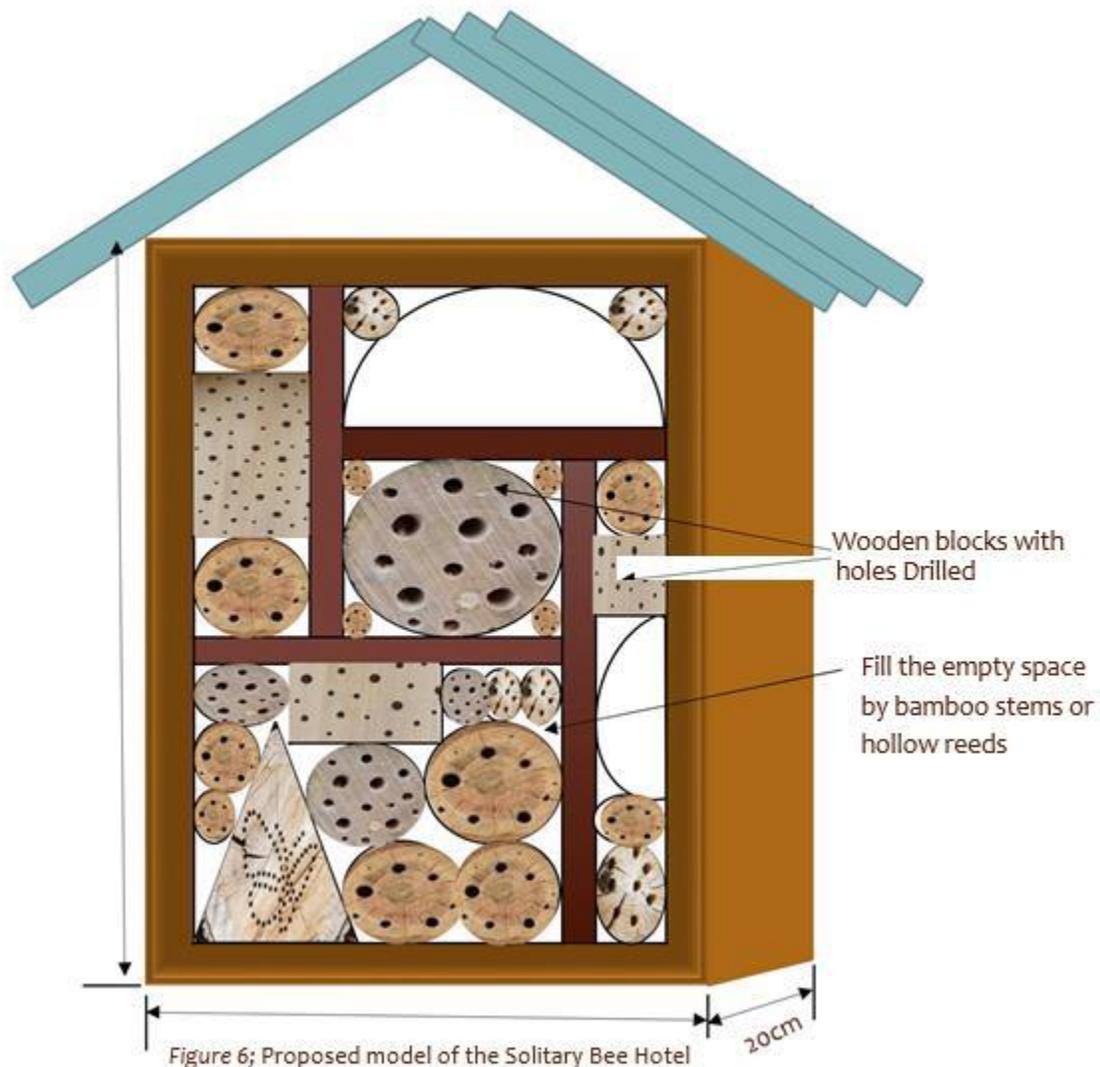


Figure 5. empty spaces can be filled with bamboo stems

Where do we place it?

The bee house must be positioned in full sun, facing south-east or south, at least a metre off of the ground, with no vegetation in front of it obscuring the entrances to the tunnels. A bee house must be firmly fixed, so that it does not swing or sway in the wind, so you should not hang it from a branch.

One of most important things to consider is vegetation types near the bee hotel. Remember to keep the bee hotel close to their preferred plants. Enriching the plants near the bee hotel with legumes such as sunn hemp (*Crotalaria juncea*) or *Crotalaria sp.*, wing beans, long bean, *Tephrosia sp.* Will help these plants grow better.



Note: Mud brick walls also another option for attracting bees, especially blue banded bees.

For this method soil Texture is critical - Usually use a mixture of 3 parts sand and 1 part clay-soil in large brick size frames will work. Then by using pencil, make few holes on one side of the brick. You can even keep this inside the bee hotel.



Figure 7; The bee house must be positioned in full sun, at least a metre off the ground, with no vegetation in front of it obscuring the entrances to the tunnels and be firmly fixed.



Plate 11. Female blue banded bees in flight. These plant is Duranta sp.



*Plate 12. (Top) Another species of wasp foraging on Duranta sp.
Plate 13. (Left) Species of wasp foraging on "Balunakuta"*

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