Stingless Bees: Their Ecological and Economic Significance

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The stingless bees are closely related to carpenter bees, orchid bees, bumble bees, and real honeybees. They are members of the Apidae family. Stingless bee is the smallest (4.0 to 5.0 mm long) bee among all the bees under Apidae. On contrary to *Apis* honeybees, the sting in stingless bees is atrophied in size and does not sting, but they defend themselves by biting when their nest is disturbed. Meliponiculture is the name given to the centuries-old practise of beekeeping using stingless bees that is carried out around the world. In India, Sri Lanka, and Nepal, stingless bees have also been kept for millennia despite little research in these countries (Crane, 1999; Kumar *et al.*, 2012).

Geographical distribution

Most tropical and subtropical areas of the world, including Australia, Africa, Southeast Asia, and tropical America, are said to be home to stingless bees. They are active all year round, however they are less active in the cooler months. In the Neoptropics upto 60 stingless bee species can be found in a single forest thus showing high local and regional diversity (Roubik, 1989). *Trigona iridipennis* is the widespread stingless bee species in the Indian subcontinent and used for meliponiculture, where colonies have been kept in tree logs, wooden boxes, and clay pots for harvesting small quantities of highly prized medicinal honey, and other hive products like wax and propolis which are used for therapeutic and household uses (Crane, 1999).

Diversity of stingless bees

Stingless bees are a large group of bees (approximately 600 species) comprising the tribe Meliponini. Stingless bees (Sub family Meliponinae) are divided into two tribes: Meliponini and Trigonini which have a large number of genera and sub-genera (Sommeijer, 1999). The tribe Meliponini comprises 23 genera and 18 sub-genera, which consist of 374 recognized species (Michener, 2000). The tribe *Trigonini* includes all species of Asian and African stingless bees. The *Trigona, Plebeia, Tetragona,* and *Nanotrigona* genera are among those in this group. *Trigona*, which has 130 species and 10 subgenera, is the largest and most widespread genus. Around 40 species of medium to large-sized bees in the genus Melipona are found exclusively in the Neotropics (Camargo *et al.*, 1988). *Trigona* has been split up into nine smaller genera and *Trigona* bees have all been placed in a genus called *Tetragonula* (Patricia *et al.*, 2013). Approximate numbers of species so far identified were 50 species in Africa, 300 species in the Americas, 60 species in Asia, 12 species in Australia and 4 species in Madagascar (Bradbear, 2009). Local and regional diversities are high in the Neotropics, where up to 60 meliponine species can be found locally in a single forest (Roubik, 1989). Stingless bees native to Brazil are represented by more than 200 species (Silveira *et al.*, 2002).

Nesting structure

They are social insects that live in colonies, much like honeybees. With hundreds or thousands of workers, the stingless bee colonies are perennial in nature. They build their nests in dark areas like hollow logs, tree trunk cavities, cracks in old walls, etc., where the nest entrance typically projects as an external tube. They prefer enclosed structures over open ones for nesting. The nest of stingless bees consists of entrance, cerumen, batumen, involucrum, storage pots and brood cells. Cerumen is a resin material mixed with wax. The wax of the stingless bee has a higher melting point compared to the wax of honey bees (*A. mellifera*) In a higher concentration of the wax than resin, the texture of the nest becomes harder. The waxy nest can furthermore be hardened by mud to make batumen, which provides excellent insulation especially with the exposed nests (Michener, 2007). Batumen and cerumen are used to protect the inner part of the hive. While involucrum is cerumen layer located around the brood cells to protect the nest from predators and parasites. Nests in large trunks or in underground dwelling inside soils are particularly well insulated (Michener 2007). The production of a new individual begins with cell construction. In cases where there are cell clusters, more brood cells are added to the edge of the nest or the edge of the comb. The brood cells are

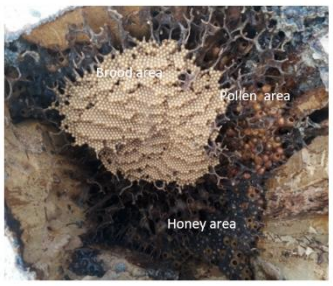

Fig.1 Stingless bee colony inside traditional log hive

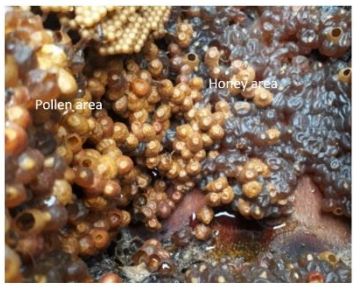

Fig.2. Close up view of honey and pollen pots

Fig.3. Nest entrance to hives

Fig. 4. Stingless bees pollinating cucumber flowers

Fig. 5. Rearing of stingless bees, *Tetragonal iridipennis* in traditional log hives in Jalukie, Nagaland (PC: R.Ch. Sangma)

spherical and organized in horizontal combs surrounded by the involucrum, a covering of waxy sheets that acts as insulation (Sakagami, 1984, Danaraddi *et al*. 2009; Chauhan and Singh, 2019). The involucrum is externally connected with the cavity wall by means of short pillars. There is no interaction between the adult population and the growing larvae in stingless bees. To feed the growing larva of stingless bees, mass provisioning is used, whereas the same are fed progressively with royal jelly and bee bread in case of *Apis* spp (Heard, 1999). The larval broods are darker and larger and pupal broods are smaller and paler in colour. The brownish workers and males were produced in similar cells and both are found in the same combs. Queen cells are elliptical and mostly positioned at the margin of combs. Stingless bees, unlike honeybees of the species *Apis*, store their honey and pollen in separate, spherical containers made of a substance called "cerumen" that is a combination of wax, resin/propolis, and mud. The food storage pots are constructed one over the other or side by side and usually found both at the top and bottom of the nest. The honey pots and pollen pots are larger in size, spherical or oval; and the walls soft, thin and dark-brown. The pollen pots in general are found closer to the brood but at times these are often intermixed. Food pots are sealed when they are filled. The nesting behavior of underground dwelling species. *Lophotrigona canifrons* found in Indian subcontinent are subterranean in nature, located within the bushy forests prevalent at sloppy places engulfing shade, small trees and shrubs preventing light. The entrance tube was found to be made of a mixture of soil, secondary roots and cerumen leading to the nest. The internal nest architecture was found to be covered with scutellum.

Hive products

Honey: Bees gather flower nectar, a mixture of sugars and other minor ingredients, which they concentrate into honey. It is a viscous, delicious fluid that honeybees make. It is gathered as nectar from nectarines at the base of flowers and plant parts other than flowers known as extra floral nectaries. Stingless bees only produce certain species-specific types of honey. Stingless bees store their aromatic honey and pollen in clusters of small spherical resin pots separately, prepared by using a mixture of wax, resin/propolis and mud called as "cerumen" near the extremities of the nest. That's why their honey is also known as pot honey. A unique blend of sweet and sour with a hint of fruit characterizes the taste of stingless bee honey. The taste, which is derived from plant resins that bees use to construct their hives and honey pots, fluctuates throughout the year depending on the flowers and trees visited. The honey of stingless bees has darker color, more acidic taste and contains higher phenolic compounds (Kek *et al*. 2014). Antioxidant flavanoids are abundant in the honey of *T. iridipennis*. Approximately 600–700 grams of honey are produced per year, which is a little amount. Researchers from the University of Queensland discovered in 2020 that certain stingless bee species in Australia, Malaysia, and Brazil produce honey with trehalulose, a sugar with an unusually low glycaemic index (GI) in comparison to glucose and fructose, the two main sugars that make up conventional honey. Humans benefit from such low glycemic index honey because it does not raise blood sugar levels, which would otherwise prompt the body to produce more insulin. This type of honey is scientifically supported as providing therapeutic value to humans as well.

Propolis: Propolis is used by honey bees to construct their hives as well as to sterilize and disinfect

the cavity that contains the colony. Propolis production by stingless bees is higher than that of honey bees. Propolis from *Tetragonula iridipennis* exhibits remarkable pharmacological qualities. *T. iridipennis* collects propolis to strengthen its nest, but humans have harvested it and found it to have a wide range of medicinal properties. Propolis exhibits notable antibacterial and antiviral properties.

Stingless bees in pollination of crops

The majority of eusocial bee species, including honeybees, stingless bees, and bumble bees, visit flowering plants and are important pollinators of crops (McGregor, 1976; Roubik, 1995). The honeybee, *Apis mellifera* L., is regarded as the primary pollinator of numerous crops due to a number of significant characteristics, including the high number of individuals per colony and its capacity to recruit numerous workers to visit rich resources. However, in tropical areas, stingless bees (Meliponini) are significant pollinating agents of numerous native plant species (Roubik, 1995). Their small size allows them to have access to many kinds of flowers whose openings are too narrow to permit penetration by other bees and they are common visitors to flowering plants in the tropics (Heard, 1999). Stingless bees gather pollen and nectar from a variety of plants since they are true generalists. Up to 100 plant species may annually provide floral rewards to a single species. Recent research shows that stingless bees are an efficient substitute for honeybees for the pollination of many greenhouse plants of considerable economic and social importance, such as strawberries (Malagodi-Braga and Kleinert, 2004), capsicum (Occhiuzzi, P. 2000), tomatoes (Macias *et al*., 2001), watermelons (Chauhan and Singh, 2021) etc. Stingless bee pollination produced greater fruit set and healthy fruits than other methods.

Conclusion

Thus, from the above we can see that Stingless bee keeping, also known as meliponiculture, is a sustainable activity that does not harm the environment, provides valuable products, such as honey, propolis, pollens etc. which has high economic value. This activity generates great benefits to the environment through pollination, which is a service provided by these insects, in a way that contributes to the regeneration of forests and increased biodiversity. Pollination has high economic value, as it is fundamental for the increase productivity of agricultural crops. Meliponiculture is a viable activity and should be popularized among the people of the country especially in rural areas for income generation and increasing yield of their crops through pollination services.

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