

Traditional Meliponiculture by *Naga* tribes in Nagaland, India

A K Singh

AICRP (Honey Bees & Pollinators), Department of Entomology, Nagaland University,
SASRD, Medziphema, Nagaland, 797106, India
E-mail: dr.akhileshento@rediffmail.com

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In Nagaland, three species (*Tetragonula irridipenis*, *Tetragonula laviceps* and *Lophotrigona canifrons*) of stingless bees were observed; however, most of the beekeepers were rearing *T. irridipenis*. Stingless bees were found to prefer low light, high humidity, and stenothermal climatic conditions with diverse abundant flora. The traditional colony capture method of terrestrial and subterranean stingless bee was logical and practical and shows immense scope to introduce precise method with scientific interventions. Usually log hive and rectangular bee boxes were used by *Naga* beekeepers, although a few have tried to modify and standardize the bee box as per their own experience. In these boxes, there was no scope for colony inspection without colony disturbance and during harvesting of bee hive products, colonies were fully disturbed. Terrestrial stingless bee colonies were arranged in cluster nests; broods were observed in the central portion at basal part, pollen balls arranged around the brood area and honey pots arranged on the surrounding beehive walls. These architecture shows envisage for standardization of scientific stingless bee box. The underground stingless bee (*L. canifrons*) broods were observed in the central part with pollen pots and honey pots arranged around the brood area. Their traditional method of harvesting beehive products requires more scientific intervention for improvement to minimize the colony disturbance and other losses. Stingless bee honey is a home remedy to all *Naga* tribes and they use it for various diseases.

Keywords: Meliponiculture, Traditional methods, Stingless bee, *Tetragonula irridipennis*, *Tetragonula laviceps*, *Lophotrigona canifrons*

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Stingless honeybee belongs to the family Apidae and comes under the sub family Meliponinae. Rearing of stingless bee is known as meliponiculture. They have no sting or in rudimentary form of sting and therefore, cannot sting. They are highly Eu-social, safer for humans due to stingless and perennial nature which is desirable attributes often found in meliponiculture. Its honey is sold at Rs. 3000/kg due to its high nutraceutical value. Stingless honey is a home remedy to all *Naga* tribes and they are used in various diseases but due to lack of adequate documentation, it is still remaining in the dark. Natural honey is effectual for haemato protection, immune enhancement, reduces the risk of dental caries, antiseptic properties, ulcers, and many more¹. More than one species of stingless bees have been prevailing in Nagaland. Eight species of stingless bees were reported from the Indian subcontinent². Stingless bees play a vital role as pollinator in agricultural, horticultural and medicinal plants. They have good pollinator characters like polylecty, floral constancy, domestication and perennial nature. Stingless bees are considered important natural pollinator for the

tropical and subtropical crops^{3,4}. Stingless bee species are considered as ideal pollinators for green house cultivated crops due to their short flight range⁵. The use of stingless bees as crop pollinators has opened a new economic possibility for meliponiculture.

Nagaland is a vibrant hill state, dominated by crumpled mountain ranges, covered by verdant forest with rich biodiversity. The mild temperature and verdant forest with wide range of flora offers incessant food source and provide congenial niche for stingless bee. *Naga* tribes have since immemorial time, practised with rich traditional knowledge and skill about stingless beekeeping. As a result of acculturation, traditional knowledge of meliponiculture is disappearing nowadays. Young *Nagas* show little interest in learning the skills of their parents and grandparents, viewed as anachronistic and oriented towards office job. Only time will tell if *Naga* youths will find some incentive to carry on the indigenous meliponiculture of their ancestors. If not, traditional knowledge of indigenous meliponiculture will pass from memory, along with countless other areas of unique human endeavor such as indigenous

methods and medicinal use of stingless beehive products and their incomparable quality. There is only scanty research and documentation accomplished on meliponiculture in this area. Hence, present study was to explore the jewels of traditional methods of meliponiculture and development envisaged for scientific interventions and improvement.

Methodology

This study was accomplished during 2012- 14 in order to know about the indigenous methods, tools and usage of bee hive products of meliponiculture in six different districts (Dimapur, Peren, Kohima, Mokokchung, Zunheboto and Wokha) of Nagaland. This geographical area lies between 25°06" to 26°31" N latitudes and 93°50" to 94°37" E longitudes. Topographically, landscape varies and depends upon the degree of slopes with elevation, can be divided into 3 groups, foothill varies less than 100 msl, lower to mid-ranges 100-1000 msl and hills/ mountainous regions varies above 1000 msl altitude. In the selected village, informal discussions were held previously with beekeepers, to identify the key knowledge holders about traditional meliponiculture. Thereafter I divulged the purpose of study and had their consent for interview. The study was accomplished from identified key stingless beekeepers on different aspects; diversity of stingless bees, nesting habitat, type of rearing box, traditional colony capture method, nest architecture of bee hive and traditional harvesting methods of beehive products. Beekeepers selection was used in order to identify Naga tribal members who were rearing stingless bee since long or from his forefather's time. Beekeepers selections were taken on the basis of different socioeconomic and literacy background. As per need, personally I was involved in it to collect practical information about traditional methods of meliponiculture. During the two year study, I contacted 63 beekeepers and observed 215 stingless bee colonies, in particular, 173 bee colonies of *Tetragonula iridipennis*, 34 bee colonies of *Tetragonula laviceps* and 8 colonies of *Lophotrigona canifrons*. The entire 8 colonies of underground stingless bee (*L. canifrons*) were caught from forest and after digging the colonies, were shifted to the apiary of AICRP (Honey Bees & Pollinators).

Results and discussion

Diversity of stingless bees in Nagaland

Three species of stingless bees; *T. iridipennis*, *T. laviceps* and *L. canifrons* were observed from

across the selected 6 districts; Dimapur, Peren, Kohima, Mokokchung, Zunheboto and Wokha. In Indian sub-continent, 8 species of stingless bees were reported including genus *Tetragonula* and *Lepidotrigona*². The abundance of *T. iridipennis* was too high and 100 per cent stingless beekeepers were rearing this species, whereas only 14.9 % stingless beekeepers were rearing both species *T. iridipennis* and *T. laviceps* and only 4.76 % stingless beekeepers were rearing *T. iridipennis* and *L. canifrons*. The highest terrestrial stingless bees (*T. iridipennis* and *T. laviceps*) colonies were recorded from Diphupar village of Dimapur, Peren, Mokokchung, Zunheboto and Kohima. The highest terrestrial stingless bee colonies were recorded from Peren and Zunheboto. The highest subterranean stingless bee colonies were recorded from Kukidolong of Dimapur district (270 msl) to Mokokchung district (960 msl). The stingless bees were confined in foot hill to mid hill which might be due to more stenothermal characteristics and similarly, temperature and radiation were the most important variables affecting flight activity⁶.

Nesting habitat of stingless bees in Nagaland

Two types of nesting habitats were observed; terrestrial and subterranean. The *T. iridipennis* and *T. laviceps* constructed their nest terrestrially. They prefer mild light intensity, stenothermal climatic condition and in the vicinity of abundant flora. The feral colonies of both species were found to have constructed their nest in hollow crevices and usually, hollow tree trunks. Meliponines nesting habits prefer tree trunks, crevices within rocks, hollow stems including tree trunks⁷. The nesting behaviour of underground stingless bee (*L. canifrons*) was subterranean⁸. The nesting sites were mostly observed within the bushy forest prevalent at sloppy places engulfing shady small trees and shrubs preventing light (Fig. 1) and generating high relative humidity with stenothermal climatic condition. Nests were made by stingless bee workers and habitats (specific location) were within forests^{9,10}. The colonies of subterranean stingless bee prefer nesting under soil containing thick litters of partially decayed organic matter. Rearing and management of terrestrial stingless bee is easy, however, management of subterranean stingless bee is very tough because they are located underground. Therefore, most of the Nagas were seen to be rearing only terrestrial species.

Colony capture methods of stingless bee

The terrestrial stingless bee (*T. iridipennis* and *T. laviceps*) prefer their nesting in the hollow tree

trunks in forest. In the forest, first of all, *Nagas* searched flowering plants and observed their pollinators/ visitors and if stingless bees' visitation can be observed on flowers, they decide to search the bee colony in that vicinity. They located feral nest of (*T. iridipennis* and *T. laviceps*) in the forest after 0800 hrs in summer season and after 1000 hrs in winter season. It might be due to foraging initiation of stingless bee similarly total external activity, as well as pollen collection, was maximum in the first hours of the morning, mainly in strong colonies¹¹. They squat down on the ground and looked upside towards light because in that position, visible and movable organisms were easily observed. As per incoming and outgoing of bees they were located and the nests were finally marked in the forest. The stingless bee nested in tree trunks were cut by saw to avoid disturbing of colony by jerk and in the end, portable logs containing colonies were obtained. Both side of the log hive was capped with pieces of wooden planks and remaining gaps were sealed with cerumen. Thereafter, the log hives were shifted in the evening to an apiary at their convenience.

The *L. canifrons* feral nests were also located and marked like the *T. iridipennis* and *T. laviceps* methods. Once located, they visited there the next day with equipments, viz. spade, machete, knife, new pot, bottle, filter cloth, thermacol, etc. First of all, they plucked out the entrance tubercles and kept it away safely (Fig. 2). Thereafter, they took long, soft and flexible straw of grass which was used as a direction indicator of Entrance tunnel way during digging. The depths of the nests were all varied from a few inches to even 5ft and more. (Fig. 3) The diggings were continued as per straw indicator towards colony and when digging reached nearer the nest, the buzzing sound was found to have increased. After reaching the nest, they slowly cut the soil with the help of knife and pulled out the whole nest in one piece and when they had pulled out the nest, they cleaned the outer portion of the nest from soil, roots, dirt, etc. The colony was placed into the new empty earthen pot (Fig. 4). After placing the colony in pot, it was covered with thermocol and the peripheral gaps were sealed by cerumen. The plugged entrance tubercles dug out at the commencement phase was fitted at the hole of basal part of earthen pot by cerumen of the same nest. This pot cum underground stingless bee colony was kept at the same place till the dusk. Temperature and radiation were the most important variables affecting flight activity⁶. All members came

back and went inside the colony before dusk. Its nest entrance tubercle helped to identify their own nest for colony members, which was made by cerumen, similarly, some of the honeybee's nest-mate recognition compounds were identified^{12,13}. The safest time to carry away the colony was after dusk because all the members went inside by that time. The colonies were shifted to an apiary at their convenience.

Bee box

Scientific stingless bee box has not been standardized till now and *Naga* tribes' have been rearing stingless bees in traditional beehive since their forefathers' time. They kept terrestrial stingless bee colonies in log hives of wooden box. Its size and shape were not standardized, therefore, bee box sizes and shapes were varied since they made as per their convenience.

Log hive

Log hives of *T. iridipennis* and *T. laviceps* were observed in all 6 districts (Dimapur, Peren, Kohima, Mokokchung, Zunheboto and Wokha). This hive was practised more in Zunheboto district. The sizes of log hives were varied, depending upon the hollow tree trunk (Fig. 5). The sizes of log hives were; length varied from 43 cm to 128 cm and diameter varied from 11 cm to 38 cm. The highest length and diameter both were observed in Emlo village of Zunheboto. The log hive was a hollow tree trunk adopted by stingless bee for nesting where some times, it might formerly be nested by other organisms. Meliponines adopt themselves in active termite nests and abandoned holes by other organisms for their nesting habitat⁷. These log hives were cut by saw to be detached from the trees. Both open sides were closed by wooden disc as a lid while entrance gate usually in the middle portion of the log is kept untouched. The gaps of the log hive and lid were closed by cerumen. Usually, log hives were hung by ropes and wires from the roof or pole or wall in shaded places (Fig. 5).

Rectangle wooden box

The rectangular box was also observed in all the 6 districts surveyed (Dimapur, Peren, Kohima, Mokokchung, Zunheboto and Wokha) of Nagaland. This box was prepared by wooden strips and these were joined with nails. The strips of wood depend upon availability although bees prefer *Gamhari* but avoided *Neem* and *Lali*. *Neem* wood and bark

chippings disruptor of *Anopheles gambiae* larvae growth¹⁴. The sizes varied from box to box because there was no standardized size or specification (Fig. 5). The length of the base of bee box varied from 25 to 32 cm, width from 18 to 26 cm and height from 20 to 64 cm. The highest size was observed in Punglwa village of Peren district. A small hole, usually at the lower front portion was made in hive as an entrance gate. One beekeeper, Nungsangwati in Chungtia, Mokochung tried to modify the rectangular bee box which was divided into 3 chambers and he was satisfied with this box (Fig. 6) but much more scientific interventions were required. The rectangular boxes provide sufficient space for their colony development and enhance honey production also. Usually, beehives were hung by ropes or wires from the roof or wall in shaded places.

Feral colonies of *L. canifrons* adopted abandoned burrow of termitaria because bees are unable to dig the soil. Stingless bee; *Trigona fulviventris* (Guerin, 1837) nested in inactive nests of subterranean termites¹⁵. Stingless bee; *Geotrigona subterranea* nested in abandoned ant nests and inactive nests of subterranean termites¹⁶. The entrance tubercles were made up of soil, secondary roots, resin, cerumen etc. however, the tube is irregular in shape. Entrance tunnel was a connecting pathway between the entrance tubercles and colony. The entrance tunnel was reported as the channel to the nest cavity, which was connecting entrance gate to nest of stingless bee (*G. subterranea*)¹⁶. The Entrance tunnel was plastered with black coloured cerumen with resins nearby colonies. Domesticated colonies were reared in the earthen pot and its top covered with thermocol. Hard and partially flexible plastic pipe was used as entrance tunnel to provide pathway from colonies to entrance gate for bees. The size of bee box variation range was too high where small bee box have constraint on restricted growth, development and bee hive productivity and vice versa while bigger size boxes were not suitable which might be because they were unable to maintain the internal congenial micro climate of bee box, and therefore, standardization of scientific bee is box required. Rectangular bee box was better than log hive. Stingless bees are stenothermal insect. Inimical nest temperatures were reported to be 41°C for *Scaptotrigona postica*¹⁷. The brood chamber is the warmest part of the nest, well insulated by a multi-layered involucre, low aerial temperature the bees are capable of heating up the

brood combs by mass incubation. They might lose more energy to maintain congenial micro-climate inside the beehive during winter season and minimize their foraging. Stingless bee foragers' flight activity was relatively constant in a wide range of temperature, from 22°C to 34°C whereas minimum temperature for the beginning of flight activity was 14 °C¹⁸. Although winter season is a honey flow period of stingless bee, therefore it may hinder their beehive productivity if they are engaged in maintaining the required temperature of hive instead of foraging.

Nest architectures of stingless bees

The entrance gate of *T. iridipennis* was projected by dark brown to black cerumen. Its shape and size were all varied where most of these were round orifices and the volume of cerumen depends upon strength and age of colony. Internal architectures of *T. iridipennis* colony consisted of brood, pollen and honey areas in arranged way (Fig. 7). The brood area was usually located centrally at the basal part of the nest. Broods were reared in the waxy cells which were oval or elliptical bids in shape. Circular brood combs were arranged in multi layers and spiral shape whereas basal comb was the biggest comb and its sizes reduce at each comb towards upper side (Fig. 8). The pollens were stored in waxy pots which were almost round in shape. Pollen pots were stored around the brood area (Fig. 9). Honey was also stored in waxy pots whose colour was light brown. Honey pots were arranged above pollen pots, surrounded brood area and attached with and around the internal sides of beehive walls.

The entrance gates of *T. laviceps* were like funnel tube and constructed by a special kind of wax which was white to light brown in colour and its sizes were varied. Internal architectures of *T. laviceps* colony consisted of brood, pollen and honey areas in arranged way. The brood, pollen and honey were covered with brownish, pliable multilayered involucre (Fig. 10). Usually, the brood area was located centrally at the basal part of the nest. Broods were reared in the waxy cells and oval or elliptical bids in shape. The brood cells were arranged in cluster form in combs. The pollen and honey pots were much larger than brood cell. Pollen pots were stored around the brood area. Honey was also stored in waxy pots whose colour was light brown. Honey pots were arranged around and above the brood area.

The nest architecture of subterranean stingless bee (*L. canifrons*) study was, for the first time reported

here. The entrance tubercles of *L. canifrons* led to the colony and were made up of soil, secondary roots, cerumen, etc., projected above the ground and capable to prevent entry of ground flow rain water. A tunnel was observed which joined to the entrance tubercles and colony. This tunnel was used as a pathway of bee from entrance gate to the colony and vice versa. The tunnel nearby the colony was plastered with black colour cerumen with resins. Internal architectures of *L. canifrons* colony were covered with scutellum. The colony architecture was observed in cluster nest; including brood, honey and pollen and all these parts were separated from each other by scutellum. Usually, nests were observed to be oval in shape. The pots meant for storing honey and pollen remain arranged in patches around the brood cells placed in horizontal fashion. The brood area was usually located in central part of the nest and brood cells were appearing like cluster of yellowish colour bids. The brood chambers contained the horizontal combs and surrounded by the honey pots and pollen pots. Honey chambers were usually the largest compartment of the nest, were irregular in shape and dull grey in colour. These pots were clubbed to each other making a honey patch in the colony. The shape of pollen pots were irregular and covered by dark brown cerumen. These pots were also clubbed to each other making a pollen patch. Honey pots and pollen pots were both arranged on the outer side of the brood area and honey pots were attached with inner walls of the box at the inner periphery of the bee box.

Traditional methods of harvesting of beehive products

Stingless bees stored three products in their colony, viz. honey, pollen and cerumen, and out of these, honey is the most important produce of beehive.

Stingless bees are poor honey gatherers; they store only limited quantity of honey (about 500 gm/ hive/ year). Stingless bee produce limited quantity of honey up to 100 ml/ colony¹⁹. In southern India stingless bee are reared in earthen pot, bamboo, etc, where internal space was a constraint of colony growth, development and honey production, whereas in Nagaland beekeepers used rectangular wooden box which have more space. Its honey was sold at a higher price (about Rs. 3000/kg). In the hive, bees stored honey in the pots of cerumen which were observed in clusters and some part was attached with the pollen clusters. The unique mode of honey storage makes harvest difficult. *Naga* beekeepers first close the entrance gate with cloth and open the box by removing wooden

plank on the upper side with the help of chisel and hammer, thereafter most of the beekeepers used bare hand or sharp wooden strip to pluck and pull out the honey pots (Fig. 11), whereas some innovative beekeepers used honey picker which were made of wood or bamboo to puncture the honey pots and honey oozed out from the honey pots. This honey was poured in to clean bowl and the collected honey was filtered with fine net or clean muslin cloth before bottling (Fig. 12).

Stingless bees are good pollen gatherers; they were found to store good quantity of pollen in comparison to honey storage. The pollen balls were stored safely in cerumen covered pots (Fig. 9). Among these stingless bees, the *T. irridipenis* stored highest pollen volume (about 300 gm/ hive/ year) followed by *L. canifrons* and *T. laviceps*. *Naga* tribes harvested only a limited quantity of pollen, because they believe that more volume of stored pollen in hive enhance colony development. After honey harvesting, beekeepers harvested surplus pollen by knife and took them out from the colony. They always kept sufficient volume of pollen for growth and development of colony. Meliponiculture also provide cerumen and it is also an important beehive product. Cerumen harvesting was done during honey harvesting and it was removed and collected after honey filter stage and stored for further use (Fig. 12).

Ethnonutraceutical values of stingless beehive products

Nagas believe it has high nutraceutical values. Its test was sweet and sour due to its acidic nature Meliponine honey contain pH (3.15-4.66), free acidity (5.9-109.0meq/ Kg), diastase activity (0.9-23.0DN) and electrical conductivity (0.49-8.77mS/cm)²⁰. *Naga* tribes used stingless bee honey as ethno-medicine for treating burns, internal wounds, eye infections, diarrhea, ulcer, etc. They also consume this honey before or when they go for hard work since they believe it provides sustainable energy. Honey increased the heart frequency and the blood glucose level during the physical performance significantly²¹. Honey is more beneficial in this regard as it releases fructose slowly into the blood stream to produce a sustained energy boost and maintain homeostasis¹. *Naga* tribes harvested only limited pollen as per need for medicinal use. Pollen is also a rich nutritious beehive products and used especially for medicinal purposes.

Traditional significance of study

It is hoped that the results of this study, viz. traditional rectangular bee box and nest architecture

provided basic information for envisaged further research on standardization of scientific bee box of stingless bee which could be a milestone for meliponiculture. The diversity and nesting habitat of stingless bees provide basic information about required congenial niche of

stingless bees for their conservation in prevalent climatic change milieu and successful meliponiculture. Indigenous methods of colony capture and traditional harvesting of bee hive products show great promises and envisages further improvement with scientific intervention.



Figs 1-12—Feral nest niche of stingless bee in bushy forest; 2-Entrance tubercles of *L. canifrons*; 3-nest's depths of *L. canifrons*; 4-Colony transferred of *L. canifrons* in pot, Fig. 5- Different size of stingless bees' log hives hung under shaded place, Fig. 6- New stingless bee box designed by Naga beekeepers, Fig. 7- Internal architectures of *T. iridipennis* colony, Fig. 8- Brood architectures of *T. iridipennis*, Fig. 9- Pollen arrangement of *T. iridipennis*, Fig. 10- Internal architectures of *T. laviceps* colony, Fig. 11- Traditional method of stingless honey harvesting, Fig. 12- Traditional method of stingless bees' honey filtration and cerumen harvesting method

Natural nesting site of terrestrial stingless bee was dry hollow tree trunks in the forest. *Jhoom* cultivation has devastated nesting site and natural niche of stingless bee as well as burns their feral nests. The traditional rectangular bee box and nest architecture provides basic information envisaged for standardization of scientific bee box of stingless bees. These indigenous methods of colony capture and traditional harvesting of bee hive products show great promises and envisage for further improvement with scientific intervention. *Naga* traditional acculturation of meliponiculture is disappearing. This has been a tool for conservation and multiplication of stingless bees since their forefather's time. Stingless honey was an ethno-remedy among *Naga* tribes as they used it to treat various diseases and before hard work for sustainable energy. However, due to lack of adequate scientific research, its nutraceutical values are still remaining in the dark. Therefore, a delve study is required on nutraceutical value of stingless honey. We recommend scientific intervention in traditional knowledge for their improvement.

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