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EDUCTION OF STINGLESS BEES (HYMENOPTERA: APIDAE: MELIPONINI) FROM THEIR NATURAL COLONIES TO HUMAN MODIFIED HABITATS

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Abstract: The stingless bees are social insects (Hymenoptera: Apidae: Meliponinae) live in cryptic nests at various diversified habitats. They are less ferocious and less venomous insects, can be used as model organisms to study and understand various aspects of living systems such as biology, ecology, ethology, mellisopalynology, melitophily and other related aspects which are useful to biology students and researchers as well. Moreover, stingless bee hives products (e.g. honey, pollen, cerumen etc.) are commercially important and are more useful materials to be used for geo-location of forage plants, floral types and quality and property of honey. Keeping in view, present investigation was conducted to develop daughter colonies from the parent colony of stingless bees to reveal the practical applications using eduction method during 2020-2021 at different human modified habitats in Mysore. Parent colonies of stingless bees located naturally at various man-made establishments were randomly selected after noticing their easily accessibility without disturbing their normal activity. Locally available empty coconut (*Cocos nucifera*) shell and little adhesive material were used to develop daughter colonies at the peripheral region of the parent colonies by following standard methods. Observations were made to record the newly established daughter colony, isolated without any disturbance and the hive parameters such as number of bees, pollen cells, honey cells and brood cells establishment on the inner surface of the *C. nucifera* shell was encouraging. Results of such findings are critically discussed in detail in this presentation.

Key words: Eduction, stingless bees, practical applications, human modified habitats.

I. INTRODUCTION

Stingless bees or ‘dammer bees’ (Hymenoptera: Apidea: Meniponini) are small sized social insects (Karthick *et al*., 2018) live in perennial colonies. They establish unique cryptic nests inside the crack/cavities of tree trunks, termite mounds, old buildings and other man-made structures (Jongjitvimol and Wattanachaiyingcharoen, 2007; Basavarajappa, 2010; Sheetal and Basavarajappa, 2009; Nayak *et al*., 2013; Vijayakumar *et al*., 2013) with unique nesting traits (Karthick *et al*., 2018). Stingless bees are known as potential pollinators, pollinate and propagate small sized flowers with narrow opening to big sized flowers/inflorescence bearing plant species (Heard, 1999). They produce medicinally important hive products which are being used to treat various disorders and diseases of man at different parts of the world (Silva *et al*., 2013). Hence, to get more benefits from their hive products, they have been considered as important insects in apiculture (Kumar *et al*., 2012) in general and meliponiculture in particular.

In meliponiculture, stingless bees are scientifically reared by providing necessary requirements to produce honey, pollen, resin etc, under human captive conditions. There are published reports available on meliponiculture using different species of stingless bees at various habitats. Their continuous foraging activity in a limited foraging distance (Karthick *et al*., 2018) help rear, maintain and monitor their colonies with little human interference midst diversified habitats. Hence, various devices are being used to rear/culture stingless bees (Heard, 1999; Kumar *et al*., 2012; Singh, 2013; Virkar *et al*., 2014 and Singh, 2016). Usually, honey is extracted using ‘hiving method’ or ‘logging method’ by lateral cutting of the trunk or substratum by destroying the colonies. Perhaps, this method would reduce the stingless bee nests or natural colonies (Heard, 1999) resulting in the reduction of stingless bee population and also damage their nest sites. Many a times, ‘hiving method’ or ‘logging method’ are not suitable to understand the nesting parameters and honey harvest from the cryptic nests established midst the cracks of man-made structures. Therefore, several researchers (Kumar *et al*., 2012; Vijaykumar *et al*., 2012; Virkar *et al*., 2014 and Devanesan *et al*., 2017) have suggested eduction method. However, no published reports are available to use spread colony sideway area at the peripheral region of stingless bee nests to produce honey. To study the biology of stingless bees, morphology of colony members, to estimate the foraging efficiency, honey and pollen producing potential simple and eco-friendly approaches are necessitated. In this context, attempt was made in the present investigation midst human modified habitats to show the usefulness of eduction method for stingless bee’s research.

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II. MATERIALS AND METHODS

Study area: The present study was conducted in Manasagangotri campus (11º45' to 12º40' N latitude and 75º 57' to 77º15' E longitude), lies at an altitude 763 meters msl in Mysore, Karnataka (Figures 1 and 2) (Kamath, 2001).

Methodology: Stingless bee cryptic nests were identified at different places in Manasagangotri campus using an all out search method as per Sheetal and Basavarajappa (2009). Naturally established few cryptic nests in the cervices of rocks and cement made wall buildings were chosen randomly and marked systematically using standard methods. The earmarked natural colonies were numbered and monitored for two to three months to check their living status and used for eduction. Round empty coconut shells bearing three small sized holes with a dimension 8.0 to 10.0 cm length and 7.5 to 10.5 cm width with an overall diameter 35 to 26 cm sized coconut shells were used. The epoxy compound called 'M-seal' (Product brand name 'Phataphat' manufactured by Pidilite Industries Ltd. India) was used as an adhesive to fix the coconut shell at the entrance tube or chamber of the stingless bee nest established on the surface of rocks and cement wall. The distance between coconut shells varied and the sites were selected based on the flora and water source availibity. Total five nest sites were chosen and fixed the coconut shells separately and nests were monitored for 167 days continuously without any disturbance. The movements of the bees were observed during morning 0800 to1030 and evening 1500 to 1700 hours. The foragers and other worker bees activity was recorded systematically by observing five to ten minutes by leaving five minutes gap between every alternate observation. Moreover, possible interferences by animals including man occurred nearby the educted nests were also recorded. Further, the growth and development of colony, established honey filled pots, pollen pots and brood cells were observed without creating any pressure on the colony members by following standard methods. One corner of the coconut shell was made free from the M-seal and created a small orifices and opened the coconut shell keeping intact 60% of the shell with the surface of the substratum on which coconut shell is placed and then recorded the growth and development of the shell. Counted the number of pollen pots, honey filled pots and brood cells. Pollen cells were gently removed and taken the weight. Similarly, honey cell was also removed and collected the honey with the help of suction pipette and measured.

Statistical Analysis: Collected data was complied and analyzed using standard methods as per Saha (2009).

III. RESULTS

The worker stingless bees inspect the inner view of empty coconut shell to seek suitable space to begin construction of new daughter colony (Figures 3 and 4). Then, worker bees start establishing the bitumen in an irregular manner (Fig. 5) after 45 days. Later, available space is initially used for the construction of pollen pots and honey pots after 120 days (Fig. 6). After 150 to 165 days, the nurse bees initiated the construction of brood cells and established the daughter colony (Fig. 7). During eduction method, once the artificial nesting features are created, there shouldn't be any interference allowed to the developing daughter colony until completion. The construction of new daughter colony on the nest entrance of parent colony require minimum 165 to 180 days and it is depending on the locally available foraging resources, prevailed temperature, availability of space inside the natural substratum etc. It may also take up to more than a year or sometimes the parental colony may fail to produce the daughter colony due to the disturbance caused by the predators, enemies, non-availability of required space inside the parent colony. Moreover, once the colony start to establish inside the coconut shell, first brood cells appear and it was followed by the establishment of honey pots and pollen pots (Fig. 8). Then, newly developed queen, workers (Fig. 9) and drones starts staying in the coconut shell, which requires carefully detachment so as to shift or transfer into the suitable substratum like earthen pot or wooden boxes, where the daughter colony would be maintained for further culture.

Brood cells: The brood cells are yellowish brown in colour having oval shape (Fig. 10), located at the central region of the nest. The length of brood cells was ranged in between 0.2 to 0.4 cm with a mean value 0.34 ± 0.06 cm. The brood cells width ranged from 0.2 to 0.3cm with a mean value 0.25 ± 0.05 cm and the brood cells diameter was ranged from 0.7 to 0.9 cm with a mean value 0.82 ± 0.09 cm.

Honey pots: The honey pots are light dark brown in colour with oval shaped body (Fig. 11). They are located at the peripheral region of the nest. The length of honey pots ranged in between 0.9 to 1.5cm with a mean value 1.22 ± 0.26 cm. The honey pots width ranged in between 0.5 to 1.4cm with a mean value 1.01 ± 0.32cm and overall diameter was ranged in between 1.6cm to 1.9 cm with a mean value 1.79 ± 0.09 cm.

Pollen pots: The pollen pots are dark brown in colour and oval in shape (Fig. 12), located at the peripheral region of the nest. The length of pollen pots ranged in between 1.1 to 1.3cm with a mean value 1.18 ± 0.06cm. The pollen pots width ranged in between 0.5 to 0.7 cm with a mean value 0.65 ± 0.07cm. The pollen pots diameter was ranged in between 1.9

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to 2.3cm with a mean value 2.13 ± 0.12 cm.

Honey: The honey of stingless bee is light yellow in colour and having sweet in taste with a tinge of lemon flavour. From every honey pot, 0.09 to 0.13ml of honey with an average of 0.10 ± 0.01 ml was collected (Fig.13).

Bee population: In the daughter colonies, quite a good number of stingless bees are increased considerably. In a six to seven months period, more than 200 to 400 stingless bees were observed in a daughter colony along with queen (Fig. 8), which is located on the peripheral part of the parent colony. Thus, eduction help enhance the stingless bee worker population, pollen cells, honey cells and brood cells also. The internal colony parameters and honey production potential of a daughter colony is depicted in Table 1.

IV. DISCUSSION

Stingless bees (e.g. *Trigona iridipennis*) adapt elite strategies (Nayak *et al.*, 2013) to establish their colonies spatially at human modified habitats (Sheetal and Basavarajappa, 2009). Karthick *et al.* (2018) have reported the improved techniques, prospects and challenges in meliponiculture in India. However, developing daughter colonies in a natural way at the vicinity of parent colonies using certain devices is difficult due to various anthropogenic interferences at human modified habitats (Basavarajappa, 2010). Moreover, there are many predators interference to the stingless bee colonies (Vijayakumar *et al*., 2012). Despite all these constraints, it is possible to produce daughter colonies from the parent colonies using eduction at human modified habitats. Eduction is quite simple method; require continuous monitoring with minimum investments. It is easy to install and management is very simple. This type of simple methods is advisable to support pollination of local vegetation and encourage meliponiculture for sustainable development of vegetation midst human modified habitats (Heard, 1999; Basavarajappa, 2010; Devanesan *et al*., 2017). Thus, eduction supports the process of duplication of colonies of stingless bees in a natural way and it becomes an innovative method to produce hive products (e.g. Pollen, honey and cerumen) in a simpler manner. Similar type of studies was made in Australia (Dollin, 2001) and other parts of the world. Our observations are on par with the observations of Dollin (2001), Slaa *et al.* (2006), Jongjitvimol and Wattanachaiyingcharoen, 2007; Kumar *et al.* (2012), Nayak *et al*. (2013), Vijayakumar *et al.* (2013), Chuttong *et al.* (2014), Virkar *et al*. (2014) and Karthick *et al.* (2018).

V. CONCLUSION

Stingless bees are considered as highly useful creatures, helping mankind in many ways. They contribute one of the most important services called pollination and propagation to upkeep the local vegetation. Besides, they provide considerable quantity of honey which is used for the preparation of folk medicine while treating various diseases such as cough, wound healing, in the treatment of eye disorders, gastrointestinal tract disorder, neurological disorders and fertility disorders. They need less expensive rearing devices, collected locally available material (e.g. coconut shell) with little adhesive. However, it requires consistent monitoring, little more time and patience during culture. Interestingly, it is an eco-friendly initiative, help capture the stingless bee hive products without damaging the parent colony. So that original parental colonies are retained at their preferred natural habitat and the new nest or daughter colonies could be propagated to produce hive products for study purpose. Hence, present study enlightened to make use the locally available biological resources for practical applications by the students.

VI. RECOMMENDATIONS

- Encourage eduction method for getting stingless bee sample for study purpose at undergraduate and post-graduate levels without harming their parent colonies.
- Avoid more human interference and disturbance during sample (e.g. pollen, honey, brood and worker bees etc.) collection from the educted natural nests.
- Educt natural colonies only at places of minimum human interferences.
- Provide required nectar, pollen and water sources at the vicinity of stingless bee parent colonies.
- Monitor the predators, enemies attack on educted parent colonies of stingless bees.
- Create awareness on locally available resources for scientific studies instead destroying complete parent colonies.

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Table 1. Internal colony parameters and honey production potential of a daughter colony

Sl. No.	Parameters		Internal parts of nest		
			Brood cell	Honey pot	Pollen pot
1.	Location		Center	Periphery	Periphery
2.	Colour		Yellowish Brown	Dark Brown	Brown
3.	Shape		Oval	Oval	Oval
4.	Length (cm)	Range	0.2 to 0.4	0.9 to 1.5	1.1 to 1.3
		Mean	0.34 ± 0.06	1.22 ± 0.26	1.18 ± 0.06
5.	Width (cm)	Range	0.2 to 0.3	0.5 to 1.4	0.5 to 07
		Mean	0.25 ± 0.05	1.01 ± 0.32	0.65 ± 0.07

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6.	Diameter (cm)	Range	0.7 to 0.9	1.6 to 1.9	1.9 to 2.3
		Mean	0.82 ± 0.09	1.79 ± 0.09	2.13 ± 0.12
7.	Honey collected per honey pot (ml)	Range	-	0.09 to 0.13	-
		Mean	-	0.11 ± 0.01	-
8.	Honey Colour	-		Light Yellow	-
9.	Worker bees population size	200 to 400			

Note. Each value is a mean of 10 observations.

Fig 1. Map showing the study area in Mysore city

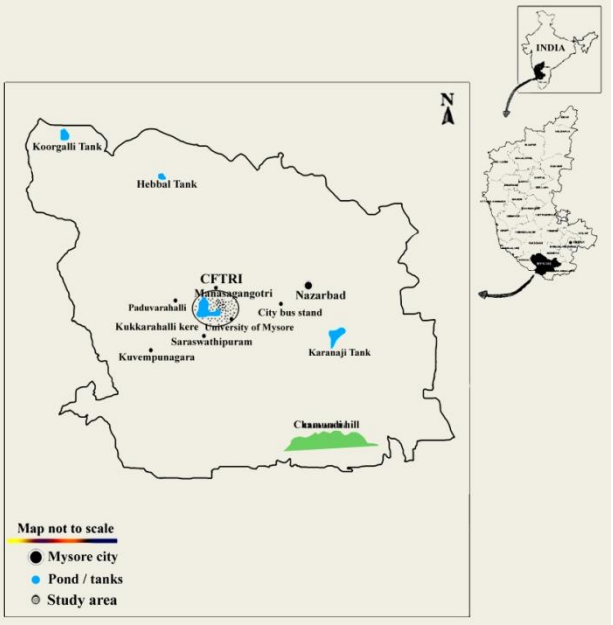

Fig 2. Map showing the study sites in Manasagangotri

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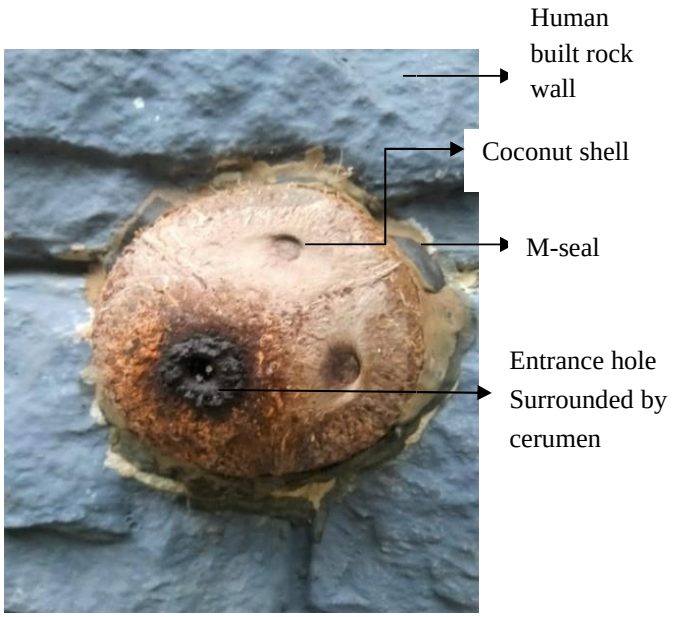

Fig. 3 Fixed coconut shell to the substratum using chemical adhesive

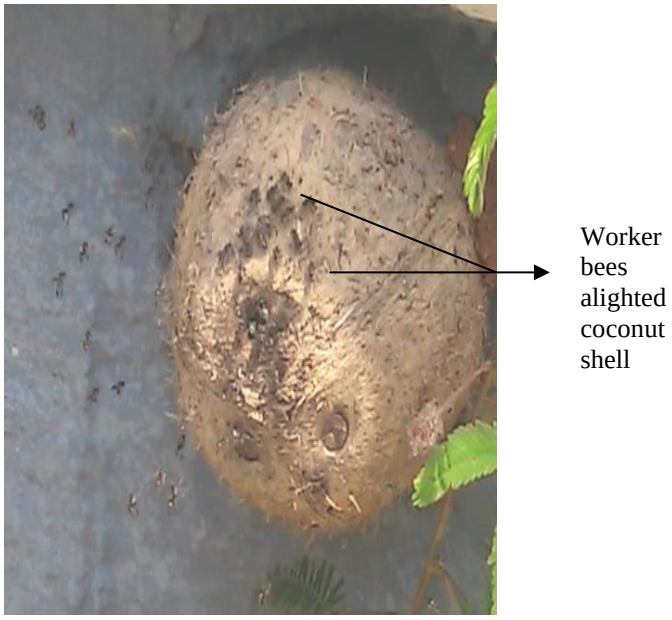

Fig. 4 Stingless worker bees on coconut shell

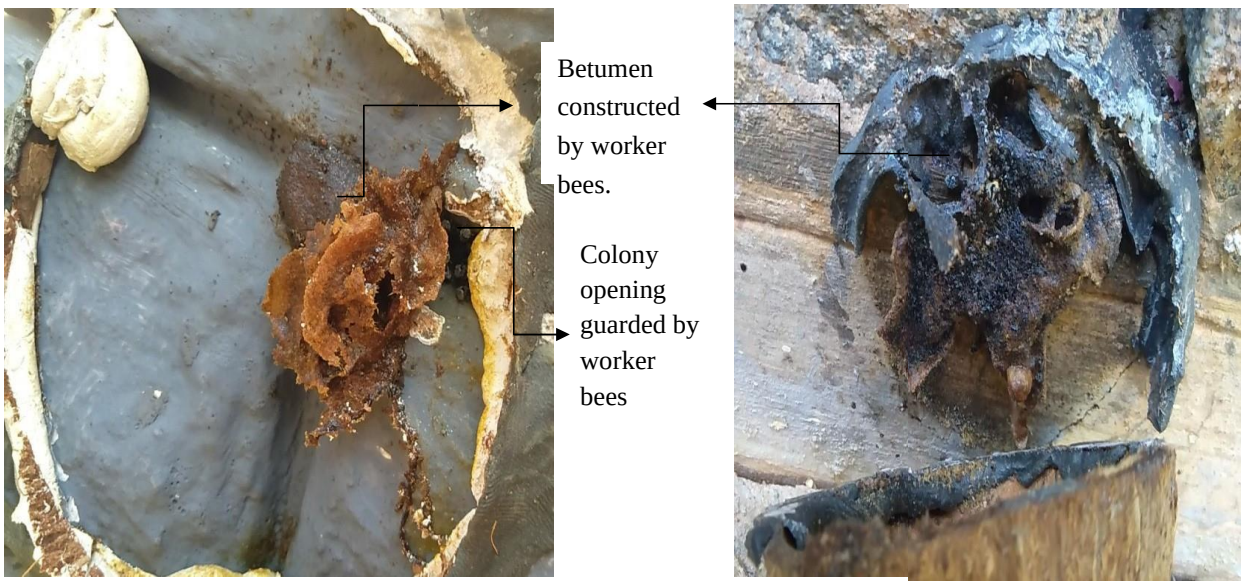

Fig. 5. Bitumen on the inner surface of coconut shell by stingless worker bees

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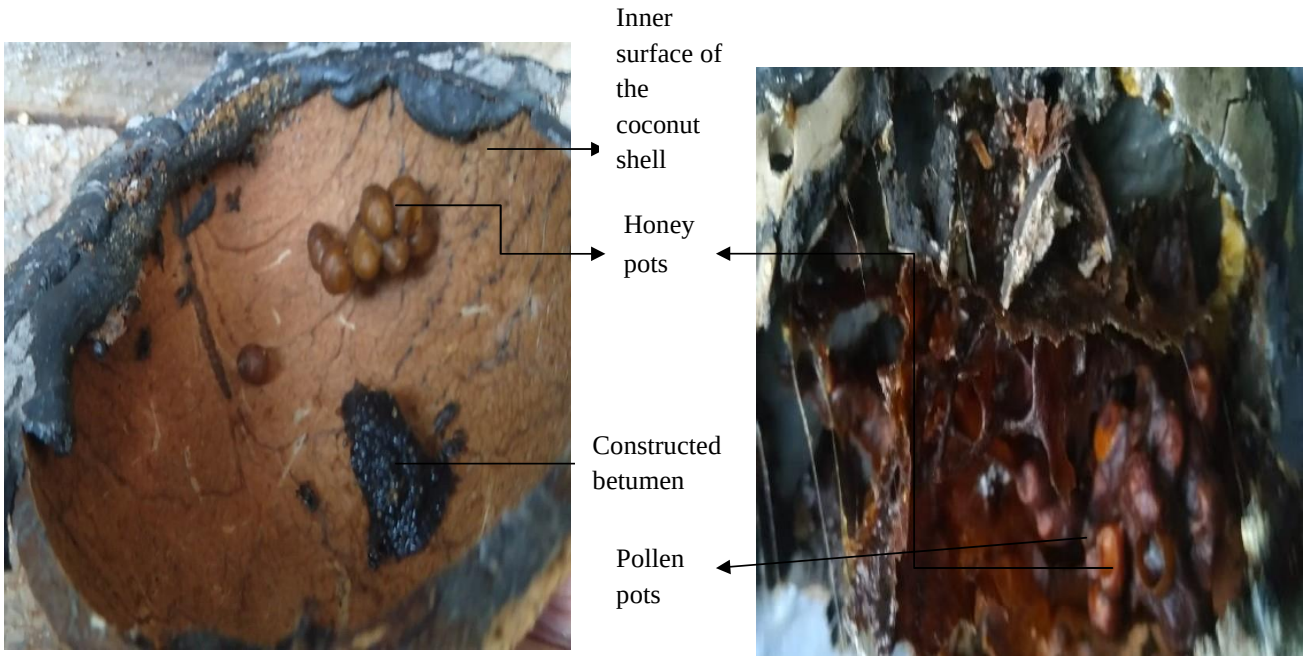

Fig. 6. Establishment of daughter colony inside the coconut shell by creating pollen pots and honey pots by stingless worker bees.

Fig. 7. Construction of daughter colony inside the coconut shell by stingless worker bees.

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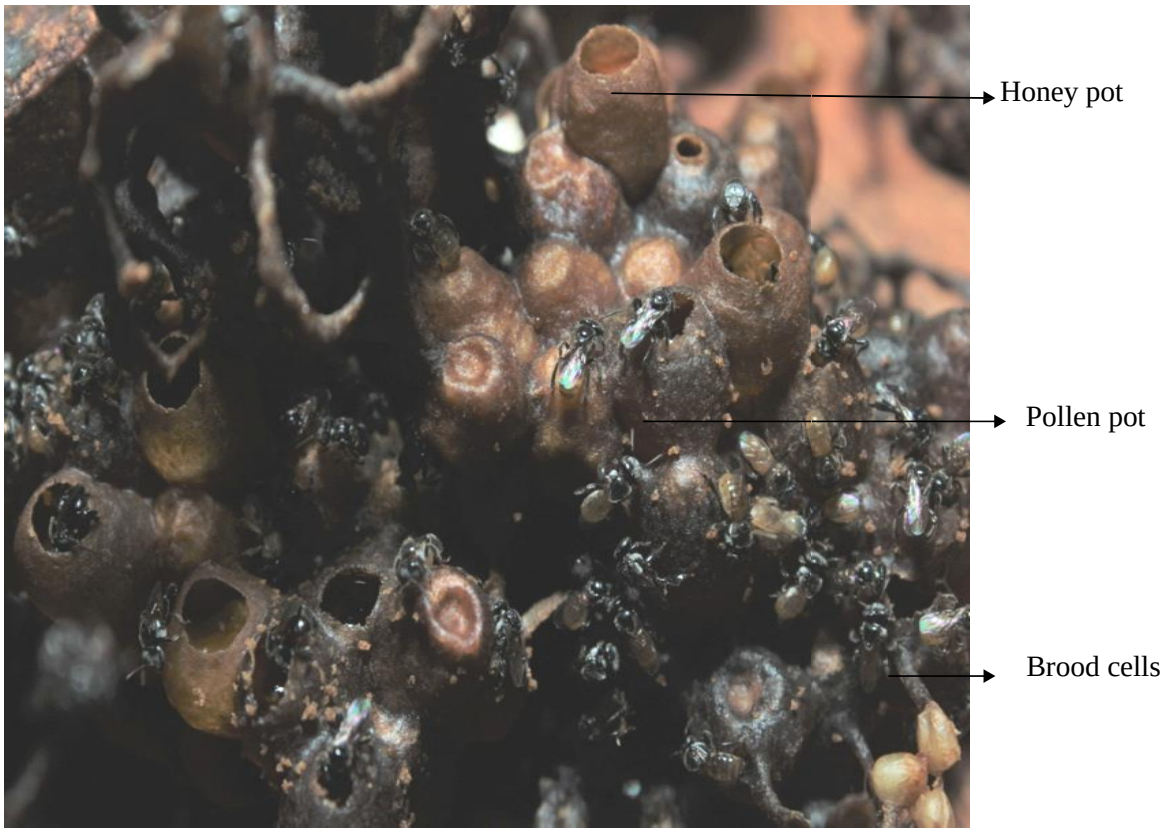

Fig. 8. Internal structure of stingless bee colony with honey pots, pollen pots and brood cells

Fig. 9. Stingless bee colony with queen and worker bees

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Fig. 10. Internal structure of stingless bee colony showing brood cells

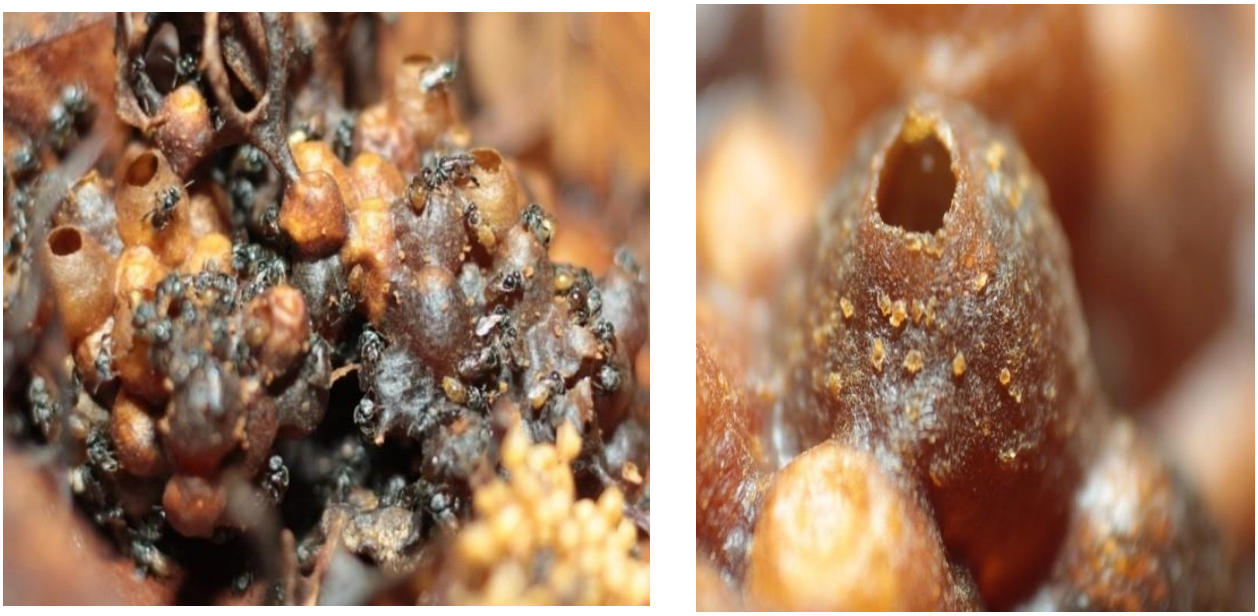

Fig. 11. Internal structure of stingless bee colony showing honey pots

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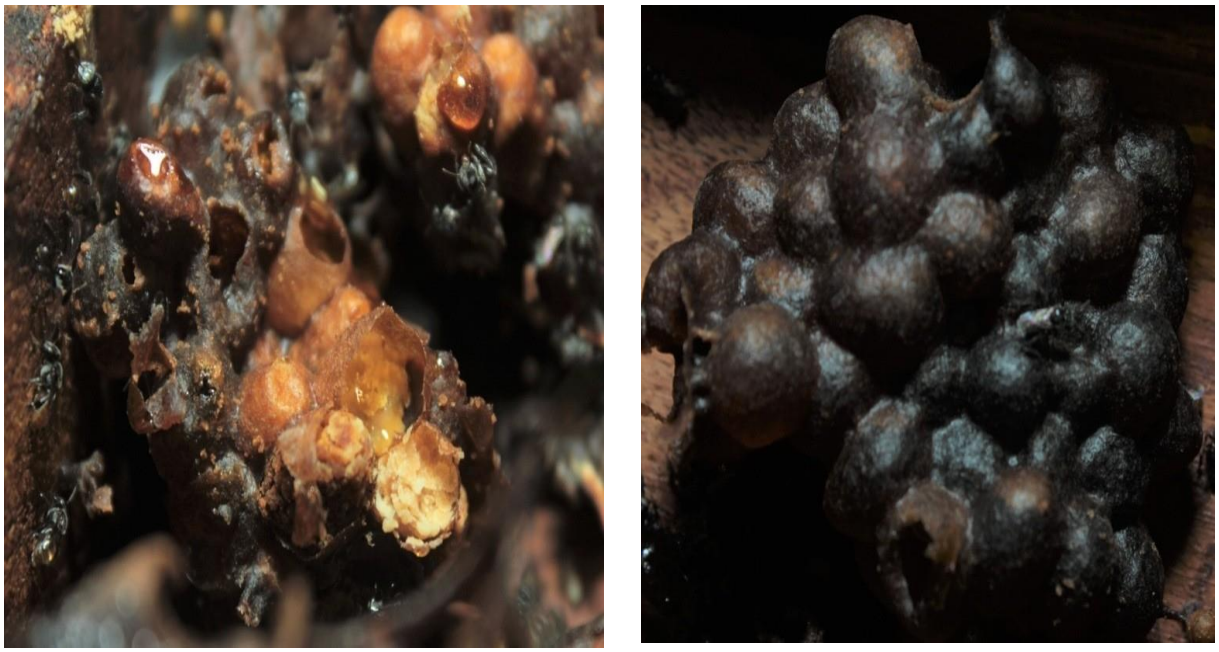

Fig. 12. Internal structure of stingless bee colony showing pollen pots

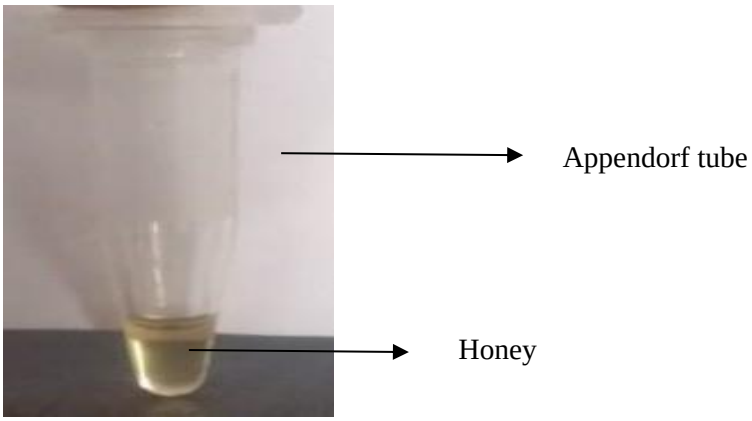

Fig. 13. Appendorf tube containing stingless bee honey from single honey pot