



Nest Architecture and Colony Characteristics of *Meliponula bocandei* (Hymenoptera, Apidae, Meliponini) in Cameroon

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Date of publication (dd/mm/yyyy): 29/11/2018

Abstract – There are several hundred species of stingless bees existing worldwide, which differ significantly in colour, body and colony size. In Africa stingless are distributed throughout the tropical and subtropical parts where they occur sympatrically with the honeybees. Stingless bees have evolved adaptive nest constructions strategies which have resulted in sophisticated nest architecture in many species while others lack certain structural components. *Meliponula bocandei* is one species of stingless bees with limited or no information on its nest biology. This study therefore is aimed at contributing to knowledge on the nest architecture and colony characteristics of *Meliponula bocandei*. Results of this study has revealed that this species can either nest in trees trunks or abandoned hollow bamboo hives in forests. 27 nests/colonies that have been recorded in the study area, 40% of which were found in the traditional hollow bamboo hives while 60% in tree trunks. The nest entrance of *Meliponula bocandei* ranged from 2–3 cm (2.5 ± 0.5 cm) in diameter with no external or internal entrance tube. A typical *Meliponula bocandei* nest is made up of a single hard brownish batumen lining which is about 2 mm thick and a nest diameter of about 30 cm. Transparent patches of sticky brown involucre sheets were found all over the brood area. The size of the brood area depends largely on the age and the strength of the colony. The height of a complete nest could be between 14–20 cm high and 15–22 cm wide. The cells of *Meliponula bocandei* are arranged in clusters with the older cells beneath while the newly constructed cells are found above. The storage pots have varied forms and shapes with a height and diameter of about 2.4 ± 0.5 mm. This study shows some similarities in the nest preferences and architecture of *M. bocandei* with other meliponula species like *M. ferruginea*. The above characteristics therefore can be useful in taxonomical, phylogenetic and ecological studies. Also, local stingless bee honey hunters can use the knowledge on the location of the honey pots to improve on their rudimentary harvesting methods without destroying the bees and the nests.

Keywords – Cameroon, Meliponini, Meliponula Bocandei, Nest Architecture and Stingless Bees.

I. INTRODUCTION

Several hundred of stingless bees (Meliponini) species exists all over the world. In Africa, 21 species of Meliponini have been listed and divided into six genera: Cleptotrigona, Dactylurina, Hypotrigona, Liotrigona, Meliponula and Plebeina (Eardley, 2004; Eardley et al., 2010). In Cameroon, six species of stingless bees grouped into four genera have been recorded (Njoya, 2009). Although Meliponini are present in savannahs, many species nest

mainly in forested areas. The forest species, such as *Meliponula beccarii* (Gribodo) and *Meliponula bocandei* (Spinola) nest on the ground or in trees (Kajobe, 2007a; Njoya, 2009). Other species, such as *Meliponula nebulata* (Smith), nest in the cavities of trees or in termite mounds (Brosset et al., 1967; Darchen, 1969; Kajobe, 2007a; Njoya, 2009). Central African countries have the highest reported diversity of Meliponini, with 17 species; 16 of these 17 species have been reported in Gabon (Fabre Anguilet, 2015).

Typically, a meliponine bee colony contains approximately 20,000 individuals, comprising of a single fertile queen, drones and workers. They pollinate approximately 90 crop species worldwide (Slaa et al., 2006; Abramson et al., 2007;). Stingless bees are known to be generalists with regards to selection of nesting sites. The majority of these bee species build their nests in either tree hollows, abandoned nests of other social insects (e, g ants, termites), which are both above- and below-ground environments (Roubik, 1990), thereby exhibiting a degree of plasticity in their nesting sites. The several hundreds of stingless bee species existing worldwide differ considerably in colony size, in body size and colour (Michener 2000). They also vary considerably in their nest architecture with different designs in brood cells arrangements. Brood cells are arranged in horizontal or vertical combs, semi combs or in clustered cells. The elaboration of their nest entrance is generally species specific. Kajobe & Roubik (2006) affirms that attributes of the nests are useful in taxonomic studies especially in equatorial tropical Africa where little has been studied. Some previous studies on nest biology of stingless bees have been carried out by Roubik (2006); Eltz et al. (2002); Slaa (2003); Kajobe & Roubik (2006).

Many species of stingless bees have evolved adaptive nest constructions strategies resulting in sophisticated nest architecture. For instance, a major component of stingless bees is the excellent insulation especially in exposed nests. This is because several of these species, particularly those of the moist tropics, are unable to withstand chilling temperatures in many species while others lack certain structural components (Michener, 2000). Nests in large tree trunks or in soils are particularly well insulated (Njoya 2016, 2017).

Threats to these social bees, which are related to diseases, parasites and habitat loss, have been reported worldwide (Jaffe et al., 2009; Van Der Zee et al., 2012). In Africa, there

is less scientific work that has been published on highly eusocial, especially for Meliponini, of which the taxonomy still must be clarified (Eardley et al., 2013).

Eardley (2013), one major difficulty is the uncertain taxonomy of specific Meliponini species, which would not facilitate the study of the diversity, biology, ecology, and other aspects of these insects.

This study therefore, is aimed at making contributions to the nest characteristics of *Meliponula bocandei* in the montane forests in abit to describe the nest architecture and colony characteristics of this species which can help in taxonomy studies.

II. MATERIALS AND METHODS

The North West Region in Cameroon is situated in the western highlands of Cameroon (Figure 1). The region

stretches from 6°20' North to 10°30' South. This study was done in Berabe, Ako, Maboua and Bafut from March to May, 2008 and February to April, 2017. Two colonies were studied in 2008 and two in 2017. A sample collection containing mounted *Meliponula bocandei* in a 12 cm X 12 cm styrofoam box was used as a guide and presented to farmers, beekeepers and hunters to facilitate recognition of the bees in the communities where the study was done. Nesting sites were found mainly from information provided by the hunters, farmers and beekeepers. Four nests of *M. bocandei* were studied for detail nest characteristics and measurements. The lateral part of the nest was excavated to measure the external part of the nest cavity and its depth measured using a measuring tape. Detail measurements some smaller parts in the nest cavities were done with a caliper.

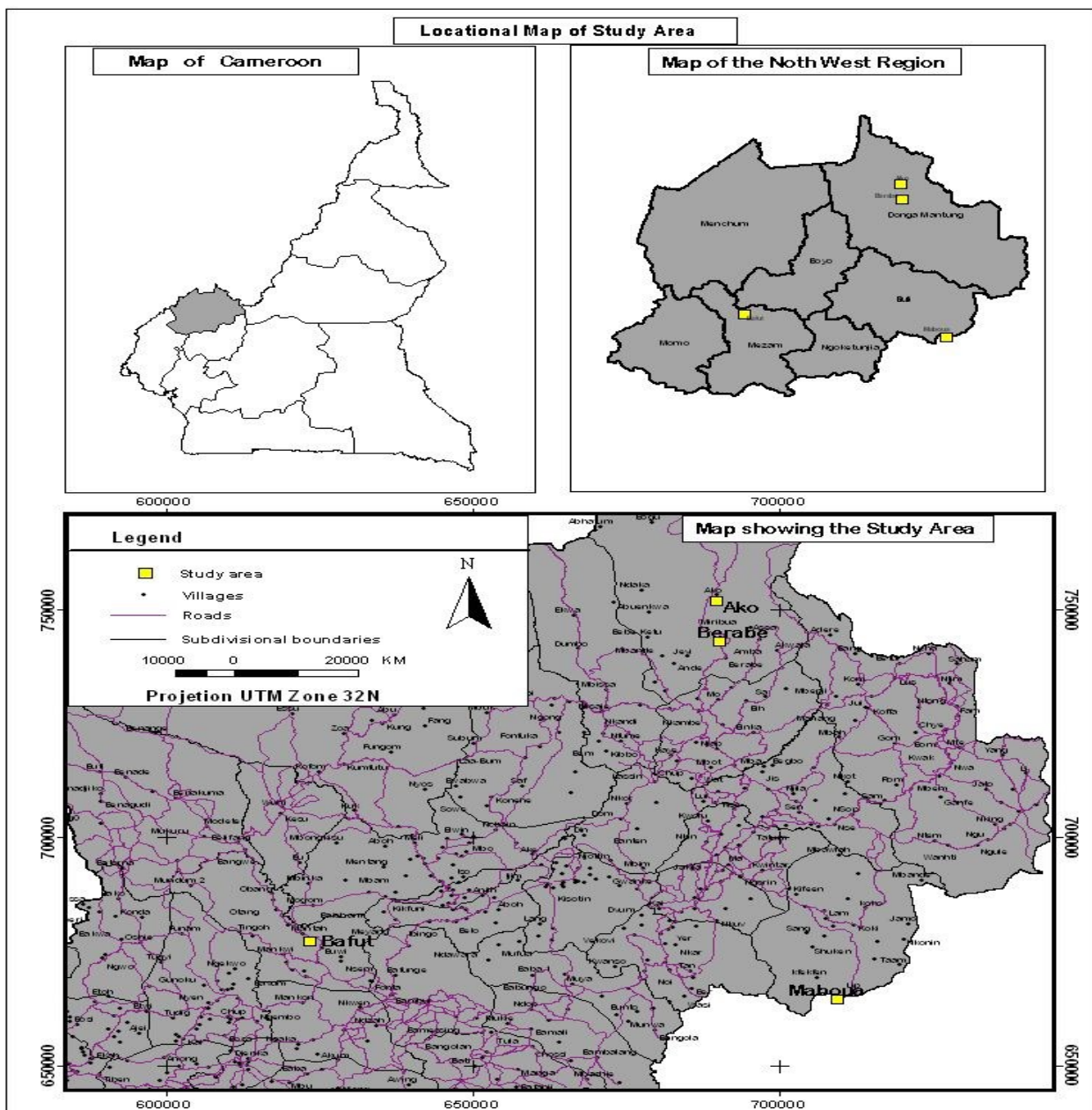


Fig. 1. Map showing the study area.
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 275

III. RESULTS

1.1. DENSITY OF *M. bocandei*

So far, 27 nests of *M. bocandei* have been recorded in seven localities in the North West Region of Cameroon. The localities are; Berabe (05 nests), Bafut (02 nests), Maboua (05 nests), Lip (03 nests), Ako (04 nests), Widikum (03 nests) and Befang (03 nests). The total surface area of all the localities where nests have been reported is 2415 Km² given a nest density of 0.011 nests. ha⁻¹ for *M. bocandei*. From the nest density, it is clear that these bees are very scarce and probably declining in population size.

1.2. NESTING SITES

Four colonies of *M. bocandei* were studied, two of which were in tree trunks in forests (Figure 2), while the other two colonies were discovered in traditional hollow hives (Figure 3). The exact nesting site preferences of *M. bocandei* remains a subject for further investigation. Some colonies have been reported in tree branches as well as in abandoned mud houses closer to the forest.



Fig. 1. Nest entrance on *Terminalia sp* trunk.

The two tree trunk nests that were studied were found in *Terminalia sp* (Combretaceae). The trees were located in the forest with very minimum human activities.

Meliponula bocandei construct their nests in tree trunks between 1.4m and 1.7m above the ground and in traditional hollow hives made of raphia bamboos (Pers. Obser.). The tree trunk nests were located on trees with circumferences of 124 cm and 145 cm respectively (Figure 1). The trees nests were found in only in the forested areas. The colonies in traditional hives attached their nests in particular areas inside in the traditional hollow hives where the nest cavity is protected with a batumen lining separating the nest from the rest of the unused area of hive. The *M. bocandei* nests occupied almost a third of the traditional hive (Figure 2).

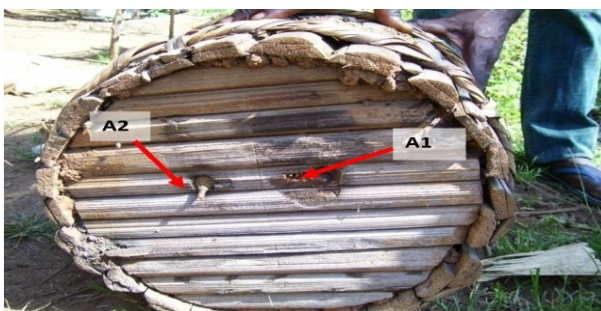


Fig. 2. Nest entrance of *Meliponula bocandei* and *Liotrigona bottegoi* in hollow hive: A₁ = nest entrance of *Meliponula bocandei*; B₂ = nest entrance of *Liotrigona bottegoi*.

Some stingless bees do practice living together in the same nests. This was the case of *M. bocandei* and *Liotrigona bottegoi* which were found in the same traditional hollow hive but their nest entrances were different from each other (Figure 2). *Liotrigona bottegoi* are very tiny stingless bees species with colony size of between 200 to 300 bees. They do not occupy much space thus can be confined to just one of the bamboos used in the construction of the hollow hive. The whole colony can fit comfortably in between a single portion of the raphia bamboo used in the hive construction. Species that live together can easily be distinguished from the shape and nature of their nest entrance. The nest entrance of *M. bocandei* do not have outward projections (Figure 3) meanwhile that of *Liotrigona bottegoi* always have 2-3 cm long external projection or tube (Figure 2).



Fig. 3. Nest entrance of *Meliponula bocandei* on a another traditional hollow hive.

1.3. Batumen Lining

The batumen lining is a thick hard brownish structure that protects the nest cavities from the external environment. It is made up of propolis and other plant materials.



Fig. 4. Batumen covering the outer part of the nest. Ba = Batumen, Bam-Bamboos used for the hive construction.

The whole nest of *Meliponula bocandei* occupied just about a third of the total area of a traditional hive. The entire colony inside the hive is protected all round by the batumen lining.



Fig. 5. Batumen lining covering the nest removed to reveal the brood area.

The batumen is very hard and made up of essentially propolis, leaves and soil. It could be as thick as 2 cm in some areas and as thin as 1cm in other places. The batumen is perforated with small holes which are very unevenly distributed and irregular in sizes.

4.3. Involucra sheets

The involucra sheets of *M. bocandei* are found in patches on the brood area. The sheets are sticky and apparently composed of wax and other plant substances. The arrangement of the patches is very discontinuous in the nests found in traditional hollow hives (Figure 6).



Fig. 6. Patches of Involucrum sheets found at some spots of the brood area.

The number of sheets could be up to 3 in some areas of the hive. The sheets are thin (1mm) and sticky and almost transparent. The patches are more visible in some areas than others.

4.4. Brood Area

The brood area is made up of cells where oviposition takes place as well as cells that are used as storage pots for honey and pollen. The cells in *M. bocandei* are arranged in clusters and are directly attached to each other with no pillar separating them (Figure 7).



Fig. 7. Old and new brood cells of *M. bocandei*. A = Older cells, B = Newly oviposited cells, C = cell under construction.

Older cells turn creamy and yellowish in colour as the wax layer of the cocoon is being removed by the workers while the new cells (both the cells under construction and newly oviposited cells) are brownish in colour (Figure 7). The cells are normally spherical in shape.



Fig. 8. Blocks of clustered cells.

The different blocks of clustered cells are grouped together in a very irregular manner with gaps in between the different blocks (Figure 8). Apparently the blocks of cells represents different batches according to queen ovipositioning. The older clusters were found beneath while the recent ones on top.

4.5. Storage Pots

Storage pots are cells that stores either pollen or honey for bees. The location of the pots within stingless bees varies with the species. A majority of the storage pots of *M. bocandei* were found underneath the brood area (Figure 10). However, a few isolated pots could be found at the sides of the brood (Figure 9). The storage pots generally had similar shape and size.



Fig. 9. Pollen and honey pots of *Meliponula bocandei*.



Fig. 10. *Meliponula bocandei* cohabiting with *Liotrigona bottegoi* in same hive A= storge pots of *M. bocandei*, B = Storage pots of *Liotrigona bottegoi*

Liotrigona bottegoi nested in the crevices of one of the bamboos used inside the construction the traditional hive while *Meliponula bocandei* occupied part of the inner hollow of the hive. These two species can live together with out any case of rubery or attacks on them (Figure 10).

The storage pots of *Liotrigona bottegoi* are much smaller than that of *M. bocandei*. It was equally noticed that both the brood cells and the storage cells of *L. bottegoi* were similar is size and always in single clusters.

IV. DEFENSE MECHANISM

The workers of *M. bocandei* as well as that of *L. bottegoi* were docile during manipulation. In very few instances, these bees were found entering body parts like the hairs and nostrils.

V. CONCLUSION

The nesting site preferences of *M. bocandei* are on tree trunks in forests as well as in traditional hollow bamboo hives placed in forests. For our studies, we selected two nests in tree trunks in forests as well as two nests in traditional bamboo hollow hives. The measurements of the various parameters are presented in Table 1.

Table 1. Summary of measurements taken for *Meliponula bocandei*.

| | Parameters measured | N ^o Sampled | Tree Nest | Tree Nest | Hive Nest | Hive Nest | Mean | SD | Variance | Shape | Colour |
|----------------|----------------------------------|------------------------|--------------------------|-----------|--------------------------|-----------|------|------|----------|--------------|-----------------------|
| Nest entrance | Height of external entrance (cm) | | | | | | | | | | |
| | Diameter of nest entrance (cm) | 4 | 2 | 2 | 2.5 | 3 | 2.5 | 0.5 | 0.25 | | |
| | Length of entrance tube (cm) | | | | | | | | | | |
| Nest cavity | Height of nest (cm) | 3 | 20 | | 25 | 23 | 22.7 | 2.51 | 6.33 | | |
| | Diameter of nest (cm) | 3 | 18 | | 17 | 22 | 19 | 2.65 | 7 | | |
| Batumen lining | Number of batumen | 1 | 1 | | 1 | 1 | | | | | Brown |
| | Thickness of batumen (cm) | 2 | 2 | | 2 | 2 | | | | | |
| Involucrum | Number of involucrum | | | | | | | | | | |
| | Thickness of involucrum(mm) | 5 | 1 | | 1 | 1 | | | | | Transparent brown |
| Brood cells | Height of cell (mm) | 30 | 3 (15) | | 2 (15) | | 2.5 | 0.51 | 0.26 | Spherical | Cream yellow or brown |
| | Diameter (mm) | 30 | 2(10) 3(5) | | 3(10) 2(5) 1.7(3) 2.7(3) | | 2.4 | 0.52 | 0.27 | | |
| Storage pots | Honey pot- height(mm) | 30 | 2(10) 3(5) | | 3(10) 2(5) | | 2.5 | 0.51 | 0.26 | Varied forms | Dark brown |
| | Honey pot - diameter (mm) | 30 | 3(10) 2(5) 1.7(3) 2.7(3) | | 3(10) 2(5) | | 2.4 | 0.52 | 0.27 | | |
| | Pollen pot- height(mm) | 30 | 2(10) 3(5) | | 3(10) 2(5) | | 2.5 | 0.51 | 0.26 | | |
| | Pollen pot - diameter (mm) | 30 | 2(10) 3(5) | | 3(10) 2(5) 1.7(3) 2.7(3) | | 2.4 | 0.52 | 0.27 | | |



The shape, color and rigidity of nest entrance of *M. bocandei* did not vary between colonies. Among the different characteristics measured, this species showed some particularities. Understanding the nesting preferences of such bees might not only help in conserving them but also to set up additional hives by providing the right kind of artificial nesting spaces. Given that these bees are important pollinators, making artificial hives could facilitate crop pollination and thereby enhance food security.

ACKNOWLEDGEMENT

The authors are very thankful to the hunters and beekeepers in the study area for their assistance in locating nesting sites of *M. bocandei* and to David Roubik for identification of the bees.

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