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# Note and record

## An African stingless bee *Plebeina hildebrandti* Friese nest size and design (Apidae, Meliponini)

Flora N. Namu[1]* and Dieter Wittmann[2]

[1]*School of Natural Resources and Environmental Studies, Karatina University, P.O. Box 1957, Karatina, 10101, Kenya and* [2]*Institut für Nutzpflanzenwissenschaften und Ressourcenschutz Lehr- und Forschungsbereich Ökologie der Kulturlandschaften – Tierökologie, Melbweg 42, Bonn, 53127*

## Introduction

The nesting of African stingless bees is little known. Meliponiculture is minimal and honey harvesting is destructive. Yet stingless bees provide hope for pollination services and honey production in the face of declining farm sizes due to human population increase and challenges in honeybee-keeping. To enhance stingless bees' conservation and sustainable utilization, we described *Plebeina hildebrandti* nests in Uganda. *P. hildebrandti* has many synonyms (Eardley, 2004), with nests described only in Tanzania and South Africa (Smith, 1954; Fletcher & Crewe, 1981). The basic nest structure has the following: entrance tube, nest cavity, batumen and involucrum layer, storage pots, brood combs and drainage tube.

## Material and methods

Ten nests of *P. hildebrandti* were dug from Macrotermitinae (*Macrotermes* sp. and *Odontotermes* sp.) mounds in Wakiso District, Kawanda Agricultural Research Institute farm, latitude 0° 22′ 39 N, longitude 32°, 32′11 E, altitude 1193 m. Kawanda receives 1218-mm annual rainfall. Measurements of nest entrance tubes, nest cavity, batumen layer, involucrum, storage pots, brood combs and drainage tubes were taken.

*Correspondence: E-mails fnamu@karatinauniversity.ac.ke or fnamu@yahoo.com

## Results: *Plebeina hildebrandti* nesting sites, nest size and design

*Plebeina hildebrandti* nests were found at the nursery part of inhabited termite mounds. Mounds occupied by bees were covered with vegetation and measured heights of 40–200 cm and diameters of 30–300 cm.

### *Nest entrance*

Entrance tubes had average diameter of 1.1 cm and lined with thin, 0.05- to 0.1-cm layer of resin. Entrances were either at the surface of the mounds or projected above with lengths of 0–25 cm. The entrances are made of cerumen and varied in concealment, firmness and perforations. Sticky droplets of resin on entrances trapped intruders. Inside the mounds, winding entrance tubes, lined with resin (length 43.5–120 cm), connected to the nest cavity. Tubes did not extend inside the cavity. Varying distances from nest cavity, a resin structure, 3–6 cm long and 0.5–3 cm wide were attached along the entrance tube (Fig. 1e).

### *Nest cavity*

All nest cavities (16.5–21.6 cm high and 6.5–7 cm wide) were within the nursery of the termite mound. Cavity walls had thin, 0.1- to 0.2-cm lining batumen.

### *Batumen and involucrum layers*

Batumen is made of a hard protective layer of propolis, which is constituted of resins, saps and gums, while involucrum, also called cerumen, is made of a soft layer of propolis (Wille & Michener, 1973). In two nests, there was no batumen layer; instead, pillars (length 1–8.8 cm, width 0.1–0.6 cm) projected directly from lining batumen on nest cavity walls to storage pots (Fig. 1b). In seven nests, the batumen layer surrounded storage pots only at the bottom of nest cavity, while on the sides' short horizontal pillars projected directly from lining batumen to storage pots. In another nest, batumen layer enclosed storage pots, with pillars absent (Fig. 1c). In colonies reared in wooden

 

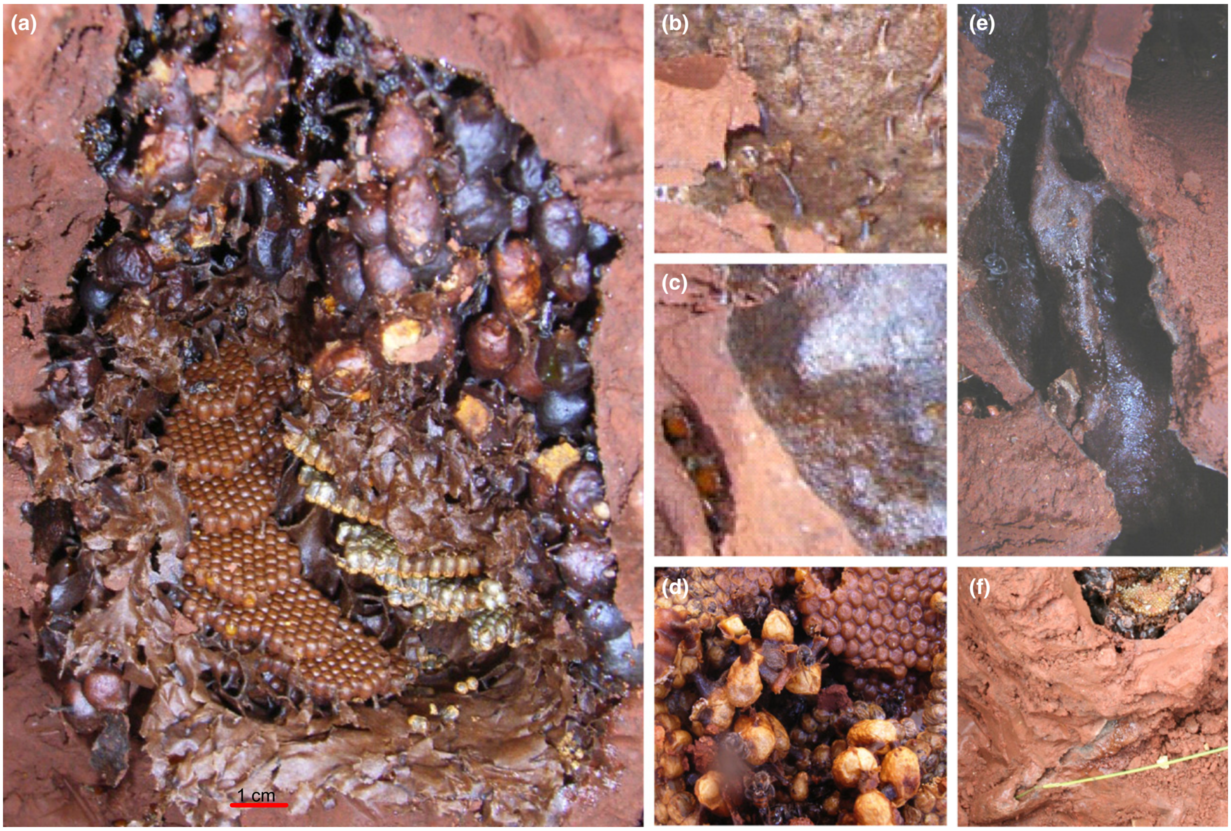


**Fig 1** *Plebeina hildebrandti* nest structure: (a) a layer of soft involucrum surrounds brood combs separating them from storage pots. Groups of pollen and nectar pots are interconnected by short pillars. Pillars also connect pots to lining batumen on the sides of the nest cavity, while at the bottom of the nest, a soft batumen layer separates the pots from lining batumen. (b) Pillars project directly from the lining batumen on walls of the nest cavity and connect to the storage pot. (c) A nest cavity with no pillars projecting from the lining batumen on the walls of the cavity. The nest had a soft batumen layer surrounding the storage pots on all sides. (d) Queen cells found at the rim of the cavity in the centre of the combs. (e) A resin structure found within the entrance tube. (f) A slanting drainage tube lined with thin layer of resin

hives, bees constructed laminate batumen round the nest with many pillars and connectives. In the excavated nests, a layer of involucrum separated brood combs from storage pots (Fig. 1a).

### *Storage pots*

Groups of pollen and nectar pots were interconnected by pillars measuring length 1.0–8.8 cm and width 0.1–0.6 cm (Fig. 1a). Pollen pots were ovoid (height 1.27 cm, SE = 0.04, n = 26; width 1.25 cm, SE = 0.04, n = 26), while nectar pots were spherical (height 1.24 cm, SE = 0.039, n = 5; width 1.37 cm, SE = 0.13, n = 5).

### *Brood combs*

Brood combs were horizontal, enclosed by involucrum sheet (Fig. 1a). Cells were 0.3–0.5 cm high and 0.2–0.3 cm wide. Each nest had six to twelve combs separated by short cerumen pillars (length 0.5–0.8 cm, width 0.1–0.6 cm). Comb diameter was 8–16 cm and thickness was 0.3–0.5 cm. There were spiral, trapezoidal, circular or both trapezoidal and circular combs in nests. Queen cells, 0.7–0.9 cm high and 0.5–0.6 cm wide, were found in the centre of the combs (Fig. 1d). There were thirteen queen cells in one nest. The number of brood cells per nest was 3300–3775, and the number of adult bees was 3091.

*Drainage tube*

All nests had resin-lined drainage tube (length 10–82 cm, width 1 cm), originating from the lowest point of nest cavity. The tube runs vertically below the nest before slanting or slanted directly from the nest cavity floor (Fig. 1f).

## Discussion and conclusion

*Plebeina hildebrandti* nested in the nursery part of an inhabited termite mound that shielded it. Nursery region has high moisture-absorbing capacity than the inner and the outer walls of the mound (Howse, 1970), enabling bees to dig and modify nest cavities. Moreover, the nursery part ensures stable microclimate as termite nests are enclosed systems (Krishnar & Weesner, 1970), with temperature maintained at 36°C and a minimum relative humidity of 96.2% (Howse, 1970).

Lining batumen waterproofs nest walls (Wille & Michener, 1973), preventing infiltration of moisture in or out. In addition to water from respiration and dehydration of nectar, a nest can have flooded rainwater and liquid waste. A drainage tube at the bottom of the bee nest gets rid of excess water that would otherwise accumulate (Smith, 1954; Wille & Michener, 1973; Camargo & Wittmann, 1989). The tube which is lined with resin ensures that water from the nest is conducted not only downwards but also sidewards through slanting. Hence, upward movement of water by capillary action when termite mound is heated up during high temperatures is prevented. However, further studies are required on the exact functional role of the drainage tube.

The bees constructed batumen layer to support, control microclimate and fill spaces within the nests as exemplified by construction of laminate batumen, pillars and connectives in colonies reared in hives. The absence of wax pillars between lining and batumen layer could reduce space enhancing insulation, while involucrum layer around brood combs protected brood cells and controlled microclimate within brood chamber. Similar findings have been reported by Fletcher & Crewe (1981), Roubik & Peralta (1983), Engels, Rosenkranz & Engels (1995) and Roubik (2006). 'Fletcher & Crewe (1981) and Engels, Rosenkranz & Engels (1995) reported that variations in construction of brood combs were an adaptation to conserve or dissipate heat'. We report that variations in comb construction could also be adaptations to fit different cavity shapes and sizes. However, 'Franck *et al.* (2004) reported that nest construction is a species specific trait that can support identification of species'. Due to the various nest architecture observed, *Plebeina hildebrandti* requires further nest descriptions and taxonomic re-examination in Africa.

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