NEST ARCHITECTURE OF THE STINGLESS BEE *PLEBEIA POECILOCHROA* MOURE & CAMARGO, 1993 AND RELATED CONSIDERATIONS (HYMENOPTERA, APIDAE, MELIPONINAE)[1]

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ABSTRACT

Nests of *Plebeia poecilochroa* Moure & Camargo, 1993 were collected from hollows in house walls and earth banks in Guarapari, Espírito Santo, Brazil. The nest entrance is a small circular hole, surrounded by dark resin and with no outer tube. The brood cells are arranged in regular horizontal combs (sometimes in spirals), and are not surrounded by an involucrum. Numerous pillars connect the brood combs to each other, to lateral parts of the nest and to the storage pots. Observations under laboratory conditions on the behavior of the virgin queen and swarming are also reported.

KEYWORDS. Hymenoptera, Apidae, Meliponinae, virgin queens, nest structures.

INTRODUCTION

The genus *Plebeia* Schwarz, 1938 (s. str.) contains about 27 described species (CAMARGO, 1989) and the nest architecture of 11 species has been reported: *P. domiciliorum* Friese, 1900; *P. droryana* Friese, 1900; *P. emerina* Friese, 1900; *P. frontalis* Friese, 1911; *P. minima* Gribodo, 1893; *P. molesta* Puls, 1869; *P. mosquito* Smith, 1863; *P. remota* Holmberg, 1903; *P. tica* Wille, 1969 (original data or references in WILLE & MICHENER, 1973); *P. julianii* Moure, 1962 (JULIANI, 1967) and *P. wittmanni* Moure & Camargo, 1989 (WITTMANN, 1989). Nests of these bees have the architecture found in other stingless bees, but by the brood cells arrangement, they can be separated in two groups, one containing the cluster-makers (*P. domiciliorum, P. minima*, and *P. tica*) and the other, the comb-makers. Further differences can be found when the nests are observed and described carefully, and this makes the sum of the characteristics of nest architecture an important source of taxonomic traits.

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This paper describes the nesting biology of *Plebeia poecilochroa*, a species recently described from the state of Espírito Santo, Brazil (MOURE & CAMARGO, 1993).

MATERIAL AND METHODS

Four nests were collected in Guarapari (20º40'S; 40º28'W), Espírito Santo, Brazil, on 6 and 7, September, 1990 (nests 40, 41, 42) and January, 1992 (nest 70). The nests were transferred to wooden boxes observed at the bee laboratory and voucher specimens were deposited in the collection of João Maria Franco de Camargo (Faculdade de Filosofia, Ciências e Letras de Ribeirão Preto, Universidade de São Paulo, Ribeirão Preto, São Paulo, Brazil). The following structures were measured and described: nest entrance, brood cells, pollen and honey pots, resin and waste stores, pillars of cerumen and the virgin queen imprisonment chamber.

RESULTS

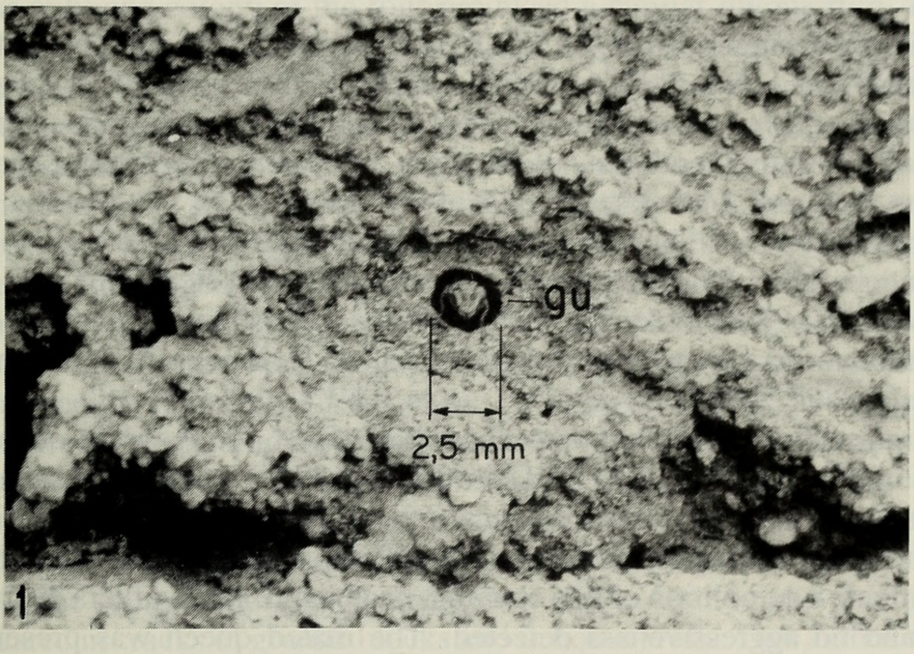
Nests 40, 41 and 70 were in walls of buildings in the city. Nest 40 was removed from a mud brick in a wall in the center of the city; nest 41 occupied the inner cavity of a cement brick (figs. 1, 2); nest 70 was in a hollow within a cement wall. Nest 42 was removed from an abandoned ant-chamber in a bank along a path in a small forested area near the city. In two days of observations in Guarapari, we found 10 additional nests, all downtown in walls of inhabited houses.

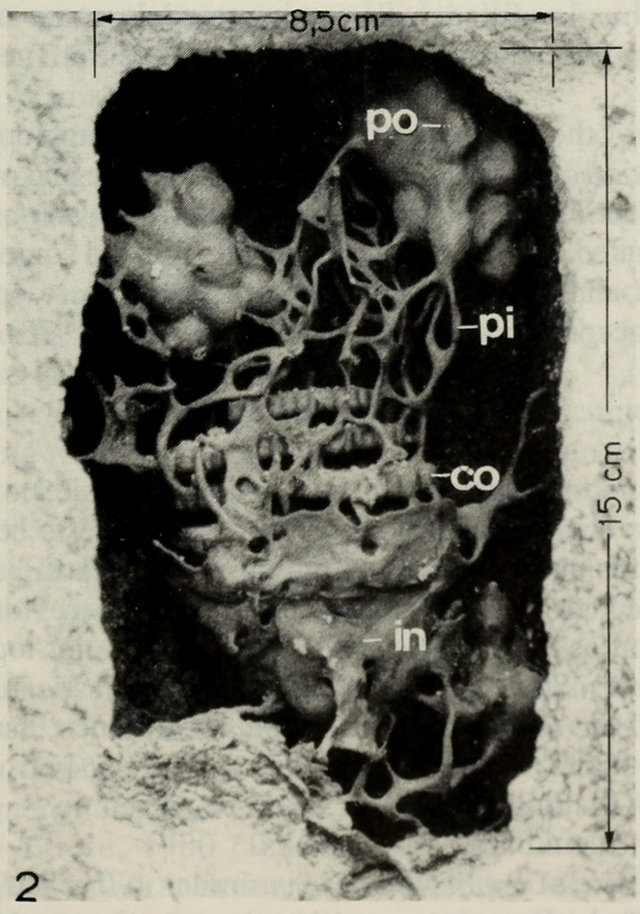
Under natural conditions, the outer entrance was a simple hole, 2.5 mm in diameter, not extending outside, and surrounded by dark resin, allowing space for only one guard bee (fig. 1). In the laboratory, a transparent plastic tube (diameter, 12mm) was used to connect the nests to the external environment. The entrance of the tube was narrowed by the workers to a central hole with 3mm in diameter. As under natural conditions, this narrowing was by means of a black resin wall. In the colonies under laboratory conditions, this small entrance was closed at night with a fine partition of perforated resin, probably mixed with small amounts of other material.

There was a rigid entrance tunnel of black resin within the nest cavity of all nests, terminating in the storage pot area. Between the entrance and the brood chamber, there were pollen and nectar pots. The pollen and nectar pots were homomorphous and oval (each one being about 1cm in diameter and 1.5cm long). The cavity occupied by nest 41 was an regular parallepiped (about 15cm long, 8.5cm wide and 5.0 cm deep), and was completely filled by the storage pots and the brood cells. The nests in narrow and irregular cavities (40 and 70) had additional storage pots behind the comb area. In the nests under natural conditions, the cavity walls were covered with a black resin layer, similar to that forming the entrance tunnel.

The brood cells were arranged in regular horizontal combs or in spirals (nest 70, under laboratory conditions). In all the nests, there was no involucrum covering the combs, except for a simple layer covering the lower half of the brood combs in nest 41. In nest 40 there were two combs, eight in nest 41, only the upper one bearing newly built cells, and six in nest 42 and under laboratory conditions a maximum of six combs. Also, there was no involucrum covering the brood chamber (nests 40, 42 and 70) and the nests as a whole had no involucrum. However, nest 41 continued to have one sheet of thick cerumen surrounding the brood area with pupae. The growth of the brood combs was concentric in the beginning, but further, shifted toward lateral growth.

The brood cells were elongate, the male and worker ones being about 2mm in





Figs. 1-2. Nest of *Plebeia poecilochroa* Moure & Camargo, 1993 (nest 41); 1, outer entrance; 2, nest architecture. Abbreviations: co, combs, gu, guard bee; in, involucrum; pi, pilars; po, pollen and nectar pots.

diameter and 4mm height and the royal cell (nest 41) about 3mm in diameter and 8.5mm long.

Both in the laboratory and the field, each nest had only one resin storage area, always located at the bottom of the nest cavity, and 3-4 dumping places localized in the lateral floor under the brood combs. All nests had numerous pillars connecting the brood combs to each other, to lateral parts of the nests and to the storage pots. Similar pillars connected the food pots to the lateral walls of the nests.

Two nests kept in laboratory (nests 42 and 70) had one oval virgin queen imprisonment chamber, constructed with cerumen and connected to the wall of the hive. They were as dark as the old combs. In nest 70 this imprisonment chamber had a small hole where the workers frequently inserted their heads. In nest 42, the imprisonment chamber was always closed.

Some aspects of swarming were observed in nest 70. A virgin queen was seen inside of the imprisonment chamber on February 4, 1992. We also noted a large number of males in all colonies of *P. poecilochroa*. On February 6 a virgin queen was observed walking in the colony, probably the same virgin queen seen in the imprisonment chamber since on February 7 demolition of this chamber had begun. The workers did not court the new queen and no aggressiveness detected. The mated queen was present, and had interrupted her oviposition. On February 7, some workers were observed leaving the colony with their corbiculae filled with cerumen and in some cases with distended abdomens. On February 27 a new nest was found 40 meters from nest 70 inside a cement block.

We did not record the presence of male and worker agglomerations around the nest. The final observation of nest 70 was on March 31 and the end of swarming probably was on March 28. On April 24 the new nest was transferred to an observation hive. It had four brood combs, a mated queen, some food pots, resin, and some workers.

Bees were timid and non-agressive when the nests were opened. This reaction corresponds to type 1 according to WILLE & MICHENER (1973).

DISCUSSION

Our data do not permit conclusions about the nesting sites of *P. poecilochroa* in natural situations. One of us (GARM) has collected five nests before this study, two within house walls in the city and three within burrows in earth bank in the same area where nest 42 was collected. These data could be considered as evidence that this species uses burrows in the soil as nesting sites. However, we did not look for nests in other substrates, like tree trunks. Some species are known to be plastic in selection of the nest substrate. *Tetragonisca angustula* Latreille, 1811, for instance, usually nidifies in tree cavities, but also can be found nesting in man-made walls and in burrows in banks (WILLE & MICHENER, 1973). A similar behaviour could be present in *P. poecilochroa*, which under natural conditions could nest in tree trunks.

The nest architecture of *P. poecilochroa* is similar to that of *P. remota* (WILLE & MICHENER, 1973; V. L. I. - Fonseca personal communication) and *P. julianii* (JULIANI, 1967) in which the nests include a pile of horizontal combs, generally not surrounded by sheets of cerumen forming an involucrum. However, an involucrum formed by one or two thicker layers of cerumen is sometimes constructed mainly in autumn, close to the combs with pupae in *P. remota* (V. L. I. - Fonseca, personal communication). In *P. poecilochroa* only one colony of the four produced a similar involucrum. The workers constructed an irregular small, thick involucrum of cerumen surrounding about 3/4 of the comb with pupae. The nests of these three species present numerous pillars of cerumen connecting the storage pots with brood combs, and the latter with each other and the walls of the nest (JULIANI, 1967; V. L. I. - Fonseca, personal communication).

The involucrum is absent in the nests of nearly all species that arrange brood cells in cluster, presumably as an adaptation to nesting in restricted cavities, but is present (one layer, sometimes incomplete) in *Austroplebleia australis* Friese, 1898 and in the related *A. cincta* Mocsáry **in** Friese, 1898 from Australia (MICHENER, 1961). The involucrum is sometimes absent in some species that arrange cells in combs, but this absence is not necessarily a specific character (KERR **et al.** 1967; CAMARGO, 1970). In most cases where a nest of a comb-making meliponine is known to lack an involucrum, other nests of the same species have the involucrum (WILLE & MICHENER, 1973).

According to WITTMANN (1989) in nests of *Plebleia wittmanni* Moure & Camargo, 1989 the brood is not surrounded by an involucrum. This combmaker species is restricted to the southeastern region of the State of Rio Grande do Sul (Brazil), and its nests are situated in cracks of granite blocks and in house walls. That author suggests that the high thermal capacity of granite, where this species prefers to nest, may keep the temperature inside the nest rather constant and independent from short term changes in ambient temperature. The absence of an involucrum in this species is probably an adaptation to the use of small cavities as nesting substrate.

A more general function commonly postulated for the laminate batumen and involucrum is protection against temperature fluctuations. WILLE & MICHENER (1973) suggest that this seems probable, specially when layers are numerous. This point of view is supported by numerous enveloping sheets characteristic of exposed nests (except for those of some *Paratrigona* Schwarz, 1938 in partially shaded places). The total thickness is greatest on the upper part of the nest, as in *Trigona corvina* Cockerell, 1912, supporting the idea that the layers is important for insulation.

Regarding *P. poecilochroa*, it is difficult to suggest any temperature control because the observations during winter were carried out in observation hives heated to 28ºC, and in this case, the workers did not stop construction. Perhaps under natural conditions, the nesting places are selected according to their protection from temperature fluctuations, and it is also possible that the nest cavities are small enough to allow the bees to regulate the internal temperature of the nest. Guarapari is situated on the coast and has a mild climate.

The imprisonment of virgin queens of *P. poecilochroa* in oval chambers made mainly with dark cerumen were also found in *Tetragonisca angustula* (JULIANI, 1962), *Plebeia droryana* (JULIANI, 1962), *P. emerina* (MOURE **et al.**, 1958), *P. julianii* (JULIANI, 1962; 1967), *P. remota* (JULIANI, 1962; IMPERATRIZ-FONSECA **et al.** 1975), *Friesella schrottkyi* Friese, 1900 (JULIANI, 1962; CAMILLO-ATIQUE, 1977), *Schwarziana quadripunctata* Lepeletier, 1836 (CAMARGO, 1974; V. L. I. - Fonseca personal communication) and in *Frieseomellita varia* Lepeletier, 1836 (TERADA, 1972).

In *T. angustula* the chambers can be round-shaped or elongated (JULIANI, 1962). In *P. droryana* the chambers have various shapes, and in some cases this species uses empty or partially built food pots as virgin queen imprisonment chamber; in other cases, when they are constructed, the chamber is gourd-shaped (JULIANI, 1962). In *P. julianii* the virgin queen imprisonment chambers are made close to storage pots or between the brood combs. The virgin queens stay recluse inside of the imprisonment chambers for variable periods (4 months, 79 days, 14 days or only 1 day). When the imprisoned virgin queen dies the chamber is demolished (JULIANI, 1967).

IMPERATRIZ-FONSECA **et al.** (1975) found three chambers in one colony of *P. remota*. They also observed trophallaxis between virgin queens and workers and in some cases there was aggressiveness by the virgin queens toward workers. In one colony of *F. schrottkyi* observed by CAMILLO-ATIQUE (1977), the virgin queen imprisonment chambers were built on the bottom of the colony. The virgin queen stayed inside the chamber and was kept by five to eight workers. The chamber had one or two holes that sometimes could be closed. After 10 days the queen was killed by the workers. In *S. quadripunctata*, V. L. I. - Fonseca (personal commnication) found in a single colony two gynes of different sizes imprisoned. She also reported that the chambers were demolished, probably when swarming occurred.

According to TERADA (1972), in *F. varia* the virgin queens expel any worker who tries to stay close to the chambers. In this case, the workers maintain the chamber which protects the virgin queen against aggressive workers and the mated queen.

In all species mentioned above the chambers have small holes to feed the virgin queens, and in most cases such virgin queen imprisonment chambers are built before swarming or when the mated queen is replaced by a new one.

Some virgin queens can be killed by the workers with pellets of resin, probably when these queens are in excess. According to SAKAGAMI (1982) in *Frieseomelitta varia* about twenty nurse-age workers encircling the prison do not allow the approach of other aggressive workers or of the mother queen to the prison. These paradoxal attitudes of workers to virgins are possibly governed by two antagonistic tendencies: aggression toward virgins and security for reserve queens, although precise motivational analysis has not been performed.

We were not able to observe the details of the swarming process in *P. poecilochroa*. The virgin queen imprisonment chamber was built before the swarm departed. The relationship between the new nest and the mother nest (at least 51 days), a relatively long time, as in some other species observed by NOGUEIRA-NETO (1954) [for instance, *Tetragonisca angustula* (67 days), and *Melipona favosa orbignyi* Guérin 1844, (about 5 months)]. V.L.I. - Fonseca (personal communication) reports that in *Schwarziana quadripunctata* this period was 76 days. Shorter periods were found in *Plebeia mosquito* (26 days) and *Friesella schrottkyi* (22 days) by NOGUEIRA-NETO (1954), in *Frieseomelitta varia* (2-3 days) by TERADA (1972), and in *Tetragonula laeviceps* Smith, 1857 (about 7 days) by INOUE **et al.** (1984). It is possible that this period varies according to the species and is dependent on the strength of the mother colony. More information is needed to clarify this question.

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