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The bamboo-nesting carpenter bee, *Xylocopa (Stenoxylocopa) artifex* Smith (Hymenoptera: Apidae), also nests in fibrous branches of *Vellozia* (Velloziaceae)

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Abstract

Previous nest records and unusually modified mandibles of females have led workers to suggest that large carpenter bees (genus *Xylocopa*) in the subgenus *Stenoxylocopa* obligatory nest in bamboo and related plants with hollow stems. This paper reports the use of non-hollow substrate for nesting by one species in that subgenus. Nests found in the fibrous branches of *Vellozia* spp. (Velloziaceae) are described from two different sites. These nests are compared with those constructed in the hollow stems of bamboo that have been previously described. The data presented here do not support the hypothesis that geographical distributions of *Stenoxylocopa* are largely defined by the availability of hollow culms.

Keywords: Carpenter Bee, Nest, *Xylocopa, Stenoxylocopa,* Apidae, Bionomy, *Vellozia,* Neotropics.

Introduction

All species of *Xylocopa* excavate their nests in plants, except for those in the subgenus *Proxylocopa*, an Old World group that construct their nests in the ground. In general, sound dead wood is used, although some species use decayed or rotten wood (Hurd, 1958). Less common are those *Xylocopa* that nest in hollow stems of plants (Hurd, 1958, 1978; Hurd & Moure, 1960, 1963). It has been suggested that, for these species, the extra effort expended to perforate the smooth and hard surface of the culms of bamboo and related plants is subsequently compensated, since females are exempted to dig galleries inside the stems *(e.g.* Maeta et al., 1996). Species of one oriental subgenus, *Biluna*, nest exclusively in bamboo (*e.g.* Hurd & Moure, 1960, Maeta et al., 1985, Maeta et al., 1996). Among neotropical *Xylocopa*, some species in the subgenera *Neoxylocopa* and *Schonnherria* nest in wood or the hollow culms of bamboo and closely related plants (Hurd & Moure, 1963; Hurd, 1978). It was also thought that species in the subgenus *Stenoxylocopa*, and possibly *X*. (*Xylocospila*) *bambusae* nest only in bamboo and related Bambusoideae (Hurd & Moure, 1960; Sakagami & Laroca, 1971; Hurd, 1978).

Female *Stenoxylocopa* have an unusually expanded apical tooth on the mandible that Hurd & Moure (1960) and Hurd (1978) considered to be structures adapted to rasp entrance holes into the hollow culms of bamboo and for scraping the interior walls for material to make cell partitions. All of the nests they located were constructed in bamboo. They also suggested that construction of nests by these bees in other kinds of wood was precluded by mandible morphology and that the geographic range of the species of *Stenoxylocopa* was determined largely by the availability of hollow culm substrate.

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Here, two nests of *Xylocopa (Stenoxylocopa) artifex* Smith, excavated in fibrous branches of species of *Vellozia* (Velloziaceae), are described.

Material and methods

Nesting sites. The nests described below were found at two sites about 250 km apart. One at 1400 m (18°07'19" S and 43°00'34" W) at 'Serra do Ambrósio', a mountain range in the municipality of Itamarandiba, northeast Minas Gerais state, Brazil, and the other at 1450 m (20°05'36" S, 43°59'00" W) at Serra da Calçada (part of the mountain range called the 'Serra da Moeda'), in the municipality of Brumadinho, southern Minas Gerais.

The climate at both sites is subtropical and moderately humid, with mean annual temperatures between 17°C and 18.5°C and mean annual precipitation between 1450 mm and 1800 mm (Golfari, 1975). Dominant vegetation at both sites is the 'campo rupestre'; a prairie to chaparral-like vegetation that develops on poor, rocky soils above 1000 m, on the mountain chains and plateaus of eastern Brazil.

Nesting substrate. At the 'campos rupestres', few plants other than *Vellozia* spp. reach diameters wide enough to offer adequate nesting substrate for females of *Xylocopa*. Additional nesting sites would be trees growing in the 'cerrados' and forests at the borders and, sometimes, in patches (mostly riparian areas) inside the 'campos rupestres'.

Leaves of *Vellozia* are hard and long with persistent bases that are densely arranged in spirals around the soft branch (Joly, 1979). Living leaves are generally concentrated in the apex of the plants. Their bases create a thick fibrous layer around the branch, which remains after the leaf senesces. This layer is constantly thickened by the addition of adventitious roots that are continuously produced and glued together along the branches and stem. Use of branches of *Vellozia* as a nesting substrate was

observed at Serra do Cipó (Santana do Riacho, Minas Gerais State, Brazil) for *Megachile* and *Centris* (Faria, 1994). Matias & Braga (1995), discussing the pollination biology of an orchid species, incidentally mentioned that *Xylocopa artifex* also nested in such substrate.

Voucher specimens. All bees and nests mentioned below are deposited in the entomological collection of the Department of Zoology and vouchers of *Vellozia compacta* are deposited at the herbarium of the Department of Botany (BHCB), both at the Universidade Federal de Minas Gerais.

Results

The nest at Serra do Ambrósio was found on January 13, 1998, in a dead inclined branch of an unidentified species of *Vellozia*. The branch containing the nest was collected and, over the next two days, an adult female and a young adult male (based on lack of wing wear) were collected in a plastic bag placed over the nest entrance. Upon opening the nest, a teneral female, still unable to fly, was found inside.

The nest consisted of two slightly arched galleries that ran parallel to the long axis of the branch (Fig. 1A). These galleries were excavated in the fibrous layer of the branch, the dead soft internal tissues being intact. The entrance was cut in the underside of the branch, across its fibers, at about 60 cm from the plant base and 30 cm above the soil surface. The diameter of the branch at the entrance was 6.5 cm. The entrance was an elliptical opening, longest longitudinally, 1.0 cm 0.8 cm, connecting through a 0.8 cm long tunnel to the exact middle of the first gallery of the nest. The entrance tunnel widened towards the interior of the nest. The diameter of the internal galleries was 1.1 cm; the first one was 14.0 cm long and the second, 5.7 cm long. Inner walls were all smooth, with no obvious lining.

Remains of three cells (cell casts – 1.3 cm long each) in the bottom of the first gallery could be discerned by the remains of their partitions. It is not clear whether these old cells had housed individuals that have emerged just before the nest was found or whether they were constructed by adult females from previous generations. Two pupae and a teneral female were found in this portion of the gallery. One of the pupae (a male) emerged in the laboratory two weeks later. No evidence of cells was found in the opposite end of this gallery. A hole in the wall of the first gallery, opposite to and just above the nest entrance, gave access to the second gallery, which also contained three cells. The two apical (top) cells (1.3 cm long each) were separated by the marginal remains of a cell partition; together they measured 2.7 cm, and were occupied by a single pupa. The third cell, with its partitions still intact, also contained a pupa. Partitions were made of sawdust cemented by the bee into a 0.1-0.2 cm thick, soft cardboard-like layer. They were almost flat, rough, with a spiral pattern inside the cell and concave and smooth outside it.

The nest at Serra da Calçada was found on May 16, 1998 and collected on May 23 in a dead branch of *Vellozia compacta* Mart. & Schult. & Schult. f. It contained only one gallery with a single female. Contrary to the nest described above, this one was excavated in the soft mid-portion of the branch, instead of in the fibrous layer (Fig. 1B). The entrance was also cut in the underside of the branch, 14 cm away from its base and 88 cm above soil level. Branch diameter at the entrance was only 3.5 cm. The entrance hole was a symmetric 0.6 cm diameter circle, entering 0.9 cm into the branch and progressively widening until it attained the diameter of the inner gallery (1.1 cm). The inner gallery was 13.5 cm long above the entrance and 6.0 cm long below it. As in the other nest, the inner walls were smooth with no obvious lining.

A single provisioned cell, 1.8 cm long, at the top of the gallery contained an egg, 1,0 cm long and 0.25 cm maximum width, laying on a solid mass of food. The cell partition, was slightly less than 0.1 cm thick; the internal surface convex and the outer one concave.

Several other nests of this species are known from the same substrate, although they are not included here because they are being used in bionomic studies.

Discussion

Only nests of two species in the subgenus *Stenoxylocopa, X. artifex* and *X. nogueirai* Hurd & Moure, have been described previously (reviews in Hurd & Moure, 1960 and Sakagami & Laroca, 1971). In all cases, nests were constructed inside the hollow stems of bamboo and related plants. Despite the obvious differences between hollow culms and the fibrous branches of *Vellozia*, the nests of *X. artifex* found in *Vellozia* are not substantially different from the nests excavated in bamboo. Entrance holes, internal diameters and length of cells of nests constructed in *Vellozia* are all inside the range of dimensions reported for nests in bamboo. Another common feature is the absence of barrel-shaped cells.

One noteworthy difference is that entrance holes of nests built in bamboo by both *X. artifex* and *X. nogueirai* have their edges beveled, with the internal diameter slightly smaller than the external one. In both nests constructed in branches of *Vellozia*, the entrance diameter gets larger from outside to inside (Fig. 1). If nests in *Vellozia* are co-opted from other species of *Xylocopa*, this may be a consequence of the reutilization of narrower nests.

In fact, there are no observations of female *X. artifex* starting nest construction in an intact *Vellozia* branch. However, female *X. artifex* have been observed occupying nests constructed by *Xylocopa (Diaxylocopa) truxali* Hurd & Moure (Silveira et al., unpublished data) at Serra da Calçada. Use of old nests by *X. (Stenoxylocopa) nogueirai* in bamboo stems was reported by Hurd & Moure (1960). It cannot be concluded from their data, however, whether these were abandoned nests or whether they were maternal nests reused by daughters.

It remains unclear where females of *X. artifex* obtain the material used for cell partitions at both nests in hollow culms and *Vellozia* branches. Hurd & Moure (1960) and Sakagami & Laroca (1971) suggested that females rasp the inner wall of their nests uniformly to obtain this material. Female *X. artifex* observed in nests first constructed by *X. truxali* spent several days scraping the internal walls to broaden their width, which originally had narrower entrances and internal galleries. However, most of these wood chips were discarded through the entrance hole (Silveira et al., unpublished data). A close relative of *X. artifex*, *X. (Stenoxylocopa) micheneri* Hurd, 1978 does make barrel-shaped cells (R.L. Minckley, personal communication), suggesting sawdust for partitions is obtained as the cells are shaped by the bees. In the distant-related oriental bamboo nesting subgenus *Biluna*, rasping is collected in particular spots,

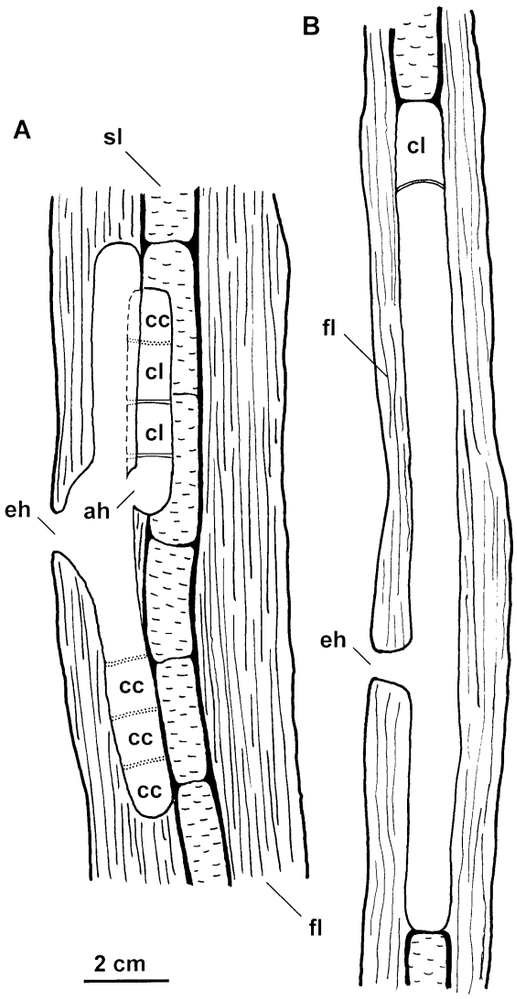

Fig. 1 - Nests of *Xylocopa (Stenoxylocopa) artifex* in branches of *Vellozia* spp., found at **A)** Serra do Ambrósio (Itamarandiba) and **B)** Serra da Calçada (Brumadinho) both at the State of Minas Gerais, Brazil. ah = access hole to the second gallery; cc = cell cast; cl = cell; eh = entrance hole; fl = fibrous layer of leaf bases and roots; sl = soft layer (true branch). Solid lines limiting cells are complete partitions; stip lines limiting cell casts are remains of cell partitions.

forming pits in the nest wall (Maeta et al., 1985, Maeta et al., 1996).

The data presented here do not support the hypothesis that geographic distributions of *Stenoxylocopa* are largely defined by the availability of hollow culms (Hurd & Moure, 1960; Hurd, 1978). Factors other than nesting substrates must define their distribution. Furthermore, *X. (Stenoxylocopa) micheneri*, occur in southern Arizona and northern Mexico, where no native bamboo are found, and nest in dead floral scapes of *Agave palmeri* and *Dasyliron wheeleri* (R.L. Minckley, pers.comm.).

Hurd & Moure (1960) and Hurd (1978) also suggested that the uniquely modified mandible of female *Stenoxylocopa* represents an adaptation for rasping entrance holes into the culms of bamboo and for scraping of the interior culm walls "for material to make cell partitions". In common, both bamboo culms and the branches of *Vellozia* are fibrous. Thus, handling or cutting fibers might be related to the mandibular structure of *Stenoxylocopa*. "Tic" sounds, heard as females worked the internal wall of their nests, suggest that fibers were being clipped. However, similar "tics" have been heard from female *X.(Neoxylocopa) hirsutissima* working in *Vellozia*. This species nests most often in solid wood and has normal mandibles. So, it does not seem necessary to possess a broad, truncate tooth to "rasp" fibrous substrates. A question that remains open is whether this kind of tooth precludes the bees from scraping common solid wood.

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