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MAPPING OF STINGLESS BEE NESTS ON THE UNIMONTES CAMPUS: SPECIES, DISTRIBUTION AND SUBSTRATES

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ABSTRACT

The study mapped 41 nests of stingless bees on the Unimontes campus, Montes Claros, identifying six species, with a predominance of *Nannotrigona testaceicornis* (49%) and *Tetragonisca angustula* (32%). Most of the nests (73%) were found in masonry structures, showing adaptation to urban environments. The density of nests was 1 per 0.50 hectare, higher than other studies in anthropized areas. The results highlight the resilience of bees and the importance of conservation strategies.

Keywords: Stingless bees. Urban nesting.

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INTRODUCTION

Native stingless bees, known as meliponines, form a group belonging to the order Hymenoptera, with more than 600 species distributed mainly in tropical regions, with the greatest diversity found in the neotropical region (ROUBIK, 2023). These bees are part of the family Apidae and the subtribe Meliponinae. In Brazil, considering both the species already described and those in the process of description, more than 300 species are known (PEDRO, 2014).

Meliponines live in colonies, small or large, depending on the species. Like honey bees (*Apis mellifera*), native stingless bees are eusocial, with perennial colonies, caste differentiation, inability of the queen to found a nest alone, elaborate nest architecture, efficient communication system, effective thermoregulation, and ability to store large amounts of food (MICHENER, 2000; SAKAGAMI, 1982).

Most species of stingless bees build nests preferentially in tree hollows, but can also use cavities in the soil, termite mounds and anthills. Each species builds a peculiar characteristic architecture at the entrance to the nest, which can contribute to the identification of the species. The structure of the nests and the activities of the meliponines make it possible for successive generations to reproduce in the same place (ROUBIK, 2020). Bees collect nectars, pollens, and resins from plants for feeding and nest maintenance. The flavonoid compounds present in the resins have antimicrobial activities to protect the nests, while the terpenoids deposited in the inlet tube exert a repellent function against ants. These examples show that bees use various defense strategies against insects, microbes, and even vertebrates (ROUBIK, 2023).

Bees are effective pollinators, whose diet is basically composed of plant products and which, during the collection of resources, promote the pollination of flowers. Pollination is an essential environmental service, contributing to the maintenance of ecosystems, as well as to the agricultural production of various plant species. In addition, bees produce honey, propolis and pollen, which can be consumed as food due to their rich nutritional composition and the presence of bioactive compounds (MICHENER, 2000; VILLAS-BOAS, 2018).

The nesting habit of bees can be affected by environmental changes, such as urbanization, fragmentation, destruction and modifications of ecosystems, impacts that reduce biodiversity and reduce the availability of sites for the construction of new nests. The reduction of green areas in urban environments can negatively affect the populations and

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diversity of stingless bees. In addition, habitat fragmentation resulting from deforestation compromises the supply of resources that bees need for survival, such as food and quality water (ROSA *et al*., 2019).

The honeys of native bees were already appreciated by indigenous peoples even before the arrival of the Portuguese in Brazilian territory. Despite the large number of existing species and their unique characteristics, native bees are still little known (DE CAMARGO *et al*., 2017.; ARAÚJO *et al*., 2023).

Faunal and floristic surveys are effective methodologies for diagnosing the situation of bee populations at a given time. However, environmental changes caused mainly by anthropogenic actions can directly affect bee species, favoring the growth or reduction of their populations (MOURE, 2000; NOGUEIRA NETO, 2000).

In urban areas there is a growing supply of artificial and man-made environments. As meliponines have different ways of building nests, many species demonstrate the ability to adapt to these new environments and substrates available, and are therefore found in anthropized areas. Taura and Laroca (1991) and Albernaz et al. (2022), as well as other studies, have already shown the importance of knowing the native social species that inhabit urban and/or anthropized areas, to understand how they are occupying these spaces. In this context, the objective of the present study was to survey the species of stingless bees on the campus of the State University of Montes Claros (Unimontes) in Montes Claros, and to contribute to the knowledge about the presence of meliponines species in the north of Minas Gerais.

OBJECTIVE

To carry out the mapping of nests of stingless bee species on the campus of the State University of Montes Claros (Unimontes), in Montes Claros - MG.

METHODOLOGY

The mapping of stingless bee nests was carried out in an urbanized area, on the campus of the State University of Montes Claros (Unimontes), which occupies 20.32 hectares (Figure 1). This campus is located in the municipality of Montes Claros, with the following coordinates: Latitude 16 43' 41", Longitude 43 51' 54" and Altitude of 638 meters; in the Upper Middle São Francisco Basin, in the north of the State of Minas Gerais. The predominant phytophysiognomy in the region is the deciduous Cerrado, with the presence

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of sub-deciduous cerrado and some occurrences of super-emifólio cerrado. The area also has a wide transition range between the Cerrado and Caatinga domains. The climate is hot and dry, with average annual temperatures ranging between 21ºC and 24ºC. Annual rainfall ranges between 900 and 1200 mm, with the highest rates recorded between the months of October and January (BRASIL, 2024).

Figure 1 – Map of the Unimontes campus, Montes Claros, MG, edited from Google Earth (ID 0A41248ED931471F801C).

Source: Edited from Google Earth.

The location and counting of nests were carried out between the months of April and June 2024, in a sampling period of 25 hours, from 9:00 am to 5:00 pm, on sunny days with little wind, to facilitate the location of nests from the external activity of the bees.

The nests were located through an active search. For this, the campus area was mapped, including buildings, buildings, walls, parking lots, streets and areas with vegetation (gardens and wooded areas). All mapped structures were inspected in search of stingless bee nests, observing from the foundation, the height of the roofs, and from the roots to the tree canopy.

For each nest found, a photographic record of the entry was carried out, observing the flow of entry and exit to confirm whether the nest was active. Then, the following data were recorded: height of the inlet tube in relation to the ground, type of substrate where the nest was installed and georeferencing using GPS (Global Positioning System). The

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measurements were made with the aid of a tape measure, Garmin eTrex portable GPS, Canon camera.

Trees with nests were also evaluated, with the measurement of trunk circumferences at breast height (CAP) at 1.30 m from the ground, in addition to photographic records and collection of material for later identification.

The identification of the nests was carried out for the most part, based on the structure of the entrance at the time of location, as each species has its own characteristics. For the nests in which this identification was not possible, samples were collected from five individuals from each nest for subsequent identification by a specialist. These specimens are stored in the collection of the Graduate Program in Biotechnology of the State University of Montes Claros (Unimontes).

DEVELOPMENT

41 nests of stingless bees were located on the campus of the State University of Montes Claros. The nests were marked on the map of the area, however, in some places, there are several very close together, so the markings were superimposed and only 27 nests appeared on the map - red dots (Figure 2). They are distributed among six species. Among these, *Nannotrigona testaceicornis* had the highest number of nests observed (n = 20), followed by *Tetragonisca angustula* (n = 13), *Scaptotrigona depilis* (n = 5), and the lowest number of nests was for *Scaptotrigona* sp1 (n = 1), *Leurotrigona muelleri* (n = 1) and *Lestrimelitta limao* (n = 1) (Figure 3).

The most abundant species in the Unimontes Campus was *Nannotrigona testaceicornis* with a frequency of 49% of the nests, followed by *Tetragonisca angustula* with a frequency of 32% of the nests observed (Figure 3).

The substrates most used by stingless bees were masonry structures, with the occurrence of 73% of the nests observed, in walls, walls and other masonry structures. Of the total number of nests found, 12% were observed in tree trunk cavities, and 15% in places such as electrical distribution boxes, air conditioning structures, or similar structures (Figure 4). The density of nests observed was 1 nest per 0.50 hectare.

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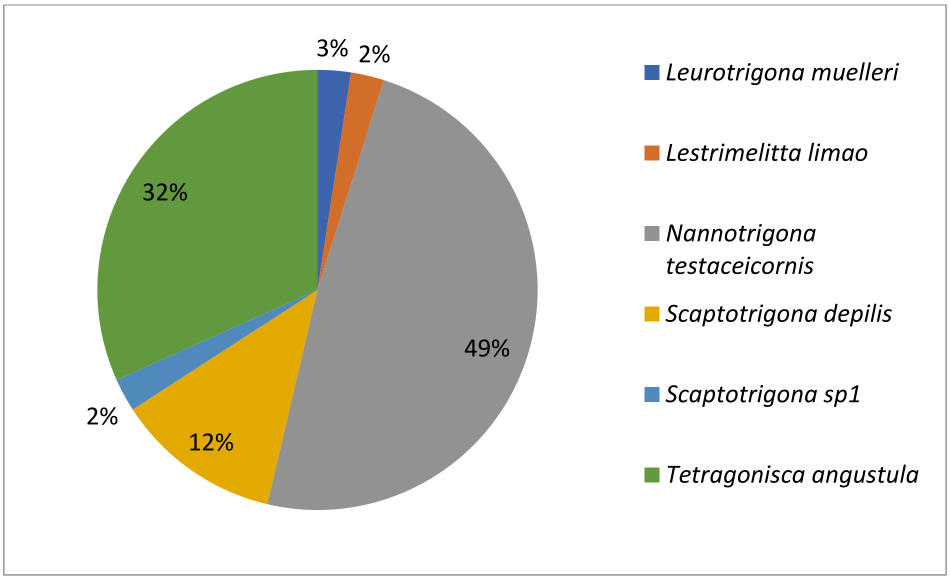
Figure 2 – Locations of stingless bee nests (in red) on the Unimontes campus

Source: Edited from Google Earth.

Figure 3 – Proportion of nests of native stingless bee species found on the Unimontes campus in Montes Claros, MG



Source: Authorship.

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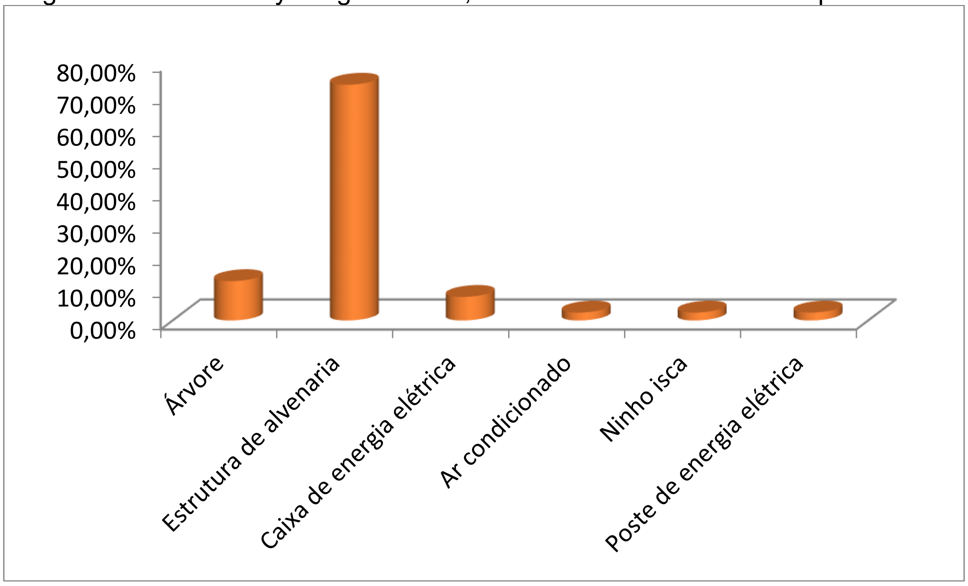
Figure 4 – Nesting substrates used by stingless bees, found at the Unimontes Campus in Montes Claros, MG.



Source: Authorship.

Five nests were observed in trees; one nest of *Scaptotrigona* sp on the trunk of an unidentified species and four nests of *Nannotrigona testaceicornis*, on the trunk of *Spathodea campanulata*. It is noteworthy that these nests were located in the trunk of the same tree. The stingless bee nests on the Unimontes campus had a height of 0.04 m to 6.0 m in relation to the ground. The greatest amplitude observed was in the species *Tetragonisca angustula with an* average height of 1.33 m at the entrance of the nests, with a maximum height of 6.0 m and a minimum of 0.20 m; however, the highest frequency of nests was at 0.50 m (Table 1). The nest of *Leurotrigona muelleri* found was 4.0 m high, as well as that of *Lestrimelitta limao*. The nest of *Scaptotrigona* sp1 was at 6.0 m, and very close to a nest of *T. angustula*. Each species of stingless bee has specific characteristics in the nest inlet tube (Figure 5). However, depending on the moment of development of the nest there may be some variation, such as the nests of *Nannotrigona testaceicornis* in a wall – typical entrance, and in a tree – larger tube, as can be seen in Figure 5.

Table 1 – Nest height in meters (m) of stingless bees at the Unimontes campus, Montes Claros, MG

Species	N	Average	SD	Median	Min	Max
Nannotrigona testaceicornis	20	0,80	0,83	0,80	0,04	3,0
Tetragonisca angustula	13	1,33	1,76	0,50	0,20	6,0
Scaptotrigona depilis	5	0,68	0,60	0,60	0,15	1,70
Scaptotrigona sp1	1	6,0	0	0	6,0	6,0
Leurotrigona muelleri	1	4,0	0	0	4,0	4,0
Lestrimelitta lemon	1	4,0	0	0	4,0	4,0

N: total number of nests; SD: standard deviation; Min: minimum nest height; Max: maximum nest height
Source: Authorship.

Figure 5 - Entrance tubes of stingless bee nests on the campus of the State University of Montes Claros (Unimontes): *Nannotrigona testaceicornis* in masonry structure (A); *Nannotrigona testaceicornis* in the trunk of *Spathodea campanulata* (B); *Scaptotrigona sp* in wall (C); *Scaptotrigona depilis* in wall (D); *Lestrimelitta limão* on wall (E); *Tetragonisca angustula* on wall (F).

Source: Authorship.

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DISCUSSION

The six species of stingless bees found on the Unimontes campus were also recorded in other surveys carried out in urban and anthropized areas. In a study conducted in an environment with characteristics similar to those of the Unimontes area, Freitas and Soares (2003) also identified these species. And some species, such as *Nannotrigona testaceicornis, Tetragonisca angustula* and *Scaptotrigona* spp were also observed in other surveys (SOUZA *et al*., 2005.; VIEIRA *et al*., 2016.; SANTOS *et al*., 2023.; ALBERNAZ *et al*., 2022.; NETTO *et al*., 2007). It is important to highlight that *Nannotrigona testaceicornis* and *Tetragonisca angustula* were recurrent in all these studies, suggesting that these species have a wide distribution and high capacity to adapt to urban and modified environments.

It was observed that all species recorded in this work occur both in environments with different levels of anthropic interference and in natural areas. All of them are naturally occurring in the state of Minas Gerais, as pointed out by Silveira *et al*. (2002), which reinforces the importance of conserving native fauna even in urban contexts.

According to Antonini et al. (2013), the most common genera in urban areas are *Tetragonisca*, *Trigona* and *Paratrigona*. In addition, Zanette *et al*. (2005) mention *Nannotrigona testaceicornis* as a particularly abundant species in urban surveys, which is in line with the data of this study.

The density of nests per area observed on the Unimontes campus was higher than that recorded in other surveys carried out in environments modified by human action (see Table 2). This result may be related to the presence of artificial cavities – such as cracks in masonry structures – used by small and highly adaptable species, such as *N. testaceicornis and T. angustula*. These species have high ecological plasticity, being able to take advantage of the available resources even in urban and urbanized environments.

Areas modified by humans, but which still offer food resources and shelter, such as urban green areas, can function as important refuges for small species, such as bees (LEMES *et al*., 2015). However, the vegetation cover of the Unimontes campus has a low density of tree species (Figure 1), which may explain the reduced number of nests in natural cavities, such as tree trunks and branches. Even among the trees of greater size and age, there was a scarcity of cavities suitable for nesting.

The availability of substrates for nesting is a determining factor in the population dynamics of stingless bees. Modifications in this condition can favor the population growth of some species and the decline of others. In addition, it is essential that floral resources are available within the flight radius of these bees for the maintenance of their populations (CANE, 2001).

Previous studies show that the choice of substrates for nesting by stingless bees can vary according to the degree of anthropization and the availability of resources in the environment. Albernaz *et al*. (2022), for example, observed that in an anthropized area with greater vegetation cover, 83.18% of the nests were located in trees, evidencing the preference for natural substrates when they are available in abundance. Similarly, Mesquita et al. (2017) reported that approximately 75% of the nests recorded in urban green areas of Santarém (PA) were also associated with trees, reinforcing the importance of this type of substrate for the nesting of different species.

However, the data obtained in the present study, carried out on the Unimontes campus, indicate a contrasting pattern: more than 70% of the registered nests were installed in masonry structures, while only 12% were found in trees. This scenario reveals the influence of urbanization and the scarcity of natural substrates in the choice of nesting sites, leading many species to use artificial alternatives available in the built environment.

Despite this, the greatest diversity of species tends to be associated with natural substrates. Vieira *et al*. (2016), when investigating the occupation of nests on the campus of the Federal University of Juiz de Fora, found that although the number of nests in artificial substrates (n = 50) was higher than in natural substrates (n = 19), species richness was higher in natural substrates (seven species versus three in artificial substrates). These data suggest that natural substrates, although less used in absolute terms, offer characteristics that are more suitable for the installation of colonies of different species, and are therefore ecologically more relevant for the conservation of diversity.

Thus, the results presented here indicate that the availability and quality of natural substrates exert a direct influence on the nesting pattern of stingless bees in urbanized environments. The replacement of vegetated areas with artificial structures can not only reduce the supply of suitable nesting sites, but also limit the diversity of species that manage to establish themselves in these environments. The preservation and enhancement of natural elements, such as trees and cavities in native vegetation, are, therefore, fundamental measures for the conservation of these important pollinators in urban areas.

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Table 2 – Density of nests by area in surveys in anthropized areas

Local	Nests	Area (hectare)	Density Nests/ha	Year
Odessa	51	-	-	Netto *et al*., 2007
Cross of Souls	107	116,74	1/1,09	Albernaz *et al*., 2022
Saviour	94	57	1/0,60	Souza *et al*., 2005
Ribeirão Preto	566	574,63	1/1,01	Freitas and Soares, 2003
Juiz de Fora	34,88	132,58	1/3,80	Sousa *et al*., 2002
Inconfidentes	13	33,43	1/2,57	Menino *et al*., 2023
Ubá	28	111,8	1/3,99	Araújo *et al*., 2016
Guarapuava	46	-	-	Marcondes and Buschini, 2007
Poços de Caldas	26	0,225	1/0,01	Santos *et al*., 2023
Montes Claros	41	20,32	1/0,49	Present work

Source: Authorship.

The bee *Tetragonisca angustula* is widely distributed throughout the country and is generally the most abundant species in urban environments, as verified in anthropized areas, in different campuses, such as Ribeirão Preto (FREITAS & SOARES, 2003), Salvador (SOUZA *et al*., 2005), Cataguases (NETTO *et al*., 2007), and Ubá (ARAUJO *et al*., 2016) and Guarapuava (MARCONDES & BUSCHINI, 2007). In these surveys, most of the nests of *T. angustula* were also found in artificial substrates, a pattern similar to that observed in the Unimontes Campus. This nesting behavior suggests a preference or adaptation of the species to ecological niches resulting from human intervention.

Popularly known as jataí, jatí, golden bees, and in some places in the north of Minas Gerais, as "fevereiro", *T. angustula* is a small, golden-colored bee with long hind legs and greenish compound eyes. The species is distributed from Mexico to southern Brazil, being recorded in the states of AM, AP, BA, CE, ES, GO, MA, MG, MT, PA, PB, PE, PR, RJ, RO, RS, SC and SP (SILVEIRA *et al*., 2002). Its honey is highly appreciated by different populations - indigenous, riverside, native peoples, rural and urban.

Due to its wide distribution, ease of adaptation, and diversity of nesting substrates, *T. angustula* is frequently recorded in studies conducted in urban environments (ANTUNES *et al*., 2012). De Souza *et al*., (2005), for example, found 94 nests on the campus of the Federal University of Bahia, 76.6% of which were of the species *T. angustula*. As in the present study, trees were not the main nesting substrate, ranking second.

In the present survey, *Nannotrigona testaceicornis* was the most abundant species. A similar result was found in anthropized areas such as Cruz das Almas (ALBERNAZ *et al*., 2022), and Juiz de Fora (SOUSA *et al*., 2002.; VIEIRA *et al*., 2016). At Unimontes, however, most nests were located in masonry substrates, unlike what was recorded in Salvador, where the greatest abundance occurred in tree substrates (ALBERNAZ *et al*., 2022). In Juiz de Fora, both in the initial survey and in the reassessment after eight years, *N. testaceicornis* showed a preference for artificial substrates, a behavior also observed in this study. The authors also point to a population increase of the species in this time interval. Freitas and Soares (2003) also found most of the nests of *N. testaceicornis,* 75%, located in masonry structures.

Popularly known as iraí. *N. testaceicornis* is a species widely present in urban areas, with nests located in walls, walls, trunks and pipes. It is small, with a dark brown and opaque chest. It is a tame bee, which hides in the face of approaching people or strange movements. At night, it closes the nest's inlet tube. Its honey, with a pleasant taste, is consumed by some populations, although there are few studies on its products. This species occurs in the states of BA, ES, GO, MG, RJ, SP (SILVEIRA *et al*., 2002).

N. testaceicornis nests in different types of substrate, as was also observed in the Cruz das Almas survey (ALBERNAZ *et al*., 2022). These authors also reported the presence of nests of the species in trunks of the exotic tree *Spathodea campanulata*, an occurrence also recorded in the present study. This is a relevant finding, considering that the nectar and pollen of this plant are toxic to bees (PORTES *et al*., 2019.; TRIGO & SANTOS, 2000.; SOUZA *et al*., 2021). For this reason, the planting of spatode has been prohibited in several Brazilian cities and states, such as in Santa Catarina, Law No. 17,694 of January 14, 2019, Santa Maria de Jetibá - ES, Law No. 2,748 of November 06, 2023 and in Novo Horizonte - SP, Law No. 5,939 of August 21, 2023, that prohibit its cultivation and commercialization, due to the mortality it causes in insects and hummingbirds.

Studies indicate, however, that extracts from the bark of the stem of *Spathodea campanulata* have antimicrobial and antifungal activity (OFORI-KWAKYE *et al*., 2009). It is not yet known whether *N. testaceicornis bees* benefit from compounds from this plant for nest protection. According to (PADHY, 2021), compounds such as flavonoids and carotenoids isolated from spathodes may have antioxidant, anti-inflammatory, and antifungal activity, which raises the hypothesis of possible indirect use by bees, something that deserves future studies.

The genus *Scaptotrigona* has a wide distribution in the Neotropical region, with at least six species recorded in Minas Gerais. This group has great morphological diversity and some are similar, which makes identification difficult (SILVEIRA *et al*., 2002). Five nests of this kind were found on the Unimontes campus: four in masonry substrates and one in a live tree trunk. These data contrast with those of Santos *et al*. (2023) and Menino *et al*. (2023), which recorded a higher abundance of *Scaptotrigona* with all nests in trees.

Two morphospecies, *Scaptotrigona depilis* and *Scaptotrigona* sp1, were identified on campus , differentiated by the characteristics of the nest entrance tubes. Some species of the genus are popularly known as "canudo", a common name that can vary and be applied to different species, including in very different geographic regions. Therefore, correct scientific identification is essential. *Scaptotrigona* honeys are consumed, but they still lack in-depth studies as to their properties and characterization.

Leurotrigona muelleri is a very small bee, less than 3 millimeters long. Its popular name is "eye-licker", as it seeks sweat and tears to obtain mineral salts. The species is found in the states of BA, ES, MG, PR, SC, SP (SILVEIRA *et al*., 2002).

Lestrimelitta limão, popularly known as "lemon bee", "iratim", "irati", or "seven-doors". It releases a citrusy, lemon-like smell noticeable near the nest. It is a kleptoparasitic species, which pillages nests of other stingless bees to obtain honey and pollen. Usually absent in nest surveys, it was recorded by Freitas & Soares (2003) on the campus of the University of São Paulo, in Ribeirão Preto, and also on the campus of Unimontes. The species is found in the states of BA, MG and SP (SILVEIRA *et al*., 2002).

According to Vossler (2012), factors such as climatic conditions and the diversity of flora in the environment directly influence the diversity of stingless bees. And according to Teixeira et al. (2022), their presence in urban environments reinforces the importance of environmental education aimed at the recognition, conservation, and management of native species in different contexts, and varied audiences.

FINAL CONSIDERATIONS

In the study carried out on the campus of the State University of Montes Claros, 41 nests of native stingless bees were recorded, distributed among six species, with emphasis on *Nannotrigona testaceicornis* and *Tetragonisca angustula*. Most of the nests (73%) were found in artificial substrates, such as masonry structures, evidencing the high capacity of adaptation of these species to urban environments.

The identification of native bees in anthropized areas highlights their resilience and potential to colonize urban niches. The results obtained can support conservation and management strategies for these species in urban environments, in addition to indicating which bees have greater resistance to environmental modifications. Such information is

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valuable for urban meliponiculture initiatives and for the planning of green areas that favor biodiversity.

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