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Implementation of Solitary Bee Hotels and Their Aspects in the Nesting Biology of Native Bees

Implantação de Hotéis de Abelhas Solitárias e Seus Aspectos na Biologia de Nidificação de Abelhas Nativas

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Maria Alice Paiva do Nascimento: Instituto Federal de Educação, Ciência e Tecnologia do Rio Grande do Norte, Campus Pau dos Ferros, Rio Grande do Norte, Brazil.

Maria Eduarda Oliveira da Costa: Instituto Federal de Educação, Ciência e Tecnologia do Rio Grande do Norte, Campus Pau dos Ferros, Rio Grande do Norte, Brazil.

Daniel de Freitas Brasil: Instituto Federal de Educação, Ciência e Tecnologia do Rio Grande do Norte, Campus Pau dos Ferros, Rio Grande do Norte, Brazil.

Maria José de Holanda Leite: Instituto Federal de Educação, Ciência e Tecnologia do Rio Grande do Norte, Campus Pau dos Ferros, Rio Grande do Norte, Brazil. *E-mail: maryholanda@gmail.com

Michelle de Oliveira Guimarães: Instituto Federal de Educação, Ciência e Tecnologia do Rio Grande do Norte, Campus Pau dos Ferros, Rio Grande do Norte, Brazil.

Abstract
Solitary bees constitute a group of bees in which a single female is responsible for all nesting activities and play a fundamental role in the pollination of various plant species. Although solitary species are extremely important for environmental conservation, their existence is often unknown to the general public. Therefore, the present study aimed to manufacture and install bee hotels for solitary bees at IFRN – Pau dos Ferros campus, with the objective of popularizing solitary bees and providing a safe place for nest construction, as well as studying the nesting aspects of these species. For the construction of the hotels, aluminum cans and wooden blocks. During biweekly inspections, the hotels were examined to identify the species that occupied the nests. The identification of the bees was carried out through direct observation of emerged individuals and the analysis of occupied nests, recording the number of nests, the number of emerged individuals per species, and the emergence time. The information was recorded in spreadsheets for further analysis. The nesting bee species identified were *Megachile sp.* and *Centris (Hemisiella) tarsata* (Smith, 1974), in addition to the wasp *Trypoxylon sp.* The preferred diameters for nesting were 6mm and 8mm. Regarding the sex ratio, more males than females emerged, and the nesting substrate, number of cells, and color varied among species. Thus, the installation of the hotels contributed to the collection of information on nesting species and to the popularization of this group of insects in the academic environment, being useful for the preservation of local fauna and flora.
Keywords: Pollinators. Nest. Emergence. Popularization of Bees.

Resumo
As abelhas solitárias constituem-se como um grupo de abelha em que uma única fêmea é responsável por todas as atividades do ninho e desempenham um papel fundamental para a polinização de diversas espécies vegetais. Embora as espécies solitárias sejam de extrema importância para a conservação ambiental, sua existência é frequentemente desconhecida para o público leigo. Portanto, o presente trabalho teve como objetivo a fabricação e a implantação de hotéis para as abelhas solitárias no IFRN – *campus* Pau dos Ferros com o intuito de popularização das abelhas solitárias e a oferta de um local seguro para a construção dos seus ninhos, além do estudo dos aspectos de nidificação dessas espécies. Para a fabricação dos hotéis, foram utilizadas latas de alumínio e blocos de madeira. Durante as vistorias quinzenais, os hotéis foram inspecionados para identificar as espécies que ocuparam os ninhos. A identificação das abelhas foi realizada por meio da observação direta dos indivíduos emergidos e pela análise dos ninhos ocupados, sendo registrados o número de ninhos, o número de indivíduos emergidos por espécie e o tempo de emergência. As informações foram registradas em planilhas para posterior análise. As espécies de abelhas nidificantes foram *Megachile* sp. e *Centris (Hemisiella) tarsata* (Smith, 1974), além da vespa *Trypoxylon* sp. Os diâmetros preferidos para a nidificação foram os de 6mm e 8mm. Quanto a razão sexual, emergiram mais machos do que fêmeas e o substrato utilizado para a fundação dos ninhos, o número de células e a cor variou entre as espécies. Com isso, a instalação dos hotéis contribuiu para a coleta de informações sobre as espécies nidificantes e para a popularização desse grupo de insetos no meio acadêmico, sendo útil para a preservação da fauna e da flora local.

Palavras-chave: Polinizadores. Ninho. Emergência. Popularização de Abelhas.

1 Introduction

Bees are insects that play essential roles in nature, particularly in the conservation and perpetuation of numerous plant species through pollination. This process is intrinsically linked to their need to collect floral resources, which serve both as building materials for their nests and as sources of food, ensuring their survival and that of their offspring (Aleixo *et al.*, 2014; Imperatriz-Fonseca; Nunes-Silva, 2010; Morato; Campos, 2000). By foraging, bees not only support their own life cycles but also contribute to the continued production of food critical to humans and wildlife, thereby playing a key role in ecosystem preservation and supporting climate stability (Klein *et al.*, 2007; Ollerton; Winfree; Tarrant, 2011).

Solitary bees represent a group in which a single female is solely responsible for foraging, nest construction, oviposition, and nest defense. Typically, she dies or abandons the nest before her offspring emerge, resulting in no contact between generations (Batra, 1984; Santos, 2002; Bertoli *et al.*, 2019). Of the more than 20,000 bee species documented worldwide, the majority are solitary in nature. However, these bees remain largely unknown to the general public, as does their vital role in the pollination of many plant species (Sazan *et al.*, 2014; Silva; Santos; Teixeira, 2021).

Despite their ecological importance and sensitivity as biological indicators of habitat quality and conservation, solitary bees are undergoing a gradual decline and are increasingly threatened with extinction. This ongoing loss makes their recognition and public awareness even more challenging

(Barbosa *et al.*, 2017; Biesmeijer *et al.*, 2006; Beringer; Maciel; Tramontina, 2019 ; Tscharntke; Gathmann; Steffan-Dewenter, 1998). Recent studies suggest that a significant portion of the academic community still lacks adequate knowledge about solitary bees and their diversity. Furthermore, compared to other bee species, fewer initiatives focus on their preservation and promotion (Anjos; Ramos, 2019; Araújo *et al.*, 2019; Barbosa *et al.*, 2021; Fontes, 2019; Paixão; Martinez, 2018).

Educational exhibits, school-based projects, and university outreach programs that provide suitable nesting habitats for solitary bees are promising strategies to mitigate their decline and increase public awareness (Fontes, 2019). In this context, developing community engagement strategies and producing environmental education materials can enhance interactions between academic institutions and local communities. These integrated actions have the potential to strengthen environmental awareness and foster social involvement (Aranda *et al.*, 2024).

Based on this premise, the aim of this study was to design and implement solitary bee hotels within an educational institution, to observe nesting behavior and promote the visibility and conservation of cavity-nesting solitary bees in academic settings.

2 Material and Methods

2.1 Research location

This study was conducted in the municipality of Pau dos Ferros, Rio Grande do Norte, Brazil, located at coordinates 06º 06' 33'' S and 38º 12' 16'' W, with an average altitude of 193 meters (Idema, 2008). The research took place at the Intituto Federal de Educação, Ciência e Tecnologia of Rio Grande do Norte (IFRN), Pau dos Ferros, from December 2023 to July 2024.

2.2 Study area characterization

Pau dos Ferros is situated in the state of Rio Grande do Norte, within the Upper West Potiguar mesoregion, encompassing a total area of 559.96 km². The predominant biome is the Caatinga, and the climate is classified as semi-arid, characterized by vegetation adapted to withstand prolonged droughts. The rainy season typically occurs from February to June, with annual precipitation ranging from 200 to 800 mm (Idema, 2008 ; Saber, 2003; Souto *et al.*, 2017).

The prevailing vegetation in the municipality is Brazilian deciduous xerophytic forest, specifically hyperxerophilous deciduous caatinga, with plant species typical of the Northeastern semi-arid region (Bezerra *et al.*, 2014).

2.3 Production and installation of bee hotels

The solitary bee hotels were made and decorated using reusable or recyclable materials such as wood, cans, and paper. Both the wooden and tin models featured cavities of varying diameters (6, 8, and 12 mm), following the methodology described by Camillo *et al*. (1995), in order to accommodate the nesting needs of solitary bees. In all models, the cavities were filled with small paper tubes, whose lengths varied according to the size of the wooden blocks, while respecting the specified diameters.

A total of ten sustainable hotels were built using aluminum cans, and approximately 97 pieces of wood were collected, cut, drilled, and filled with black cardboard tubes (sealed at one end). These were then arranged into wooden frames and installed to provide nesting sites for solitary bees. In total, 148 nesting cavities were provided in the decorated cans and 352 in the wooden frames.

After preparation, the nests were installed and distributed across strategic locations at the IFRN Pau dos Ferros campus, sheltered either under trees or in a wooden structure built to protect against abiotic factors.

2.4 Bee sampling using trap nests

Solitary bees were studied through the use of trap nests, also known as bee hotels. The wooden blocks used in the structures featured internal cavities lined with black cardboard tubes sealed at one end, which facilitated both nest maintenance and monitoring of nesting bees. These perforated blocks were inserted into wooden frames and aluminum cans, comprising the overall structure of the bee hotels.

2.5 Data collection

Inspections were carried out biweekly from May to August 2024 to monitor bee nesting activity and assess the condition of the hotels. This three-month period was defined in accordance with the objectives of the research project supporting this study, aimed at evaluating early nesting patterns. Although this time frame does not represent a full annual cycle, it was considered appropriate for identifying initial nesting activities and potential disturbances in the installed hotels.

When the black cardboard tubes were found to be occupied and sealed, they were collected, labeled, individually placed in PET bottles or transparent hoses (to enable observation of possible emergence), and taken to the laboratory. Once removed from the field, the tubes were replaced with new ones of similar diameter to maintain a constant number of nesting sites.

Upon emergence, the individuals were photographed, and the nests were later opened and analyzed regarding construction material, length, number of brood cells, and mortality rate.

Species identification was carried out by Dr. Thiago Mahlmann of the National Institute of Amazonian Research (INPA) through photographs of the specimens.

2.6 Guided visit to the nests

Following the installation of the solitary bee hotels, a guided tour was conducted at IFRN Pau dos Ferros campus with first-year students from the technical beekeeping course, aiming to introduce them to the nests distributed around the campus**.**

2.7 Data analysis

To evaluate the nests occupied at IFRN, the data were organized into tables showing the number of nests established by species and their relative frequency. The data were analyzed collectively, without distinguishing between morphospecies, as the goal was to provide an overview of nesting activity during the sampling period.

The relative frequency was calculated using the following equation:

$F = (ni \times 100) / N$

Where:

F – Relative frequency

ni – Number of nests established by a given species

N – Total number of nests established by all species

The emergence time of completed nests was counted from the collection date, with daily inspections to monitor potential emergence events. The results were presented using tables showing averages calculated as follows:

$M = (d1 + d2 + d3 + ... + dn) / n$

Where:

M – Mean emergence time

d – Number of days for each nest to emerge

n – Number of nests

The standard deviation was calculated using Microsoft Excel.

The sex ratio of the nesting bee species was determined using the following formula:

$R = N / n$

Where:

R – Sex ratio

N – Number of females

n – Number of males

To compare emergence times among groups (*Centris tarsata*, *Megachile* sp., and wasps), the Kruskal-Wallis test was applied, as it is suitable for non-parametric data and independent samples with potentially non-normal distributions. For pairwise comparisons (*Centris tarsata* vs wasps, *Megachile* sp. vs wasps, and *Centris tarsata* vs *Megachile* sp.), the Mann-Whitney U test was used, which is appropriate for comparing two independent groups with small sample sizes and no assumption of normal distribution.

3 Results and Discussion

3.1 Installation of bee hotels for solitary bees

Ten bee hotels made from aluminum cans and one hotel containing 97 wooden blocks were produced and strategically distributed throughout the IFRN – Pau dos Ferros campus. The wooden hotel was installed in a protected environment. Together, these structures provided approximately 500 cavities intended for the nesting of solitary bee species (Figure 1).

Figure 1 - Wooden and aluminum can bee hotels with cavity diameters of 6, 8, and 12 mm designed for the nesting of solitary bees

Source: the authors.

Solitary bees usually make use of pre-existing cavities in nature for building their nests. Therefore, the provision of holes made from materials such as wood serves as an excellent mechanism to promote the construction and occupation of nests by solitary species, especially in anthropized environments where the availability of natural nesting habitats is limited (De Oliveira *et al.*, 2023; Nery *et al.*, 2013).

3.2 Occupation of Solitary Bee Hotels

A total of 58 occupations were recorded in the solitary bee hotels. Of these, 39 were found in structures with wooden blocks, with specimen emergence occurring in only 10 nests. These yielded a total of 49 emerged individuals - 40 belonging to bee species and nine to wasps.

Table 1 - Number and relative frequency of nests founded in the hotels installed at IFRN, in the municipality of Pau dos Ferros

Family/Species	**N°Nests**	**Frequency (%)**	**N°Emerged Individuals**	**Emergence Time (days)**	**Diameters (mm)**		
					6	**8**	**12**
Bees							
Apidae							
Centris (*Hemisiella*) *tarsata* Smith. 1974	2	10	12	38±9.90	0	2	0
Megachilidae							
Megachile sp.	8	40	28	22.12±5.02	6	2	0
Subtotal	10	50	40				
Vespas							
Crabronidae							
Trypoxylon sp.	10	50	31	27.2±16.86	9	1	0
Subtotal	10	50	31				
Total	20	100	71				

Source: the authors.

In the aluminum cans, 19 nestings were observed; of these, only 10 resulted in the emergence of individuals, with a total of 22 emergences, exclusively of wasps (Table 1). In the remaining nests, total mortality was recorded in 20 cases (34.48%), and in 18 cases (31.03%) it was not possible to identify the emerged individuals.

Three nesting species were sampled in the available cavities, distributed across three genera (*Centris*, *Megachile*, and *Trypoxylon*). Of these, two genera belong to bees (*Centris* and *Megachile*) and one genus to wasps (*Trypoxylon*) (Table 1).

Among the bee species that nested in the hotels, *Megachile* sp. showed the highest nesting frequency among bees, occupying 40% of the nests distributed in the hotels, followed by *Centris (Hemisiella) tarsata* Smith (1974), which occupied 10% of the bee nests. Regarding the wasp nestings, the only nesting species was *Trypoxylon* sp., with a relative frequency of 50% in the sustainable hotels that were installed (Table 1).

Some studies using the same methodology as this one affirm that species of the genus *Megachile* are abundant in anthropized, open areas, with sunny climates and herbaceous plants, which provide nectar and pollen. In this context, the areas where the bee hotels were installed are favorable for *Megachile* sp. nesting, as they are located in human-modified areas but still have native vegetation within and around the campus, offering resources for effective nesting of this species (Schlindwein, 1998; Aguiar; Zanella, 2005; Batalha-Filho *et al*., 2007; Moura, 2008; Schlindwein, 1998; Rodarte; Silva; Viana, 2008).

Bees of the species *C. tarsata*, belonging to the family Apidae, also nested in the hotels. This species prefers warm habitats and open vegetation, such as caatinga environments (Aguiar; Garófalo, 2004; Aguiar; Martins, 2002), which is consistent with the characteristics of the area where the nests were installed. *C. tarsata* is recognized as an efficient pollinator of acerola in northeastern Brazil. Therefore, the presence of this fruiting and floral oil-producing plant at IFRN may have favored nesting by the tribe Centridini, which uses floral oils to build nests and feed larvae (Vilhena, 2009; Camargo; Mazucato, 1984).

In addition to bee nesting, there were also nests founded by solitary wasps of the family Crabronidae, genus *Trypoxylon* sp., which is one of the main groups nesting in trap-nests (Salustiano *et al*., 2021). *Trypoxylon* sp. is a genus of wasps with strong environmental adaptability, capable of nesting under adverse conditions, such as during dry periods (Melo; Zanella, 2010; Camillo; Brescovit, 1999).

3.3 Emergence of individuals

Among the 58 occupied nests, there were 40 bee emergences and 31 wasp emergences, totaling 71 emerged individuals. Table 2 presents the emergence time (in days) for the solitary bees and wasps collected.

Overall, the bees recorded in the hotels had emergence times ranging approximately from 22 to 38 days, with most emergences occurring between 22 and 27 days. *Trypoxylon* sp. accounted for the highest number of emerged individuals (31), followed by *Megachile* sp. (28) and *Centris tarsata* (12). Table 1 presents the complete data, including the species recorded, the number of emerged individuals, and the average emergence time in days.

Thus, it is possible to observe that in the development of the emerged species, there were no signs of diapause, since the bee families (Apidae, Megachilidae) and wasp family (Crabronidae) did not exceed a period of three months (Melo; Zanella, 2010).

The development of immature individuals of *Megachile* sp. was superior to that of other solitary bee species nesting in the hotels, likely related directly to temperature, as higher average temperatures contribute to shorter emergence times and lower individual mortality. A statistically significant difference was observed in the emergence time between individuals of *Centris* and *Megachile* (Mann-Whitney U test, U = 16, p = 0.0488), with *Centris* being the species with the longest average development time. Understanding this relationship between temperature and development is crucial for the use of these species in pollination programs (Kemp; Bosch, 2000)..

3.4 Diameter preference

The bees and wasps nested in both types of trap-nests provided, with the vast majority of individuals showing a preference for the 6 mm diameter. No species nested in the 12 mm diameter (Table 1).The species *Megachile* sp. founded eight nests, two of which were in the 8 mm diameter and six in the 6 mm diameter, as did the wasps of the species *Trypoxylon* sp., which founded nine nests in the same diameter. The species *Centris (Hemisiella) tarsata* nested exclusively in the 8 mm diameter (Table 1).

According to the study conducted by Melo and Zanella (2010), bees and wasps from the genera *Megachile* sp. and *Trypoxylon* sp., respectively, show a preference for nests with a 6 mm diameter, whereas the genus *Centris* prefers a 9 mm diameter. Thus, the divergence observed in the Apidae family, with the species *Centris*, may be due to the diameter size being proportional to the bee's body size, since nests with larger diameters require a higher energy expenditure for construction (Aguiar; Martins, 2002).

Solitary bees are crucial for the pollination of plant species and are widely used in various agricultural crops (Roubik, 1995; Imperatriz-Fonseca, 2004). However, for the effective use of these species in agricultural systems and pollination programs, it is essential to understand the biology of solitary species — and this includes knowledge of their diameter preferences (Freitas, 1998; Imperatriz-Fonseca *et al*., 2012).

3.5 Nest Structure

Table 2 presents the structure of the nests of bee and wasp species nesting in the solitary bee hotels.

Table 2 - Nest size, number of constructed cells, type of substrate used for foundation, nest color, sex ratio, and mortality

Family/Species	**Nest Size (cm) (X ± SD)**	**Number of Cells Built**	**Substrate Type Used in Construction**	**Color**	**Nº Males (♂)**	**Nº Females (♀)**	**Sex Ratio (♂/♀)**	**Total Mortality**
Bees								
Apidae								
Centris (Hemisiella) tarsata Smith, 1974	4.95 ± 0.77	11	Oil/Sand	Brown	7	5	01:00.7	1
Mechachilidae								
Megachile sp.	5.19 ± 1.50	118	Leaf/Resin /Clay	Yellow	19	9	01:00.5	13
Subtotal		129			26	14		14
Vespas								
Crabronidae								
Trypoxylon sp.	7.11 ± 1.98	80	Clay/Sand	Brown	*	*		6
Subtotal		80						6
Total		209			26	14		20

Note: The asterisks (*) mean data not specified or unavailable.
Source: Authors (2024).

The bees of the species *C. tarsata* used sand and an unidentified oily binding substance for the construction of their nests. In general, the cells exhibited colors ranging from light yellow to dark brown and were arranged horizontally in a linear series, with a rough external texture and a smooth internal surface. In both nests analyzed, no vestibular cells were identified; these act as a barrier or additional compartment between the external environment and the internal cells and serve functions related to protection against predators, temperature and humidity control, or structural organization of the nest (Muniz, 2021). Nest sizes ranged from 4.4 cm to 5.5 cm (Figure 2), with an average of 4.95 ± 0.77 cm, and the number of cells found in the nests was 11 (Table 2).

Bees of the species *C. tarsata* are popularly known for using floral oils in nest construction and in feeding their offspring (Buchmann, 1987; Vogel, 1974). Thus, the use of oily substances by these bees and their ability to adapt to preexisting cavities is a valuable tool for the use of this species in pollination programs in orchards of plant species such as *Malpighia emarginata* DC (acerola), as well as for the population increase of this bee species (Magalhães; Freitas, 2013).

Figure 2 - Nest built by *Centris (Hemisiella) tarsata* (Smith, 1974)

Source: the authors.

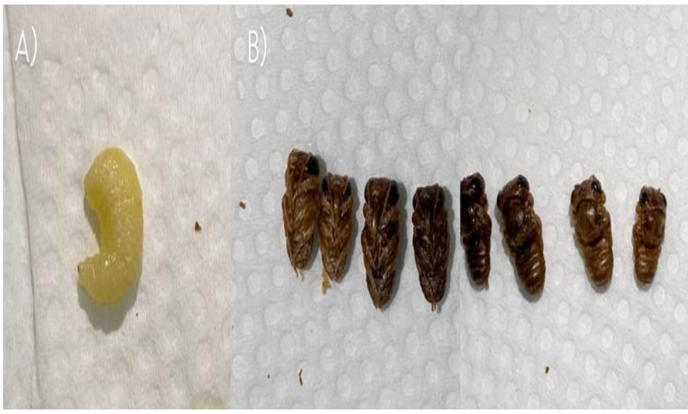
The material used for nest construction by the species *Megachile* sp. was, in general, dry leaves, clay, and plant mixture. The nest coloration ranged from yellow to dark green and purple, with both the external and internal textures being somewhat rough (Figure 3). Additionally, the cells were arranged horizontally, and together, the nests of this species totaled 118 cells. In the nests where no emergence was recorded, individuals were found in two developmental stages: larva and pupa (Figure 4). Nest length varied from 3 cm to 7 cm, with an average of 5.19 ± 1.50 cm (Table 2).

The structure of the nests founded by *Megachile* sp. is mainly due to the species being popularly known as "leafcutter bees," as they use petals of various sizes and leaves to construct their shelters, which are generally built in preexisting cavities in nature or in artificial nests (Batra, 1984; Pitts-Singer; Cane, 2011).

Figure 3 - Coloration and texture of the nests built by *Megachile* sp

Source: the authors.

Figure 4 - a) Bee in the larval stage. b) Bee in the pupal stage



Source: the authors.

The nesting material used by *Trypoxylon* sp. was mud and sand, with nest coloration ranging from light to dark brown. The nests of this species showed little to no resistance when opening the shelters, and their texture was rough, with smooth, brown-colored cocoons. The cells were arranged horizontally in a linear series, with mud partitions between them. Spider remains were also observed (Figure 5). The length of the nests ranged from 5 cm to 13.4 cm, with an average of 7.11 ± 1.98 cm, and a total of 80 brood cells were recorded (Table 2).

Wasps of the genus *Trypoxylon* sp. primarily use mud as the main component for nest construction. Additionally, it is common to find spider remains in nests built by these wasps, as they are frequently used by the species to feed their offspring (Santoni; Lama, 2007; Almeida; Lama, 2007; Santoni ; Brcovit; Del Lama, 2009).

Figure 5 - Nests built by *Trypoxylon* sp. wasps

Source: the authors.

Regarding the sex ratio, it was only possible to determine it for the bee species that nested in the bee hotels. From the species *C. tarsata*, a total of 7 males and 5 females emerged, resulting in a sex ratio of 1:0.71. For the species *Megachile* sp., a total of 19 males and 9 females emerged, resulting in a sex ratio of 1:0.47 (Table 2).

According to the literature, the sex ratio can vary due to the availability of natural resources, as during periods of high availability of natural inputs, a greater emergence of females may occur, since they require more food for their development compared to males. However, the findings in the literature differ from the present study, as there was a higher emergence of males than females (Pérez–Maluf, 1992; Morato; Campos, 2000; Mendes; Rêgo, 2007; Cordeiro, 2009). Nevertheless, in addition to resource availability, another factor that influences the sex ratio is the length and diameter of the offered nests, as well as the sex ratio of the parental generation, which in this case produced more males than females (Aguiar; Martins, 2002; Mendes; Rêgo, 2007; Gazola; Garófalo, 2009; Carvalho, 2011; Krombein, 1967; Aguiar; Garófalo, 2004).

3.6 Mortality of Individuals

In the present study, total mortality was observed in 20 nests, with individuals found in the larval, pupal, and adult stages (Figure 6).

Figure 6 - a) Individual in the larval stage. b) Bee in the pupal stage. c) Dead adult bee.

Source: the authors.

The species *Centris (Hemisiella) tarsata* Smith, 1974 showed total mortality in one nest, while *Megachile sp.* and *Trypoxylon sp.* exhibited total mortality in 13 and 6 nests, respectively (Table 2). This was possibly due to biological activity from microorganisms or inadequate handling.

It is common for high immature mortality to occur in trap nests, from the egg development stage to pre-emergent adult bees. According to some authors, this mortality rate may be attributed, for example, to bacterial, mite, and fungal activity, as these microorganisms may be present in the nectar collected for nest foundation and larval feeding, directly or indirectly contributing to the death of these individuals. Additionally, incorrect handling and relocating collected nests to environments with humidity and temperature different from the original installation site are also determining factors for mortality (Parizotto, 2019; Camarotti-de-Lima; Martins, 2005; Vinson; Frankie; Cônsoli, 2010).

3.7 Guided Tour of the Nests as a Tool for Popularization

The visitation to the nesting sites took place with first-year students of the integrated technical course in beekeeping at IFRN – Pau dos Ferros campus. During the visit, discussions were held on what solitary bee species are, how they behave, and how they build their nests. The visit also contributed to the popularization of this group of bees by promoting interaction between the students and the bee hotels, as they were able to inspect and observe the already-nested structures.

The guided tour of the solitary bee hotel sites served as a valuable tool for education and popularization of these species. During the visit, students showed great interest and enthusiasm, as evidenced by their questions and curiosity about solitary bee species. Moreover, this activity emphasized the importance of this group, which typically nests in preexisting cavities, for pollination services and their contribution to ecosystem balance and maintenance, helping to raise awareness of these species within the academic community (De Oliveira *et al.*, 2023).

4 Conclusion

The solitary bee hotels installed at the Instituto Federal de Educação, Ciência e Tecnologia of Rio Grande do Norte, Pau dos Ferros Campus, hosted the nesting of three species: *Centris (Hemisiella) tarsata* (Smith, 1974), *Megachile sp.*, and *Trypoxylon sp.*, with a relative frequency of 50% bees and 50% wasps.

Among the species with the highest number of nestings, *Megachile sp.* and *Trypoxylon sp.* stood out, with emergence times of 22.12 ± 5.02 days and 27.2 ± 16.86 days, respectively. The preferred diameter for nest construction by the most frequently nesting species was 6 mm, whereas *Centris (Hemisiella) tarsata* (Smith, 1974) preferred a diameter of 8 mm.

The nesting species in the hotels differed in their nesting habits, as they showed variations in the number of cells built, the type of substrate used for nest construction, and nest coloration. Regarding the sex ratio, the number of emerged males was higher than that of females.

The results of the research were favorable to the implementation of the bee hotels, contributing to the collection of information about the solitary pollinator bees of the area where the nests were installed and promoting the popularization of these species in academic environments. The data obtained may be useful for the preservation of local fauna and flora; however, further studies are needed on the nesting behavior of species in trap nests to mitigate possible handling issues and the impact of microorganisms responsible for bee mortality.

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