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SHORT NOTE

First Record of Female Philopatry in the Tribe Centridini (Hymenoptera: Apidae)

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ABSTRACT

This study addresses the behavior and ecology of the solitary bee Centris aenea. The objective was to verify the philopatry of this bee's females. The study was carried out in a nest aggregation in the Restinga area in Coroa Vermelha, Santa Cruz de Cabrália, Bahia. To investigate nesting occurrence and aspects, monthly visits were conducted between December 2021 and December 2022. During the reproductive period, emergence traps and dorsal-thorax marking of emerging females were used for subsequent verification of these in the foundation of new nests. Centris aenea proved to be a univoltine and protandric bee. Furthermore, of the 14 marked emerging females, 11 returned to nest in the aggregate. Thus, the philopatry suggested in some studies for solitary bee species was confirmed in this study.

Among solitary bees, which represent approximately 85% of all bee diversity (Michener, 2007), the Centridini tribe is one of the most diverse in the Neotropical region (Michener, 2007; Silveira et al., 2002). Traditionally, this tribe comprises two genera: *Centris* Fabricius 1804 and Epicharis Klug 1807. *Centris* is the most diverse genus, with about 230 species, widely distributed throughout the Americas (Moure et al., 2007; Vivallo, 2020), whereas *Epicharis* currently has 35 cataloged species and is restricted to the Neotropics (Moure et al., 2012).

In the genus *Centris*, most species build their nests in the ground, and some of them use pre-existing cavities in dead wood for nesting (Coville et al., 1983; Frankie et al., 1993).

The target species of this study, *Centris* (*Centris*) *aenea* Lepeletier, 1841, is a medium-sized bee with a wide geographical distribution (Moure et al., 2012) and is present in various habitats in Brazil, especially in areas of open vegetation, such as Caatinga (Martins, 1994; Zanella, 2000), Cerrado (Silveira & Campos, 1995), and Restinga (Silva & Martins, 1999; Viana & Alves-dos-Santos, 2002). The species' nesting biology was described by Aguiar & Gaglianone (2003), demonstrating that it nests on the ground and in aggregations.

The construction of nests in aggregations and their persistence in nature (Aguiar & Gaglianone, 2003; Dec & Vivallo, 2019; Pina et al., 2020; Sabino et al., 2017; Uemura et al., 2021) indicate that females of the Centridini tribe return to their birthplace to build their nests. This probable philopatric behavior may have negative effects, such as high levels of kinship within populations (Danforth & Ballard, 2003; López-Uribe et al., 2015; Paxton et al., 1996). However, returning to the same location may indicate assertive security from past nesting and reuse of abandoned

nests (Pina et al., 2020). Therefore, the objective of this research is to verify the philopatric behavior of the solitary bee *Centris aenea* that nested in a restinga area.

The research was conducted in a Restinga area in Coroa Vermelha (-16°27'S and -39°02'W), municipality of Santa Cruz Cabrália, located in southern Bahia (Google Maps, 2024) (Fig. 1).

The study area is in the Atlantic Forest domain, except for areas devastated by urbanization. According to Koppen's classification, the region's climate is AF, tropical humid and relatively homogeneous, with high average temperatures and high rainfall distributed throughout the year. The average annual temperature ranges from 22°C to 28°C, with the hottest and rainiest months from December

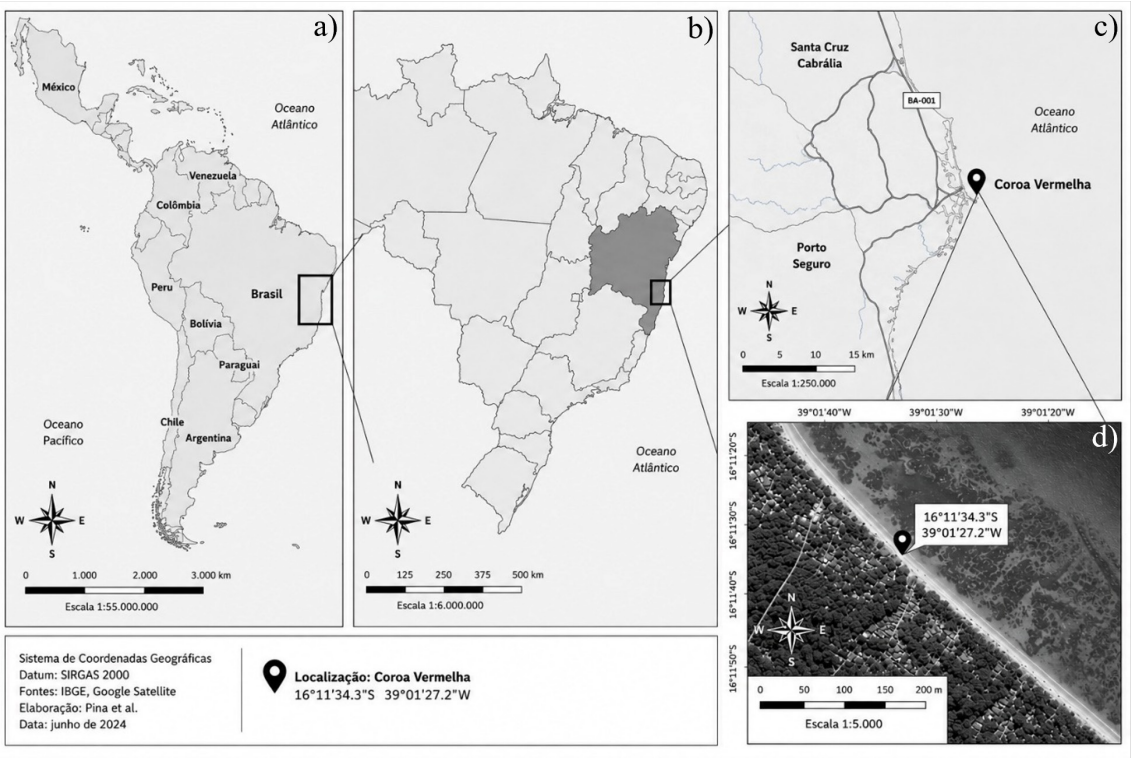

Fig. 1. Map of South America (a), highlighting Brazil, Bahia (b), the municipality of Santa Cruz de Cabrália (c) and the collection area at Coroa Vermelha beach (d).

to March and the coldest from June to August (Bahia, 1997).

The aggregation of *C. aenea* nests is located in an area close to sea level and currently occupies an area of approximately 600 m2, and the average density of nests in the aggregation is approximately one nest/m^2. The area where the nests are found is flat, with variable average nest density within the aggregation, and is composed of low vegetation, mainly morning glories, *Ipomoea cairica* (Sweet, 1826).

The aggregation was monitored by the research team of the Zoology Laboratory (LabZoo) of the State University of Bahia, Campus X. Specimens were collected, assembled, preserved, and identified using taxonomic keys. For this study, nesting activity was observed through one monthly visit conducted from December 2021 to December 2022. Observations were made between 6:00 a.m. and 6:00 p.m. during the dry days.

To verify the philopatry of *C. aenea*, emerging bees were captured using 10 ground emergence traps (covered with fine-mesh fabric), each measuring 1.5 m x 1 m x 0.5 m, which were randomly distributed throughout the nesting area within the aggregation (Fig. 2- (a)).

After the bees emerged in the traps, they were removed, anesthetized on ice, marked on the thorax (mesoscutum) with tags and/or painted (model: Posca Uniball Mitsubishi), and then released (following Pina et al., 2020) (Fig. 2 (b)). When new nests were founded and built, the bees were collected with an entomological net and checked for markings (Fig. 2 –(c)).

The nesting activity in the *Centris aenea* aggregation was recorded from October to December, with no nests in other months, clearly indicating that it is a univoltine species. A similar result was recorded by Aguiar & Gaglianone (2003) for the same species. In addition, one generation per year in bees of the tribe Centridini has been commonly reported (Alcock et al., 2009; Gaglianone, 2001; Sabino et al., 2017; Uemura et al., 2021).

In this study, male *C. aenea* began to emerge twelve days before females, confirming protandry. For the species targeted in this study, Aguiar & Gaglianone (2003), despite analyzing only a few brood cells, found average emergence times of 81 days for females and 64 days for males, demonstrating a pattern similar to that observed here.

Fig. 2. (a) Emergency traps randomly distributed in the aggregation of the solitary bee, *C. aenea*. (b) - Female C. aenea searching for a nest building site in the aggregation area. (c) - The solitary bee, *Centris aenea*, being collected in the nesting area for marking on the dorsal thorax (mesoscutum)

Of the 14 emerging females marked, 11 returned to nest in the aggregation, meaning that 78% of them returned and demonstrated philopatry or fidelity to their native site. Philopatry in solitary bee species has been suggested in some studies, especially in species of the genera *Centris* and *Epicharis* (Aguiar & Gaglianone, 2003; Alcock et al., 2009; Dec & Vivallo, 2019; Hiller & Wittmann, 1994; López-Uribe et al., 2015; Pina et al., 2020; Uemura et al., 2021); however, none of these studies have actually confirmed it. Thus, this research is the first to demonstrate philopatry in the tribe Centridini.

The persistence of this nest aggregation at the same site over consecutive years is likely associated with female philopatry and the favorable characteristics of the sandy soil, which provide suitable nesting conditions. In bees, nesting aggregations and philopatry may confer evolutionary advantages under specific conditions, such as reducing dispersal costs (Bonte, 2012) and increasing the probability of mate encounters at low population densities (Matthysen, 2005). On the other hand, it is expected that both behaviors can lead to high levels of inbreeding (Paxton et al., 1996), resulting in possible increases in the proportion of homozygotes, decreasing levels of individual genetic diversity (Hartl & Clark, 1997) and a possible reduction in the level of individual fitness (Freeland, 2005), as well as inbreeding depression in the population (Allendorf et al., 2012).

On the other hand, as it has been demonstrated that females are philopatric and have a univoltine life cycle, *C. aenea* males may be able to disperse to other aggregations, which would consequently increase gene flow in the nest aggregation and decrease levels of inbreeding, reducing the risk of inbreeding depression in the population (López-Uribe et al., 2015).

Finally, avoiding urbanization (which can negatively impact local and regional gene flow levels in native bees (Jha & Kremen, 2013; Lopéz-uribe et al., 2015) and limiting tourism/bathers in the area can provide important subsidies for the preservation, conservation, and expansion of this population in the environment. To ensure the long-term survival of these bees, it is essential that local authorities, environmental managers, and the public actively protect habitats, implement robust conservation strategies, and raise awareness of the ecological significance of these pollinators.

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Authors' Contribution

D.H.M.M: Investigation, visualization, writing - original draft, writing - review & editing

M.E.P.G: Writing - original draft, writing - review & editing

W.C.P: Supervision, writing - review & editing

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