Sociobiology 72(3): e11681 (September, 2025) DOI: 10.13102/sociobiology.v72i3.11681

Sociobiology
An international journal on social insects

SHORT NOTE

Monitoring a Nest Aggregation of a Solitary Ground Nesting Bee (*Epicharis nigrita* Friese) in an Urban Area

Celso F. Martins[1], Valdemar I. Santos Neto[1], Cândida Maria L. Aguiar[2]

1 - Departamento de Sistemática e Ecologia/CCEN, Universidade Federal da Paraíba, João Pessoa-PB, Brazil

2 - Departamento de Ciências Biológicas, Universidade Estadual de Feira de Santana, Feira de Santana-BA, Brazil

Article History

Edited by
Evandro Nascimento Silva, UEFS, Brazil
Received 03 May 2025
Initial acceptance 28 June 2025
Final acceptance 03 August 2025
Publication date 16 September 2025

Keywords
Apidae, Epicharitini, nesting biology, population fluctuation.

Corresponding author
Celso F. Martins
Departamento de Sistemática e Ecologia/CCEN, Universidade Federal da Paraíba, João Pessoa-PB, Brasil.
E-Mail: celsofmartins@gmail.com

Abstract

Bees are one of the most important ecological (as pollinators of cultivated and wild plant species) and economic (fruits and seeds produced by pollination, and several bee products commercialized and consumed) groups of insects. Most bee species are solitary and ground nesting, and some form nest aggregations that can last for some years. Here, we studied a nest aggregation of *Epicharis nigrita* Friese from 2013 to 2025 in an urban area. We found that bee populations can vary from one year to the next and may persist for many years despite human interventions in the ground areas used by females to build nests. The aggregation of this species persists for at least 23 years in the area.

Epicharis (*Xanthepicharis*) *nigrita* Friese is a ground nesting bee species of Epicharitini (Hymenoptera, Apidae) distributed in the Neotropical region (Brazil) (Moure & Melo, 2023). Interestingly, for tropical species, most *Epicharis* species are univoltine and nest only in the hot season during three months of the year, forming aggregations (e.g. Hiller & Wittmann, 1994; Inouye, 2000; Gaglianone, 2005; Rocha-Filho et al., 2008; Gaglianone et al., 2015; Thiele & Inouye, 2007; Vivallo, 2020; Pina et al., 2020; Uemura et al., 2021). *Epicharis* species are also important pollinators of crops and native plant species (e.g., Vilhena et al., 2012; Sazan et al., 2014; Giannini et al., 2015; Wolowski et al., 2019).

At the beginning of nest digging, nest entrances are surrounded by a tumulus approximately 7cm in diameter and 3-5 cm high (Fig 1). The entrance led to a vertical main tunnel that may extend 80 cm below the surface, with lateral tunnels branching off. Brood cells were at 17–80 cm depth (Martins et al. 2019).

In our study site, in general, the peak of nest density of *E. nigrita* occurs in the first week of January or end of December (nesting season from December to February, median of 3.0–32.3 nests per 1-m^2 quadrat) and each female builds nests during a medium period of activity in each nest of 6.9 days, producing 4–5 brood cells in average (Martins et al., 2019). However, females exhibit considerable plasticity during nest construction, cell building, and oviposition within each nest, as they may remain active for 2 to 26 days in each nest (Martins et al., 2019; C.F. Martins, unpublished data).

Although it is known that some non-Epicharitini bee aggregations can persist for 20-37 years (Michener, 1974; Neff, 2003) and as long as 50 years in the case of the sustainably managed *Nomia melanderi* Cockerell (Cane, 2008), most ground nesting bee aggregations have not been monitored so far. The only data found for Epicharitini consisted of an aggregation of *Epicharis dejeanii* Lepeletier, with at least six years of records (Uemura et al., 2021), and aggregations of

ISSN: 0361-6525

Epicharis metatarsalis Friese, whose larval provisions were sampled between 1996 and 2005 (Thiele & Inouye, 2007).

To determine how long one aggregation of *E. nigrita* can remain active, we continued to monitor the same nest aggregation previously studied during four nesting seasons from 2013 to 2017 (Martins et al., 2019). From 2013 to 2025, nests were counted in six 1-m^2 quadrat samples per subarea, per week, and per nesting season (Fig 2).

Fig 1. Nest entrances at the beginning of the nesting season, showing a tumulus with a diameter of approximately 7 cm and a height of 3-4 cm. For more details on nests, including videos, see Martins et al. (2019).

Fig 2. Sampling the number of nests using the 1-m^2 quadrat sampler.

This nest aggregation of *E. nigrita* was established in a central garden (total area of 300 m², excluding cement walkways) of a hospital in an urban area of João Pessoa city (7º 9' 11" S; 34º 50' 28" W), Paraiba State, Northeastern Brazil. Because the walls of two floors surrounded the central garden, it was only fully sunny at midday. Surrounding the hospital garden area are vacant lots and urbanized areas with houses and buildings. Approximately 400 m away is a 471-ha fragment of a well-conserved Atlantic Rainforest, where bees find floral resources (Martins et al., 2019). However, in December 2017, a chapel was built in the central garden area, and only two smaller subareas (gardens) remained (garden A: 35 m², and garden B: 30 m²). Females of *E. nigrita* continued to build nests in gardens A and B. Nevertheless, it is interesting to note that in subsequent years, after the chapel construction, females started to build nests in another garden, also surrounded by the walls of two floors, 25 m from the first two gardens (garden C: 40 m²)

It was noted that in the first two nesting seasons of the study, the average nest density was higher in garden A (Fig 3). Particularly during the 2013-2014 season, the peak nest density reached 78 nests/m², with an average of 50.5 nests/m². The nest density decreased approximately fivefold, without a clear reason, in the third and fourth nesting seasons of the study (2015-2016 and 2016-2017), showing a significant difference (Table 1). A further decline occurred after 2017, following the construction of a chapel (2018-2023), with a slight recovery in 2024-2025. Overall, there were significant differences in nest densities among the three groups of nesting seasons: 2013-2014/2014-2015, 2015-2016/2016-2017, and 2018-2025 (Table 1).

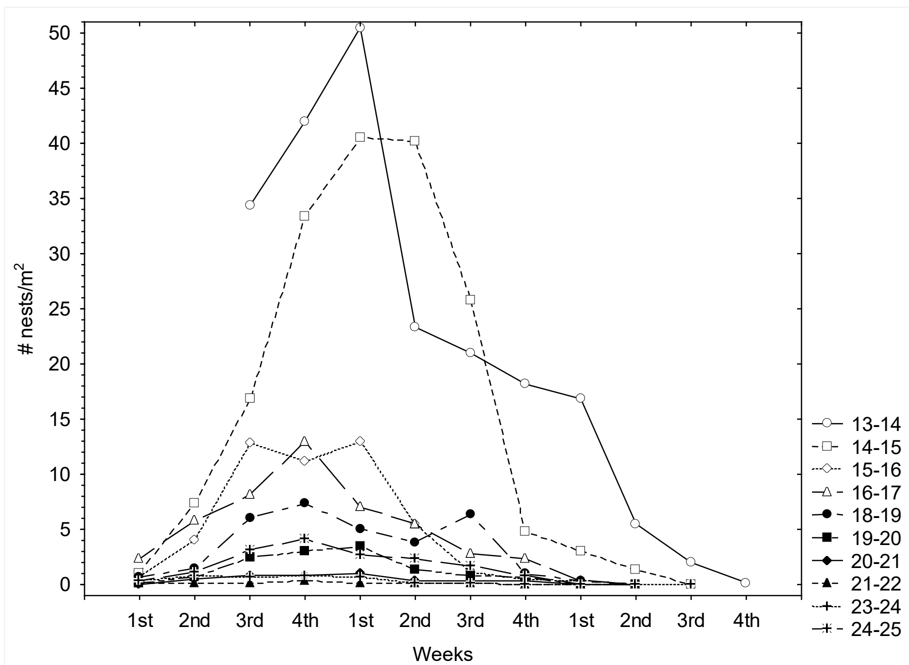

Fig 3. Mean nest abundance/m² per nesting season along the weeks of December, January, and February of each year at garden A. The first four weeks on the X axis correspond to December, the next four to January of the following year, and the last four to February. The years 2013-2014 are represented as 13-14, and so on.

Table 1. Results of Kruskal-Wallis analysis comparing nest abundance/m² between years (nesting season) at garden A. The abundance of nests across all years was significantly different (Kruskal-Wallis H = 226.5285, $p < 0.0001$). Subsequently, each pair of years was compared a posteriori using the Dunn test. The years 2013-2014 are represented as 13-14, and so on.

Years	13-14	14-15	15-16	16-17	18-19	19-20	20-21	21-22	23-24	24-25
13-14		ns	*	*	*	*	*	*	*	*
14-15			ns	ns	ns	*	*	*	*	*
15-16				ns	ns	ns	*	*	*	ns
16-17					ns	ns	*	*	*	ns
18-19						ns	*	*	*	ns
19-20							ns	*	ns	ns
20-21								ns	ns	*
21-22									ns	*
23-24										*

ns = not significant, * = p<0.05

Similarly, in garden B, the average nest density was higher in the first two years of the study, with a significant decrease in subsequent nesting seasons (Fig 4, Table 2). There were no significant differences between the number of nests built in the 2013-2014 and 2014-2015 nesting seasons. However, these two nesting seasons showed significant differences with the number of nests built in the subsequent nesting seasons (Table 2).

As highlighted earlier, after the construction of the chapel, many females began to nest in garden C. It is observed that there was a fluctuation in nest density over the years (Fig 5). There was an intermediate number of nests built in the 2018-2019 and 2019-2020 nesting seasons (maximum of 5-7 nests/m^2), with an increase in the 2020-2021 and 2021-2022 seasons (maximum of 10-14 nests/m^2). In the years corresponding to the 2022-2023, 2023-2024, and 2024-2025 nesting seasons, human interventions occurred in the area of garden C, first with the placement of a small dense gravel, then painting the walls and walking over the nests, and then finally planting a dense grass, respectively. All these interventions resulted in a drastic reduction in the bare ground area available for nesting, and consequently, in the number of nests (Fig 5, Table 3).

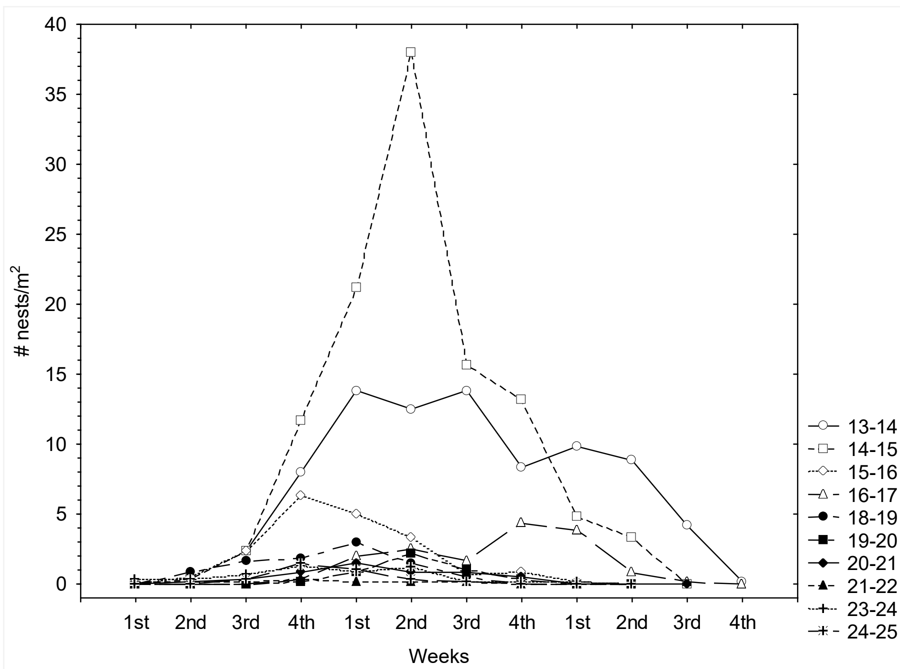

Fig 4. Mean nest abundance/m^2 per nesting season along the weeks of December, January, and February of each year at garden B. The first four weeks on the X axis correspond to December, the next four to January of the following year, and the last four to February. The years 2013-2014 are represented as 13-14, and so on.

Table 2. Results of Kruskal-Wallis analysis comparing nest abundance/m2 between years (nesting season) at garden B. The abundance of nests for all the years compared together was significantly different (Kruskal-Wallis $H = 212.8717$, $p < 0.0001$). Subsequently, each pair of years was compared a posteriori using the Dunn test. The years 2013-2014 are represented as 13-14, and so on.

Years	13-14	14-15	15-16	16-17	18-19	19-20	20-21	21-22	23-24	24-25
13-14		ns	*	*	*	*	*	*	*	*
14-15			*	*	*	*	*	*	*	*
15-16				ns	ns	*	*	*	*	*
16-17					ns	ns	ns	ns	ns	ns
18-19						ns	ns	ns	ns	ns
19-20							ns	ns	ns	ns
20-21								ns	ns	ns
21-22									ns	ns
23-24										ns

ns = not significant, * = p<0.05

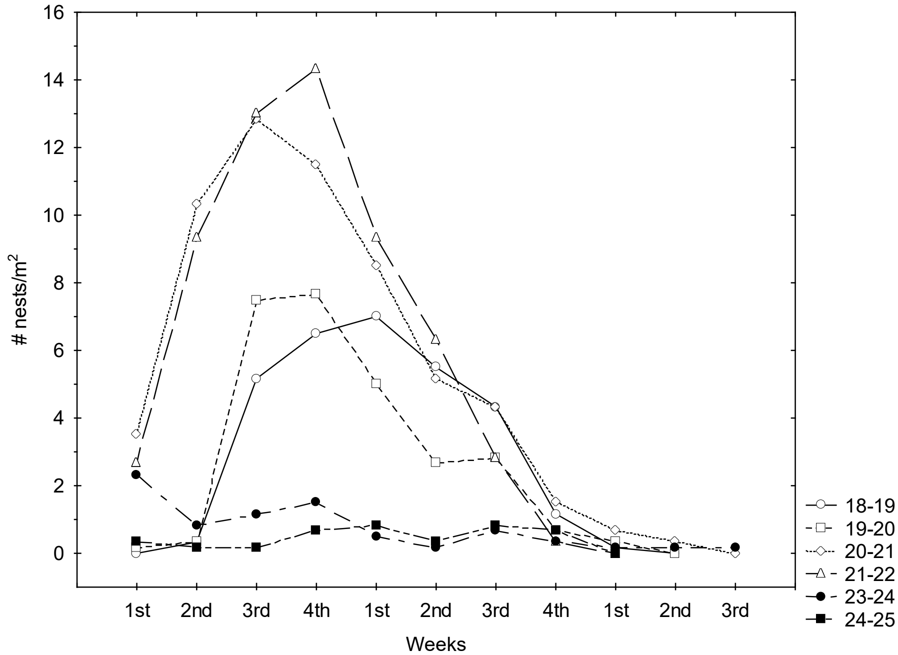

Fig 5. Mean nest abundance/m² per nesting season along the weeks of December, January, and February of each year at garden C. The first four weeks on the X axis correspond to December, the next four to January of the following year, and the last three to February. The years 2018-2019 are represented as 18-19, and so on.

The dense layer of gravel and grass also prevented the emergence of adults, which spend most of the year as prepupae in the lower layers of the soil (Martins et al., 2019).

Therefore, it is noted that the aggregation of nests in general has decreased over the years, for unknown reasons and due to human interference. However, there was a change in location after a major interference, such as the construction of a chapel. After the first two nesting seasons, there was an increase in two subsequent nesting seasons. The nesting aggregation had existed for at least 11 years before the study began, according to personal information provided by several hospital staff members. Thus, in 2025, the aggregation has existed for at least 23 years. The data show that the ground nesting *E. nigrita* can nest in the same area for decades and that population size fluctuates over time. Furthermore, despite negative human pressure, females can be resilient, adapting to new areas and recovering populations. However, due to the enormous human pressure resulting from the hospital expansion, this aggregation is at a greater risk of disappearing. This highlights the importance of maintaining natural or free intervention areas for the conservation of this species that depends on these environments.

Table 3. Results of Kruskal-Wallis analysis comparing nest abundance/m2 between years (nesting season) at garden C. The abundance of nests for all the years compared together was significantly different (Kruskal-Wallis $H = 58.5672$, $p < 0.0001$). Subsequently, each pair of years was compared a posteriori using the Dunn test. The years 2018-2019 are represented as 18-19, and so on.

Years	18-19	19-20	20-21	21-22	23-24	24-25
18-19		ns	ns	ns	*	*
19-20			ns	ns	*	*
20-21				ns	*	*
21-22					*	*
23-24						ns

ns = not significant, * = p<0.05

Acknowledgments

We thank the staff of HNL for allowing us to conduct the study in the hospital gardens.

Authors' Contributions

CFM: Conceptualization, formal analysis, investigation, data curation, writing-original draft, review and editing.
VISN: Investigation, data curation, writing-original draft.
CMLA: Writing-original draft, review and editing.

Declaration of Competing Interests

All authors declare that they have no conflict of interest.

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