International Journal of Scholarly Research in
Multidisciplinary Studies
Journal homepage: https://srrjournals.com/ijsrms/
ISSN: 2961-3329 (Online)

(RESEARCH ARTICLE)

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Floral visitors of the muricizeiro *Byrsonima verbascifolia* (L.) rich in the Atlantic forest of northeast Brazil

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International Journal of Scholarly Research in Medicine and Dentistry, 2023, 02(02), 052–057

Publication history: Received on 29 April 2023; revised on 14 June 2023; accepted on 16 June 2023

Article DOI: https://doi.org/10.56781/ijsrms.2023.2.2.0063

Abstract

The muric tree (*Byrsonima verbascifolia* (L.) Rich) is a native fruit plant used by humans for various purposes, from edible fruits to the medicinal uses of its leaves, bark, and fruits. Bees are the main pollinators of wild and cultivated plants, and without pollination, there is no formation of fruits and seeds, so floral visitors perform ecosystem services in exchange for pollen, nectar, and oil. Muricizeiro offers pollen and oils to its floral visitors, which attracts several species of native bees to its inflorescences, mainly *Centris* and *Epicharis* bees, specialists in oil collection. Thus, the presence of muric trees close to the planting area can contribute to the pollination of the cultivated plants. The objective of this study was to survey floral visitors to muricizeiro in São Cristóvão. The work was carried out in the Emília Maria settlement in São Cristóvão, Sergipe, where the floral visiting bees of muricizeiro were captured with an entomological net, for ten days, in the morning and afternoon. Twelve bee species belonging to the Apidae and Halictidae families were collected, with the most abundant species being *Euglossa chalybeata* (38.41%) and *Eulaema nigrita* (25.42%). The presence of *Eulaema nigrita* is related to environmental changes during the implementation of agriculture. The specimens were deposited in the entomological collection of the IFS/Campus São Cristóvão.

Keywords: Murici; Pollination; Solitary bee; Native bee; Ecological function

1 Introduction

It is estimated that in the genus *Byrsonima*, belonging to the Malpighiaceae family, there are about 200 species, 100 of which are widely distributed in the country, characterized by individuals with bushy and arboreal habits, yellow inflorescences and colorful and edible fruits [1, 2].

The muricizeiro *Byrsonima verbascifolia* (L.) Rich, is a plant native to the North and Northeast of Brazil, occurring in the Cerrado zones of the Amazon, coastal tablelands, Cerrados and coastal lowlands of the Northeast and Cerrados of Central Brazil to the Pantanal [3]. It has a size between 1 and 5m in height, tortuous trunk with thick and rough bark; simple leaves concentrated at the end of the branches, short-petiolate; simple raceme inflorescences concentrated at the end of the branches, with many yellow and red flowers. The fruit is a globose drupe, with a juicy and sweet pulp; yellow; thin; from 1 to 3 locules with about 6mm in diameter, seeds 1 to 3, adnata to the endocarp; slightly larger calyx in the fruit [4, 5].

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In Northeastern Brazil, the muricizeiro presents leaf abscission in the months of less precipitation (July to December), sprouting of new leaves at the end of the rainy season (August) until October, and few plants can flower during the year, but the intensity of flowering is observed in the months of October and November and fruiting in the months of November and December [3].

The fruits are of the globose drupe type, with fleshy mesocarp, edible and much appreciated by local populations, and can be consumed in natura or sold in the form of pulps, juices, jams, jellies, ice creams and liqueurs [5, 6], in addition to being mixed with brandy. Edible oil is extracted from the seed or for the food and cosmetics industry [7].

The production of fruits and seeds is related to pollination carried out mainly by bees. Knowledge of floral biology, pollinators and understanding of the reproductive system are key points to understand the reproductive biology of species and interactions between plants and animals and their evolutionary and adaptive processes [8].

Bees seek pollen, nectar, oils and resins. In this way, one can find several species of Apoidea in search of floral resources [9, 10, 11]. As Murici flowers do not offer nectar, it is common for oil-collecting bees to visit, belonging to the Centridini, Tapinotaspidini and Tetrapediini tribes. These bees actively collect oil through the friction of the basitarsal combs (modified hair structures) located on the anterior and middle legs, which break the cuticle of the elaiophores (oil-producing structures). Then, the oil is transferred to the scopes of the hind legs and transported to the nest [10]. Floral oils are used by bees to build nests [12], are mixed with pollen to feed larvae (honey bread) [10, 11], and adults [13], while most bees are looking for pollen.

Among insect-plant interactions, pollination is one of the most important for fruit and seed production. It is therefore necessary to show that there are hundreds of other species in Brazil besides the honeybee (*Apis mellifera*) that play important roles in pollination and maintenance of ecosystems and in increasing the productivity of agriculture and food production [14].

The value of bees and other pollinators for maintaining biodiversity is incalculable. Many of the species have not yet been identified, with huge gaps in information mainly for species occurring in the tropical region. Studies show that only 2% of wild species that act in agricultural pollination are responsible for about 80% of pollination services (GARIBALDI 2016). Thus, the importance of regional wild pollinators has been emphasized in many publications promoting better pollination that results in better quality fruits and crops with higher yields (KLATT *et al*. 2014; GIANNINI *et al*. 2015; JUNQUEIRA & AUGUSTO 2017).

Among the pollinators, according to SILVEIRA *et al*. (2002), the bees of the genus *Eulaema* Lepeletier, 1841, have 22 species distributed from Rio Grande do Sul to Mexico. The genus *Euglossa* Latreille, 1802, is the most diverse of the Euglossina genera and also the one that contains the smallest bees within the subtribe. They present metallic green or blue coloration, in some species they present areas of red, coppery or violet coloration. They are low frequency floral visitors, usually attracted by essences or scent bait. The species is distributed from Paraguay to Mexico.

The genus *Trigona* Jurine, 1807, is one of the largest Neotropical Meliponina genera, with species from northern Argentina to Mexico. In Brazil, there are about 20 species. The genus *Oxytrigona* Cockerell, 1917, has the species *O. ignis* Camargo, 1984, *O. obscura* (FRIESE 1900) and *O. tataira* Smith, 1863, described for Brazil. The genus *Melipona* Illiger, 1806 consists of a large number of species occurring throughout the neotropical region with greater diversification in the Amazon basin. In the genus *Apis* Linnaeus, 1758, there are eight species distributed in the world, and in Brazil only *A. mellifera* Linnaeus, 1758 occurs.

The genus *Centris* Fabricius, 1804, is divided into several subgenera, brings together a large number of species distributed from Argentina and Bolivia to the United States, they are abundant in humid tropical regions, however, some groups occur in temperate semi-arid regions. All *Centris* species appear to be solitary, although nests form large aggregations on the ground. Epicharis Klug, 1807 is a moderately diverse genus that occurs from Argentina and Bolivia to Mexico. It is considered the sister group of *Centris*.

The genus *Augochlora* Smith, 1853, contains 131 species (most of them in South America) and has a geographical distribution approximately equal to that of the Augochlorini. Four subgenera are recognized, of which two occur in Brazil. *Megalopta* Smith, 1853, is a genus with many crepuscular or even nocturnal species, being attracted by artificial sources of light. It is divided into two subgenera, with the 11 species that occur in Brazil belonging to *Megalopta* s.str.

Based on the above, this work aims to survey the floral visitors of Murici, in a remnant of Atlantic forest in São Cristóvão, Sergipe.

2 Material and methods

The study was carried out at the Emília Maria camp in São Cristóvão, Sergipe (S 10°57'04" W 37°09'58"), at an altitude of 43 m. It is a remnant of the Atlantic Forest, where part of the area is being deforested for the implementation of family farming for Landless Movement (MST) settlers. The region has an average temperature of 25.5ºC and a relative humidity of 75%, with the rainy season concentrated between April and August (DANTAS *et al*. 2012). According to the Köppen classification, the climate of the region is as follows: As, tropical rainy with dry summers (Figure 1).

Figure 1 Camp Emília Maria in São Cristóvão, Sergipe, Brazil

The Murici plants used for collecting bees were in open areas resulting from deforestation. Bees were collected with entomological nets in the morning (6:00 am to 10:00 am) and afternoon (3:00 pm to 6:00 pm) on 10 uninterrupted days, in February, the peak phase of flowering. Bees were collected from the IFS Animal Biology Laboratory for assembly and identification. The specimens were deposited in the entomological collection of the IFS/Campus São Cristóvão. Data were treated with descriptive statistics.

3 Results and Discussion

A total of 177 bee specimens were collected and distributed across 12 species, two families and three tribes. The family Apidae had the highest number of species (10 species), corresponding to 83.33%, followed by Halictidae, with two species (16.66%). The most abundant species were *Euglossa chalybeata* (38.41%), followed by *Eulaema nigrita* (25.42%), both of which were from the Apini tribe. The other species together represented 36.17% of the individuals collected. *A. caerulior*, *Melipona quadrifaciata*, and *Euleama athleticana* were the least abundant (Table 1).

According to RÊGO *et al*. (2006) and VINSON *et al*. (1997), in Brazil, muricizeiro is considered a flagship plant and can attract a great diversity of bees to its inflorescences, whether for pollen and/or oil collection. Being common the occurrence of diversity of floral visitors, as registered by RIBEIRO *et al*. (2008), in Maranhão, where he collects bees from the Halictidae family, with three species, and the Apidae family, with 15 species. RAMALHO & SILVA (2002) also reported two families in Bahia, corroborating this work. In a study by TEIXEIRA & MACHADO (2000), carried out in Pernambuco, they recorded only three species of Apidae; however, despite the families being the same, the species are different, showing that there is a variety of species that visit the inflorescences of muricizeiro.

Bees of the *Centris* and *Epicharis* genera specialize in oil and pollen collection (OLIVEIRA *et al*., 2015). *Centris* species stand out because they are considered key pollinators in the maintenance of several plant species in tropical ecosystems, including Murici (RAMALHO & SILVA 2002; REGO *et al*. 2006). In this study, only one species of *Centris* was recorded, unlike the work by RIBEIRO *et al*. (2008), who recorded a great diversity of species, as well as the work by MENDES *et al*. (2011), where the genus *Centris* was the most diverse.

The abundance of *Eulaema nigrita* (25.42%), the second most abundant species, corroborates the anthropic changes observed in the study area, as these bees are usually found in open areas and are constantly affected by anthropic actions, which are common in cities and are considered indicators of environmental changes (PERUQUETTI *et al*. 1999). Despite the existence of a relatively conserved Atlantic Forest fragment, the number of this recorded bee species reflects the changes suffered by deforestation in the region.

Table 1 *Byrsonima verbascifolia* (L.) floral visitor bee species collected in São Cristóvão, Sergipe. NI: number of individuals; % relative abundance

Family/ Tribe	**Species**	**NI**	**%**
Apidae/ Apini	*Eulaema nigrita* (Lepeletier, 1841)	45	25.42
	Euleama atleticana Nemésio, 2009	01	0.56
	Euglossa augaspis Moure 1966	03	1.69
	Euglossa chalybeata Friese, 1925	68	38.41
	Trigona spinipes (Fabrício, 1793)	08	4.51
	Oxytrigona tataira (Smith, 1863)	14	7.90
	Melipona quadrifaciata Lepeletier	01	0.56
	Apis mellifera L.	10	5.64
Apidae/ Centridini	*Centris vittata* Lepeletier, 1841	10	5.64
	Epicharis flava (Friese, 1900)	04	2.25
Halictidae / Augochlorini	*Augochlora caerulior* Cockerell, 1900	01	0.56
	Megalopta amoena (Spinola, 1851)	12	6.77
Total / Frequency		177	100

The Emília Maria settlement is an example of what happens in other places destined for this type of land use: deforestation of a part of the area for housing and implementation of family agriculture. However, the conservation of native vegetation fragments is of paramount importance for the maintenance of local native bees, guaranteeing the pollination of wild species for the maintenance of the Atlantic Forest and other native vegetation, depending on the ecosystem and the cultivated species, and improving agricultural production (OLIVEIRA *et al*. 2015).

Solitary bees occur in agricultural areas when there are oil-producing plants in their flowers, as the oil is used to build nests and feed the immature ones. Thus, the cultivation areas in consortium with plants that provide oil, such as the acerola tree (*Malpighia punicifolia* L.) and muricizeiro (*Byrsonima crassifolia*), can increase productivity, as it allows the establishment of these bees in the areas, raising the level of pollination, and consequently, productivity (KLEIN *et al*., 2014; KLEIN *et al*., 2020).

4 Conclusion

The Emília Maria settlement is located in a fragment of the Atlantic Forest of Sergipe, and as a hotspot area, it must have the maximum conservation of its floral resources for the maintenance of bee fauna.

The muric tree was used as a bee sampling plant because it is an attractive plant for several species of social and solitary native bees, it is part of the natural landscape, and it has been spared from deforestation, even in areas of agricultural cultivation.

There was a diversity of bees visiting the inflorescences of the muric tree, with a predominance of *Euglossa chalybeata* and *Eulaema nigrita*, species adapted to the collection of aromatic substances.

The Atlantic Forest fragment studied is in constant environmental degradation; therefore, it is necessary to continue monitoring the bee species that occur and their relationships with native and cultivated plants.

Compliance with ethical standards

Acknowledgments

The authors thank all the contributors for this study.

Disclosure of conflict of interest

No conflict of interests.

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