Urban parks as a functional area for the maintenance and diversity of bee populations

Parques urbanos como área funcional para a manutenção e diversidade das populações de abelhas

DOI: 10.55905/revconv.16n.10-098

Recebimento dos originais: 01/09/2023
Aceitação para publicação: 03/10/2023

Walkiria Aparecida Benites
Master in Entomology and Biodiversity Conservation by Universidade Federal da Grande Dourados (UFGD)
Instituição: Universidade Federal da Grande Dourados
Address: Dourados - MS, Brasil
E-mail: walkiriaaparecidaw@gmail.com

Jean Carlos dos Santos Lima
Master in Plant Production by Universidade Estadual do Norte Fluminense Darcy Ribeiro (UENF)
Instituição: Universidade Federal da Grande Dourados
Address: Dourados - MS, Brasil
E-mail: jecarloslima@gmail.com

Cristiano Ramos Gonçalves
Master in Entomology and Biodiversity Conservation by Universidade Federal da Grande Dourados (UFGD)
Instituição: Universidade Federal da Grande Dourados
Address: Dourados - MS, Brasil
E-mail: cristianogonca.bio@gmail.com

Favízia Freitas de Oliveira
PhD in Biological Sciences - Entomology by Universidade Federal do Paraná (UFPR)
Instituição: Universidade Federal da Bahia
Address: Salvador - BA, Brasil
E-mail: favizia.freitas@ufba.br

Valter Vieira Alves Júnior
Doctor in Zoology by Universidade Estadual Paulista "Júlio de Mesquita Filho" (UNESP)
Instituição: Universidade Federal da Grande Dourados
Address: Dourados - MS, Brasil
E-mail: valteralves@ufgd.edu.br

ABSTRACT
Urbanization restricts native vegetation to small fragments surrounded by paved areas, grasses and degraded areas that strongly affects several biotic communities, including pollinator...
populations, which are not only greatly affected, but are also declining in several parts of the world. Bees are considered to be the main organisms to perform pollination, as they need to visit a great number of flowers daily to satisfy their individual food needs, their offspring and their colony, since they depend on floral resources at all stages of their life. Thus, the aim of this study was to verify the effectiveness of urban parks as refuges for bee species, having its veracity as a hypothesis. It was considered to evaluate the diversity of bees and their foraging activities in plant species in two urban parks over a year located in the city of Dourados-MS/Brazil. Sampling was performed every two weeks, from 8:00 a.m. to 4:00 p.m. for 13 months, from 2019 to 2020. For this purpose, active samplings were carried out with an aerial entomological net. Bee species were found distributed in 5 families: Apidae, Halictidae, Colletidae, Megachilidae and Andrenidae. *Apis mellifera* was the most abundant species followed by *Trigona spinipes*. Considering the two parks, 34 species of bees visiting 33 plant species were sampled. Results suggest that urban parks represent a significant area for maintenance of bee populations in the city of Dourados - MS, protecting a very diverse fauna, confirming the hypothesis that urban parks represent relevant and functional areas for bees, helping in the diversity maintenance of these pollinating organisms.

**Keywords:** apidae, halictidae, biodiversity, pollinators, urban bees.

**RESUMO**
A urbanização restringe a vegetação nativa a pequenos fragmentos cercados por áreas pavimentadas, gramíneas e áreas degradadas, o que afeta fortemente várias comunidades bióticas, inclusive as populações de polinizadores, que não só são muito afetadas, mas também estão em declínio em várias partes do mundo. As abelhas são consideradas os principais organismos a realizar a polinização, pois precisam visitar um grande número de flores diariamente para satisfazer suas necessidades alimentares individuais, de sua prole e de sua colônia, uma vez que dependem de recursos florais em todas as fases de sua vida. Assim, o objetivo deste estudo foi verificar a eficácia dos parques urbanos como refúgios para espécies de abelhas, tendo como hipótese a sua veracidade. Considerou-se avaliar a diversidade de abelhas e suas atividades de forrageamento em espécies vegetais em dois parques urbanos ao longo de um ano, localizados na cidade de Dourados-MS/Brasil. A amostragem foi realizada a cada duas semanas, das 8:00 às 16:00 horas, durante 13 meses, de 2019 a 2020. Para isso, foram realizadas amostragens ativas com uma rede entomológica aérea. Foram encontradas espécies de abelhas distribuídas em 5 famílias: Apidae, Halictidae, Colletidae, Megachilidae e Andrenidae. *Apis mellifera* foi a espécie mais abundante, seguida por *Trigona spinipes*. Considerando os dois parques, foram amostradas 34 espécies de abelhas visitando 33 espécies de plantas. Os resultados sugerem que os parques urbanos representam uma área significativa para a manutenção das populações de abelhas na cidade de Dourados - MS, protegendo uma fauna bastante diversificada, confirmando a hipótese de que os parques urbanos representam áreas relevantes e funcionais para as abelhas, auxiliando na manutenção da diversidade desses organismos polinizadores.

**Palavras-chave:** apidae, halictidae, biodiversidade, polinizadores, abelhas urbanas.
INTRODUCTION

Urbanization is a global reality and along with it, there is an increase in the use of natural resources, these two factors are inherent to the development of societies. However, it became aware that such resources are finite, and for them not to run out, it is necessary to use them in a sustainable way (Millennium Ecosystem Assessment, 2005).

Human occupation in cities causes a mosaic of heterogeneous matrices composed of parks, residential and commercial areas, combined with the inappropriate introduction of exotic flora and fauna, which can lead to an imbalance between extinction and immigration rates (McIntyre, 2000; McIntyre et al., 2000; Wu, 2014). Such transformations mainly result in the loss of biodiversity, both of animal and plant species that originally used to occur in a certain location, especially several insect species (Seto et al., 2013; Cardoso and Gonçalves, 2018), sometimes also causing the replacement of species and the favoring of synanthropic species.

Pollinators are one of the populations affected by environmental degradation, and consequently, they have been declining in various regions of the world (Potts et al., 2010). Bees are considered the main pollinating organisms (Shepherd and Ross, 2003; Ricketts et al., 2004) because, even though they vary in size, shape and life habits, they all need to visit, daily, a large number of flowers to satisfy their individual food needs, as well as their offspring or their colonies (Michener, 2007), depending on floral resources in all their life stages, and that is why they are known as essential pollinators.

Pollination performed by bees is considered an essential ecosystem service, acquiring a role of great significance, both in the conservation of ecosystems and in the productivity of agricultural derivatives, so it is necessary to pay attention to agricultural management techniques and conservation practices (Imperatriz-Fonseca and Nunes-Silva, 2010; Ayers and Rehan, 2021).

Bee diversity studies comprising different types of environments is a significant starting point that can result in useful information for decision makers (Anacleto and Marchini, 2005). There are approximately 20,800 bee species already known to science worldwide (Ascher & Pickering, 2023), in which the tropical and subtropical regions is the most biodiverse areas. Brazil has a bee fauna around 2000 species already known to science (Ascher & Pickering, 2023), this represented by five families, but with an estimated biodiversity of more than 3,000 species to be found in the country (Silveira et al., 2002; Silva et al., 2014).
Since bees are completely dependent on flowers as their main source of food (Banaszak-Cibicka et al., 2018), different species of bees are directly affected by the urbanization process because it leads to the loss of local habitat and the exclusion of countless species (Normandin et al., 2017).

The hypothesis is that urban parks represent significantly functional areas for bees, helping to maintain the diversity of these organisms in the urban region. Thus, this study aimed to carry out a survey of bee diversity in two urban parks in the city of Dourados, State of Mato Grosso do Sul, located in the Midwest region of Brazil, as well as to describe the foraging behavior based on the plant species visited by these individuals.

2 MATERIAL AND METHODS

2.1 STUDY AREA

The study was carried out in the city of Dourados, located in the South of the Mato Grosso do Sul State, Brazil, at coordinates 22° 16´ 30´´ S, 54° 49´00´´W (EMBRAPA, 2016). Two municipal urban parks were listed: Arnulpho Fioravante Park and Antenor Martins Park, considered two large urban green areas in the city.

The AF Park has an area of 582,523.76m², holding important water sources and has an artificial lake that is home to many native species in the region, such as anacondas, capybaras, herons, among other fauna species (Santos et al., 2017). The AM Park has a demarcated area of approximately 244,049.00m², that includes a large artificial lake that was built to receive rainwater, in which, nowadays is used for sport fishing and recreation and leisure activities (Lunas and Ribas, 2013).

2.2 SAMPLING AND IDENTIFICATION OF BEE SPECIES

Every two weeks, samplings were carried out in each park, for 13 months, totaling 26 visits (2/month), between 8:00 a.m. and 4:00 p.m., from June 2019 to August 2020. Active sampling methodology was used with an entomological net made of voile fabric, with 0.40 m in diameter and cable reaching 1.60 m in length. Each specimen collected was transferred to a death chamber with ethyl acetate and subsequently packed in Kraft paper bags, identifying the park, day and time of sampling, as well as identification of the collection point for subsequent association with the botanical species of reference.
The definition of the sampling sites was based on the presence of flowering specimens in the local vegetation, considering only the bees on the flowers at the time of each sampling. Upon verifying the occurrence of flowering, the plant was observed for 20 minutes to verify if it would be visited by bees. In each positive occurrence, the botanical species was photographed at the time of the visit, and later the plant material was collected for the preparation of exsiccates, identification of the species and its relationship with the floral visitor. Bees were kept under refrigeration at the Apiculture Laboratory (LAP), Faculty of Biological and Environmental Sciences (FCBA) at Federal University of Grande Dourados (UFGD).

Subsequently, they were pinned with entomological pins, dried in an oven at 40 °C for 24 hours and, whenever possible, classified at the taxonomic level of species. Afterwards, they were transferred to entomological sampling boxes and kept at the LAP for further identification at the most refined taxonomic level.

For the initial identification of bees at the LAP, specific taxonomic keys for the group were used, according to Silveira et al. (2002) and, when necessary, sent to Laboratory of Bionomy, Biogeography and Insect Systematics (BIOSIS), located in the Biology Institute of the Federal University of Bahia (IBIO-UFBA) and analyzed by Dra. Favízia Freitas de Oliveira, a bee taxonomist. The plant specimens visited by bees, were stored and identified afterwards by Dr. Allan Sciamarelli, a specialist from FCBA/UFGD.

2.3 STATISTICAL ANALYSIS

The Shannon (H'), Simpson (D) and Pielou (J) indices were used to calculate, respectively, diversity, dominance, and evenness. Shannon index measures the degree of uncertainty in predicting which species an individual, chosen at random, will belong to. Thus, the lower the value of the Shannon index, the lower the degree of uncertainty. Therefore, the sample diversity is considered low. The Simpson's index varies from 0 to 1, where values close to 1 correspond to a greater probability of individuals belonging to the same species, that is, greater dominance and less diversity. The Pielou index, on the other hand, allows representing the uniformity of the distribution of individuals among the existing species, its value has a range from 0 to 1, where values close to 0 correspond to minimum uniformity and 1 to maximum uniformity.
The t-test was used to compare the richness and abundance of bees in both parks. The accumulation curve was constructed from data on species richness (S) versus sampling effort (n). Analyzes were performed using Past 4.03 and EstimateS 9.1.0 software (Colwell 2013).

3 RESULTS

3.1 SPECIES RICHNESS AND ABUNDANCE

Species richness and abundance between parks showed similarity (p=0.8233 and F=0.36711). In Arnulpho Fioravante Park, 1975 individuals were obtained from the following families: Apidae=1824, Halictidae=148, Colletidae=2 and Megachilidae=1, while in Antenor Martins Park, 2016 individuals from the following families were obtained: Apidae=1928, Halictidae=84, Colletidae =2, Megachilidae=1, Andrenidae=1. The diversity values obtained from the parks were (H'=2.09) for Arnulpho Fioravante Park and (H'=1.86) for Antenor Martins Park (Figure 1). Equitability and dominance recorded from both parks were Arnulpho Fioravante Park (J=0.19; D=0.7882) and Antenor Martins Park (J=0.21; D=0.7527).

![Species accumulation curve in both parks (AM = Antenor Martins Park; AF = Arnulpho Fioravante Park).](image)

In Arnulpho Fioravante Park, from a total of 24 genera identified, ten of them frequently appear in the interval between 7 and 13 months, namely: *Apis* (100%), *Trigona* (100%),...
Augochlora (100%), Tetragona (100%), Tetragonisca (100%), Paratrigona (92.30%), Xylocopa (69.23%), Centris (69.23%), Exomalopsis (61.53%) and Plebeia (53.84%).

While in Antenor Martins Park, from a total of 22 identified genera, 9 of them appear with a frequency of intervals between 7 and 13 months: Apis (100%), Trigona (100%), Augochlora (92.30%), Tetragona (84.61%), Tetragonisca (84.61%), Paratrigona (84.61%), Exomalopsis (76.92%), Plebeia (53.84%) and Centris (53.84%). The relative abundance of the genera sampled for both parks is shown in Figure 2. In addition, the genera common to both parks were: Apis, Trigona, Tetragona, Tetragonisca, Paratrigona, Exomalopsis, Centris, Melitoma, Melissaoptila, Diadasina, Plebeia, Nannotrigona, Thygater, Euglossa, Ceratina, Xylocopa, Augochlora, Pseudaugochlora, Hylaeus, Megachile; on the other hand, genera Tetrapedia, Ancyloscelis and Eufriesea, were restricted to Arnulpho Fioravante Park, while the genus Oxaea was restricted to Antenor Martins Park.

Figure 2. Relative abundance of bee genera found in both parks (AF=Arnulpho Fioravante Park; AM=Antenor Martins Park).

In both parks, the total foraging/month of bees in plant species had peaks of different frequencies. In Arnulpho Fioravante Park, the months with the highest frequency of visits were...
August and September, while in Antenor Martins Park those months were February and March (Figure 3).

Figure 3. Frequency of foraging by bees in flowering plants recorded according to the evaluation months in the urban parks of Dourados/MS between June/2019 to August/2020. (AF=Arnulpho Fioravante Park, AM=Antenor Martins Park).

The vegetation composition between the two parks was different. Thus, 34 bee species were recorded foraging a total of 33 plant species. From the identified bee species, three visited over 90% of the plants: *Apis mellifera* (Lepeletier, 1835) (100%), *Trigona hyalinata* (Lepeletier 1836) (91.30%) and *Trigona spinipes* (Fabricius, 1793) (91.30 %), all of them eusocial bee species of the Apidae family, which have very populous perennial colonies.

In Arnulpho Fioravante Park, 34 bee species visited 21 flowering plant species during the evaluation period, in which the three most visited plant species were *Sidastrum micranthum* (Malvaceae) (10.42%), *Erythina verna* (Fabaceae) (10.42%) and *Senna hirsuta* (Fabaceae) (8.56%), while in Antenor Martins Park, 30 bee species visited 23 plant species. The three most
visited plant species were *Callistemon viminalis* (Myrtaceae) (11.57%), *Erythina verna* (Fabaceae) (9.58%) and *Tridax procumbens* ((Asteraceae) (7.94%). The complete list of bee visits on plant species recorded in the parks is shown in Figures 4 and 5.

Figure 4. Frequency of relative abundance of bee visitation in the different species of flowering plants present in the Antenor Martins Park.

Figure 5. Frequency of relative abundance of bee visitation in the different species of flowering plants present in the Arnulpho Fioravante Park.
In Arnulpho Fioravante Park, the species that made the most visits were *A. mellifera*, (100%), *T. hialinata* (90.47%), *T. spinipes* (90.47%), *P. wasbaueri* (Gonzalez & Griswold, 2011), (80.95%), *Augochlorea sp* (76.19%), *T. clavipes* (Fabricius, 1804), (76.19%), *E. aurophilosa* (Spinola, 1853), (47.61%), *T. fiebrigi* (Schwarz, 1938), (47.61%), while the other bee species visited less than 10 plant species. In Antenor Martins Park, bee species with the highest frequency of visitation were *A. mellifera* (100%), *T. hialinata* (91.30%), *T. spinipes* (91.30%), *T. clavipes* (91.30%), *T. fiebrigi* (60.86%), *Augochlorea sp.* (60.86%), *P. wasbaueri* (56.52%), *E. aurophilosa* (47.82%) and *P. peruvicola* (Moure, 1994) (43.47%), while the others visited less than 10 recorded plant species.

4 DISCUSSION

In both parks, the three most representative genera were *Apis, Trigona* and *Tetragonula*, all of them showing eusocial behavior and very populous perennial colonies. Studies carried out in Brazil, such as those by Taura et al. (2007), Zotarelli et al. (2014) and Cardoso and Gonçalves (2018) demonstrated a tendency for eusocial bees to be more abundant in urban areas. The exotic eusocial species *A. mellifera* and the stingless bees *T. hialinata* and *T. spinipes*, found in great abundance in this study, are quite common in urban areas, especially because all of them do not depend on natural cavities to build their nests, building aerial nests that only require a fixing support. However, bee richness and abundance are dependent on regional or biogeographical aspects. Geslin et al. (2016) observed a greater abundance of individuals of the Halictidae family over the others while carrying out a survey of bee fauna in urban parks in Paris (France).

Factors that may contribute to the presence of *A. mellifera, T. hialinata* and *T. spinipes* species in these environments may be associated with: (1) having highly populated colonies, (2) foraging at great distances from their nests, (3) exploring numerous plant species, (4) efficient communication systems and (5) no need of pre-existing cavities for nesting (Neves and Viana, 2002).

Biesmeijer et al. (2005) and Biesmeijer and Slaa (2006) classify *A. mellifera* and *T. spinipes* species as super generalists, as they have the broadest niche of all eusocial species. It should also be considered that *A. mellifera* and *T. spinipes* are distinguished by their ability to nest in strategic places in urban areas, such as power poles, basements, house ceilings, building structures in general, trees that compose urban vegetation, among others. The main reason is
because these species benefit from this environment both for collecting resources and for nesting (Brun et al., 2007).

The low value of the Pielou index obtained can be explained by the high incidence of *A. mellifera* in all evaluation months (about 40%) when compared to the other species. The intense presence of the honeybee (*A. mellifera*) in studies of diversity within urban environments is also reported by Daniels et al. (2020), Matteson *et al.* (2008) and Hausmann *et al.* (2016). According to Fox *et al.* (2022), the urban environment gives this species a rich diet, since it contains high diversity of plants when compared to other types of environments, such as suburban or rural ones. Plant diversity found in natural urban landscapes along with the variety of natural and artificial substrates, available and used for nesting, are among the main factors that favor the permanence of bees in these areas (Aidar *et al.*, 2013).

The high incidence of *A. mellifera* may also explain the reason for the low presence of other bee species reported in the study. *A. mellifera* is a competitive species and its presence in the environment can decrease the reproductive efficiency of native pollinators, resulting in consequences on the size of their populations (Geslin *et al.*, 2017). Studies such as Hudewenz and Klein (2015), Renner *et al.* (2021), Prendergast and Ollerton (2021) and Cunningham *et al.* (2022), reinforce that the population density of native bees tends to be lower in places where *A. mellifera* is present. Goulson and Sparrow (2009) show that honeybees can change physical parameters of other bees, the authors observed that bees of the genus *Bombus* were physically smaller in environments that had *A. mellifera* colonies, such fact, may explain the reason for the low number of native and solitary bees in our study. In addition, the high frequency of visits by exotic species can also affect the reproductive success of native plants that, when receiving many visits, particularly by large and very abundant species, have reduced its success (Aizen *et al.*, 2016).

Regarding the foraging frequency, it was observed that the months with the highest number of visits to plants by bees were August, September, November, February and March. Coincidentally, these are periods that correspond to the rainy season with intense flowering. This fact is common and the high incidence of bees in the rainy season was also observed by Povoda-Coronel *et al.* (2018) when studying bee diversity in the Tatacoa Desert in Colombia. The rainy season favors flowering, which may explain the higher visitation rates recorded, since there are more flowers, and thus, a greater intensity in resource collection as also demonstrated by Aleixo
et al. (2017) while studying the seasonality on the bee foraging behavior *Scaptotrigona depilis* (Moure, 1942).

The two parks have dissimilar natural resources, such as: availability of water sources; vegetation cover of variable area and formed by different plant species. Since both parks have different resources, it was observed that the most visited species also differed between locations: in Antenor Martins Park, the three most visited plant species were *Erythina verna*, *Callistemon viminalis* and *Tridax procumbens*, while in Arnulpho Fioravante Park, they were *Tecoma stans* (Bignoniaceae), *Erythina verna* and *Senna hirsuta*. In general, these plants are invasive and constitute the main food sources for bees in urban environments. Commonly, herbaceous species are found in altered environments, since they are the first to colonize and establish themselves in these places (Castellani and Stubblebine, 1993; Sá, 1996; Vieira and Pessoa, 2001). Studies involving the pollination ecology of these species can provide important information for understanding their reproductive biology and their importance for the animal and plant community that occur in this environment (Bawa, 1990; Maués and Couturier, 2002).

Silva et al. (2007) while studying bee diversity in *Tecoma stans* in the urban environment, demonstrated that this plant was an important source of food for 48 species of bees and that the nectar was the most collected resource. Santos et al. (2012) observed five species of bees (*Apis mellifera*, *Plebeia flavocincta* (Cockerell, 1912), *Dicranthidium arenarium* (Ducke, 1907), *Tetragonisca angustula* (Latreille, 1811) and *Bombus brevisillius* (Franklin, 1913) visiting *T. procumbens*, a species belonging to the Asteraceae family. This plant family are frequent colonizers of anthropized areas with floral strategies that can optimize cross-pollination (Machado-Filho et al., 2015). According to Mani and Saravanan (1999), species of the Asteraceae family are of great ecological importance, as their inflorescences are visited by several animals that seek nectar and pollen throughout the year.

Although many studies demonstrate that there is a greater diversity of bees in preserved areas, other studies have shown that urban areas constitute a favorable habitat for different groups and species of bees, similarly to natural areas (Banaszak-Cibicka et al., 2018) and several factors can contribute to this. One of the reasons for this high diversity of bee species in the two evaluated areas is that the phenology of plant species varies greatly between the two environments, and this may contribute to pollinators remaining in these areas for long periods. This fact favors the maintenance of pollinators in places that have flowers as available resources throughout the year.
(Parrish and Bazzas, 1979). Another aspect that should be highlighted is the availability of favorable structural resources for nest formation, such as branches and forks in the treetops, as well as cavities in live or dead stems. Bruening (2001) also highlights the presence of termite mounds and anthills, whose internal spaces can be used for nest construction, as favorable factors.

In addition, in some cases, some resources are enhanced by anthropic action, such as the availability of water and food by introducing spaces for human food in internal or peripheral areas of the parks, providing synthetic sources of food for the bee community, such as: leftover soft drinks, seeds and other fruits, such as the mango fruit, which is a common fruit in the city, provision of artificial substrates for nesting through buildings (Taura et al., 2007), such as the wooden beams of kiosks and bridges.

The species *Tetragonisca angustula* (Latreille, 1811) and *T. spinipes* (Taura and Laroca, 2001) were identified in Passeio Público Park, located in the center of the city of Curitiba, State of Paraná, where the circulation of people is quite intense. Taura et al. (2007) recorded the species *Nannotrigona testaceicornis* (Lepeletier, 1836), *Plebeia droryana*, (Friese, 1900) *T. angustula*, *T. clavipes* and *T. spinipes* in Pioneiros Forest Park, in the central region of the city of Maringá, also located in the State of Paraná. Zanette et al. (2005) identified *N. testaceicornis*, *T. spinipes* and *T. angustula* species in the Center-South and Pampulha regions of the city of Belo Horizonte, Minas Gerais.

The sampling effort developed in the evaluation areas proved to be sufficient to relate the frequent bee species in the regions, as evidenced in the stabilization of the curves to the indices that indicate greater diversity in the Antenor Martins Park, which is in a region with greater vegetation cover area (Figure 1). However, the surrounding urban matrix in both parks seems to have contributed to the presence of several common species between them, even considering the distance of approximately 7.5 km, suggesting that their urban surroundings favor the presence of these species in the considered regions.

Araújo and Moreira (2020) have demonstrated that urban forests play an important role in stabilizing and maintaining the diversity of trees that exist within the city environment. The main benefits in which urban parks provide are precisely comfort and microclimate changes (Graça and Telles, 2020). Thus, it is considered that the diversity of bees in an environment is strongly linked with the diversity of plants, so it is reasonable to understand the connection that these bees have with urban parks.
5 CONCLUSION

The results allow us to conclude that the bee fauna in the urban parks in the city of Dourados – MS is quite diversified, and the plant species are able to provide these bees with the necessary resources for their population development. The species composition that inhabits each park is justified by the relatively diversified floristic composition present in each one.

The interrelationship between different bee species in the parks indicates a unique ecological habit, which can only be maintained in size and quality by the existence and protection of urban parks. Therefore, it is assumed that the parks have a significant functional area for the maintenance of bee populations, helping to maintain the diversity of these pollinating organisms in the urban region, confirming the proposed hypothesis.

ACKNOWLEDGEMENTS

We thank to Dr. Allan Sciamarelli by plants identification and the CAPES for scholarship. The authors are indebted to all funding institutions financing this work. We are grateful to the National Council for Scientific and Technological Development (CNPq) of Brazil for awarding a research productivity grant to FFO (Process: 316639/2021-4).
REFERENCES


