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Bees of the Megachilidae family (Insecta: Hymenoptera)

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Abstract

Bees of the Megachilidae family are solitary, they build their nests with pieces of leaves and vegetable remains or use holes in trunks. Bees of this family are found with high frequency, mainly in open areas. Frequent visitors to Asteraceae and Fabaceae flowers, the genus *Megachile* is the most diverse of the group. Megachilidae nests, built with pieces of plant leaves, are found inside the camera. Megachilidae bees cut the leaves of a plant to build their nests. The objective of this bibliographical production is to know the biology, ecology and taxonomic characteristics of the Megachilidae family. In terms of the type of research source, we worked with scientific articles published in national and international journals and other documents. This modality of production, in addition to being commonly the most valued in the set of bibliographic production, is the most easily accessed. Access to articles was through virtual libraries such as SciELO, ResearchGate, Hall, USP, UNB, CAPES, Qeios and LILACS.

Keywords: Nest; Damage; Woods; Roche; Pollination

1. Introduction

Bees of the Megachilidae family are solitary bees, they build their nests with pieces of leaves and vegetable remains or use holes in trunks. Bees of this family are found with high frequency, mainly in open areas. Frequent visitors to Asteraceae and Fabaceae flowers, the genus *Megachile* is the most diverse of the group. Megachilidae nests, built with pieces of plant leaves, are found inside a camera. Megachilidae bees cut the leaves of a plant to build their nests (Figures 1-3) [1,2,3].

Sources: Photo 12339, (c) Sean McCann, some rights reserved (CC BY-NC-SA) and https://www.inaturalist.org/photos/12339

Figure 1 Mason, leafcutter, carder, and resin bees (Family Megachilidae)

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Sources: Photo 98816292, (c) sixlegs, all rights reserved, uploaded by sixlegs and https://www.biodiversity4all.org/photos/98816292

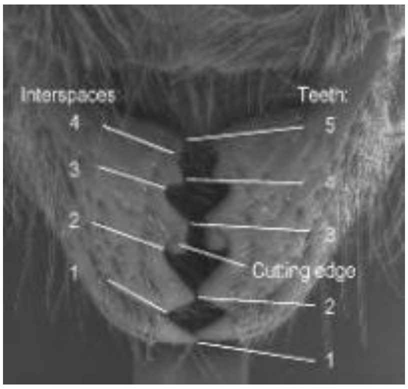
Figure 2 *Anthidiellum perplexum* (Smith, 1854)

Source: https://es.wikipedia.org/wiki/Megachilidae

Figure 3 *Anthidium manicatum* (Linnaeus, 1758)

1.1. Description

Members of this family form a fairly uniform group, which can be clearly distinguished from other bees. Females of non-parasitic species have a belly brush, i.e. the lower part of the abdomen is densely covered with long, stiff, obliquely protruding hairs. These are used to collect bee pollen as food for the larvae (Figures 4-8) [4,5].



Sources: Picture by Andreas Müller and https://jhr.pensoft.net/article/11255/element/2/19/

Figure 4 Female mandible of *Megachile centuncularis* (Linnaeus,1758); the white lines and the numbers indicate the five teeth (numbers on the right) and the four interspaces (numbers on the left); in this species, there is a partial cutting edge in the second interspace and, in front view, no visible cutting edge in the other interspaces

Source: https://jhr.pensoft.net/article/11255/element/2/19/

Figure 5 (I) Female mandible of *Megachile centuncularis* (Linnaeus,1758). (2) Front view; the white lines indicate the brushes of hairs in the grooves near the base of the tooth (1-3) Lateral view; the cutting edge is continuous and spans the interspaces (2–4), although it is completely recessed behind the mandibular margin and thus not visible in front view

Source: https://jhr.pensoft.net/article/11255/element/2/19/

Figure 6 Claw of hind leg of females; the white lines show the basal seta; the seta is considered elongate in (4, 6 and 7) and modified to a thick process in (5 and 4). *Megachile patellimana* (Spinola 1838)

Source: https://jhr.pensoft.net/article/11255/element/2/19/

Figure 7 Female clypeus and mandibles, front view. (38) *Megachile patellimana* Spinola, 1838 (39), *Megachile rotundata* (Fabricius, 1787) (40), *Megachile deceptoria* Pérez, 1890 (41) and *Megachile giraudi* Gerstäcker, 1869

Source: https://jhr.pensoft.net/article/11255/element/2/19/

Figure 8 Inferior projection of male mandible. (8) *Megachile leachella* Curtis, 1828, inferior projection pointed and projecting posteriorly (9) *Megachile albisecta* (Klug, 1817), inferior projection rounded and directed ventrally

The body is generally stocky, especially in the larger species, many have a very wide, and in some, the abdomen is almost spherical. The smaller species are mostly cylindrical. An interesting morphological characteristic is that the females of the non-parasitic species have abdominal scab in the lower part of the abdomen, densely covered by hairs that are used to collect pollen during oraging (Figures 9-13) [6,7].

Source: https://jhr.pensoft.net/article/11255/element/2/19/

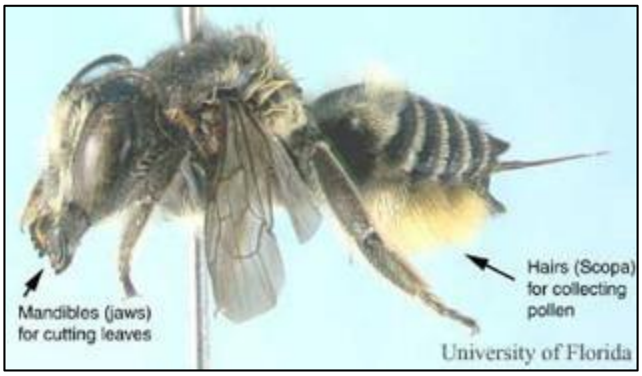
Figure 9 Female clypeus and mandibles, front view. (24) *Megachile seraxensis* Radoszkowski, 1893, (25) *Megachile saussurei* Radoszkowski, 1874 (26) Female hind basitarsus, lateral view (27) *Megachile ericetorum* Lepeletier, 1841 (28) *Megachile incana* Friese 1898 (29) and *Megachile giraudi* Gerstäcker, 1869

Source: https://jhr.pensoft.net/article/11255/element/2/19/

Figure 10 Apex of male metasoma, dorsal view. (50) *Megachile* sp. aff. *Inornata,* (51) *Megachile ericetorum* (52), *Megachile saussurei* Radoszkowski, 1874 and (53) *Megachile foersteri* Gerstäcker, 1869

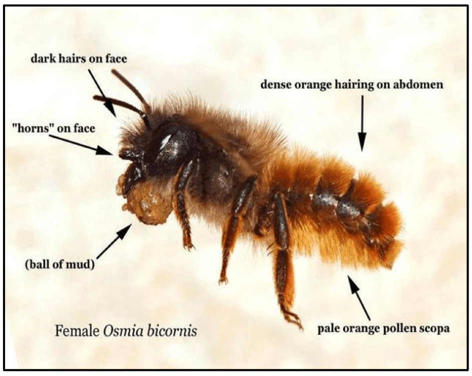
Sources: Photograph by David Almquist and David Serrano, University of Florida and https://entnemdept.ufl.edu/creatures/misc/bees/leafcutting_bees.htm

Figure 11 A leafcutting bee, Megachile sp.



Sources: Photograph by David Serrano, University of Florida and https://entnemdept.ufl.edu/creatures/misc/bees/leafcutting_bees.htm

Figure 12 Side view of a female leafcutting bee, *Megachile medica* Cresson. Note the pollen-carrying hairs on the underside of the abdomen



Source: https://osmiafuture.com/en/2-about-solitary-bees

Figure 13 *Osmia bicolor* (Schrank,1781)

1.2. Biology, Ecology and Habitat

Megachilidae is a family of bees that is diverse throughout the world. The bee belonging to this group have diversified nesting behavior, being able to build their babies in pre-existing cavities such as woods, rocks and alone. These bees can also use various materials in the construction of their children, such as petals, leaves, resin, soil particles, shells and plant trichomes (Figures 14-17) [8,9,10].

Source: https://osmiafuture.com/en/2-about-solitary-bees

Figure 14 (a,b), female and male (enlarged); (c), rose-leaves with several pieces clipped out and a bee at work; (d), nest in a willow stem; (e)A single cell; (f), the lid of same; (g-h), pieces of leaf; (i-k), side pieces

Source: https://osmiafuture.com/en/2-about-solitary-bees

Figure 15 The red mason is an insect that should live in every garden and orchard because it is universal and effective as a pollinator. The efficiency of pollination of apple, plum, or raspberry trees is comparable to that of the honey bee. It is also an excellent pollinator for plants grown under cover. If we employ a red mason bee to work in greenhouses and tunnels, in such conditions it can be active up to 14 hours a day

A

B

C

Sources: Photograph © Dawid Kok (Bloemfontein) and http://www.waspweb.org/Apoidea/Megachilidae/Fideliinae/index.htm

Figures 16 (A-B-C) *Fidelia* female carrying a piece of leaf (that she has cut out herself) back to her nest to line the burrow with (C) *Fidelia* nests in Kalahari dune-veld east of Keetmanshoop in Nanibia

Source: https://www.britannica.com/animal/leaf-cutter-bee

Figure 17 Leaf-cutter bee, (family Megachilidae)

In the formation of the nest, the females used mainly resin for the internal coating, cell division and closure. Sand grains, fine wood chips and small pieces of paper are also adhered and mixed with the resin. The cell partition is formed by a wall. In some nests, the females built a resin wall at the bottom before starting the first cell. In others, they used the wood of the trap itself as the bottom of the nest and started the pollen deposit there directly. Several females built nests in holes pre- or semi-occupied by other bees or wasps (Figure 18) [11,12,13].

Sources: Photograph by L, Buss J, University of Florida and https://entnemdept.ufl.edu/creatures/misc/bees/leafcutting_bees.htm

Figure 18 Typical leaf damage caused by leafcutting bees, *Megachile* spp. The bees use the leaf pieces to construct nests

In addition to these natural enemies, a species of wasp of the genus *Sapyga* Latreille, 1796 (Sapygidae) with the typical behavior of a kleptoparasite species was recorded. Females patrol the area and inspect nest entrances of *Anthodioctes megachiloides* Holmberg, 1903. They often perch close to the entrance and wait for the host female to leave. In its absence, they enter the nest and lay eggs. The parasite's first larval stage approaches the host's egg before it hatches to attack it. Several cells examined contained both eggs: host and parasite; demonstrating that this parasite is successful in nest invasions (Figure 19) [14,15,16].

Sources: Photograph by Castner JL, University of Florida and https://entnemdept.ufl.edu/creatures/misc/bees/leafcutting_bees.htm

Figure 19 Nest of leafcutting bee pulled out of a cavity such as a hole in wood. This nest contains several cells; each cell will produce one adult leafcutting bee

The resin is carried in flight attached to the mandibles and deposited in the place where it will be used. Still with her jaws, the female extends this "acorn" and spreads it around. In addition, small portions of resin are deposited around the entry hole. When they start the process of closing the nest, the females make about seven trips to collect resin and spend a long time handling this material at the entrance. The resin quickly hardens and leaves a glazed appearance in the closed nest [17,18].

Some genera of megachilids are parasites of the nests of other members of this family. They enter the nest of the host bee before it is closed and deposit their new one there. Generally, the parasitic larva kills the larva of the host and feeds on the supply. Suelen be of the same size or more chicas than the species they parasitize (Figures 20-28) [17,18].

Sources: © Gary Taylor and https://ausemade.com.au/flora-fauna/fauna/insects/bees/megachile/

Figure 20 *Megachile aurifrons* Smith, 1853

Sources: © Gary Taylor and https://ausemade.com.au/flora-fauna/fauna/insects/bees/megachile/

Figure 21 *Megachile erythropyga* Smith, 1853

Sources: © Gary Taylor and https://ausemade.com.au/flora-fauna/fauna/insects/bees/megachile/

Figure 22 *Megachile* sp.

Sources: Alice Springs, NT and https://ausemade.com.au/flora-fauna/fauna/insects/bees/megachile/

Figure 23 Resin-capped nests of the golden-browed resin bee *Megachile aurifrons* Smith, 1853

Sources: Geraldton WA © Gary Tayl and https://ausemade.com.au/flora-fauna/fauna/insects/bees/megachile/

Figure 24 *Megachile duboulaii* (Smith 1865)

Sources: Geraldton WA © Gary Tayl and https://ausemade.com.au/flora-fauna/fauna/insects/bees/megachile

Figure 25 *Megachile canifrons* Smith, 1853

Sources: Geraldton WA © Gary Tayl and https://ausemade.com.au/flora-fauna/fauna/insects/bees/megachile

Figure 26 Nest built on the ground

Source: Alice Springs, an https://ausemade.com.au/flora-fauna/fauna/insects/bees/megachile/

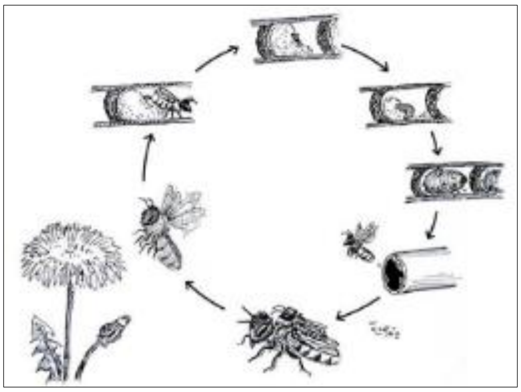
Figure 27 Nesting selections of the golden-browed resin bee *Megachile aurifrons* Smith, 1853

Source: Alice Springs, an https://ausemade.com.au/flora-fauna/fauna/insects/bees/megachile/

Figure 28 Two small, west-facing, store-bought insect lodges attached to the fence. There is another larger home-built bug hotel facing northwest

1.3. Life cycle

Pollen and nectar were collected in the morning and resin was collected in the afternoon, and it took an average of 15 days to complete the construction of the nest. Resin is used by females as a building material. The average offspring emergence time was 43 days, the emergence rate was 1.2 males to 1 female, and the larval mortality rate was only 18.5%. They also observed that the number of nests built per female ranged from 1 to 4, with an average length of 7.97 mm (Figure 29) [19,20].



Source: https://osmiafuture.com/en/2-about-solitary-bees

Figure 29 Before the female lay's eggs, she fills the cells with the accumulated food, i.e., pollen and plant nectar. In the next stage of the breeding process, it seals the cells, making it difficult for the natural enemies of its larvae to attack. The males are the first to leave the nest, but their flight time ends faster than in the case of females. It only takes 3 weeks. Females live about 7-8 weeks. At this time, there is also the reproductive period of these insects, after which inseminated females build a nest, collect pollen and nectar, lay eggs, and then die. Young larvae hatch a few days after the nest cells are closed

1.4. Taxonomy

Subfamilies: Fideliinae and Megachilinae (Figures 30-31).

Source: https://idtools.org/tools/1078/index.cfm?packageID=1181&entityID=8956

Figure 30 Subfamily Fideliinae

Source: https://en.wikipedia.org/wiki/Megachilinae

Figure 31 Subfamily Megachilinae

Distribution: Worldwide.

Biology: Provision the nest with pollen and nectar. Some species are kleptoparasites laying their egg on the pollen stores collected by other megachilids bees.

- **1-Subfamíly Fideliinae**

Genus: *Fidelia* Friese, 1899 (Figure 32).

Source: Photographs of pinned specimens © Simon van Noort (Iziko Museums of South Africa)

Figure 32 Genus *Fidelia* Friese, 1899

Distribution: Botswana, Namibia and South Africa.

Some Species: *Fidelia fasciata* Whitehead & Eardley, 2003 (Namibia, South Africa), *Fidelia friesei* (Brauns, 1926) (Botswana, Namibia, South Africa), *Fidelia hessei* Whitehead & Eardley, 2003 (Namibia, South Africa), *Fidelia kobrowi* Brauns, 1905 (Namibia, South Africa) and *Fidelia major* Friese, 1911 (Namibia, South Africa).

Distribution: Botswana, Namibia and South Africa.

Biology: Nest in soil, often in aggregations. Burrows may be as long as 2 meters, usually constructed at an angle into the ground and are lined with plant material. These bees collect pollen from a variety of flowers commonly those in the families Asteraceae and Mesembryanthemaceae (Aizoaceae).

- **2-Subfamily: Megachilinae.**

Some Tribes: Megachilini and Osmiini (Figures 33-34).

Source: https://insecta.pro/taxonomy/925503

Figure 33 Tribe Megachilini

Source: https://es.wikipedia.org/wiki/Osmiini

Figure 34 Tribe Osmiini

Distribution: Worldwide.

Biology: Provision the nest with pollen and nectar. Some species are kleptoparasites laying their egg on the pollen stores collected by other megachilids bees.

2. A-Tribe: Megachilini.

Genus: *Coelioxys* Latreille, 1809 and *Megachile* Latreille, 1802.

Distribution: Worldwide.

Biology: Provision the nest with pollen and nectar. Some species are kleptoparasitoids laying their egg on the pollen stores collected by other megachilids bees (Figures 35-36).

Source: https://entnemdept.ufl.edu/hallg/melitto/floridabees/coelioxys.htm

Figure 35 Genus *Coelioxys* Latreille, 1809

Source: https://journals.ku.edu/melittology/article/view/4564

Figure 36 *Megachile Latreille*, 1802

Some Species*:* *Coelioxys afra* Lepeletier, 1941 (Democratic Republic of the Congo, Eritrea, Gambia, Malawi, Mozambique, Nigeria, South Africa, Togo. Also in the Palaearctic region), *Coelioxys albociliata* Pasteels, 1968 (Guinea)a and *Coelioxys albomarginata* Friese, 1922 (Democratic Republic of the Congo, Tanzania), *Megachile abessinica* Friese, 1915 (Ethiopia), *Megachile abnegatula* Cockerell (Mozambique), *Megachile abongana* Strand, 1911 (Cameroun, Malawi) and *Megachile acanthura* Cockerell, 1937 (South Africa) (Figure 37).

Source: http://www.waspweb.org/Apoidea/Megachilidae/Megachilinae/Osmiini/index.htm

Figure 37 *Megachile abessinica Friese*, 1915

Distribution: Worldwide.

Biology: Nest in soil, often in aggregations. Burrows may be as long as 2 meters, usually constructed at an angle into the ground and are lined with plant material. These bees collect pollen from a variety of flowers commonly those in the families Asteraceae and Mesembryanthemaceae (Aizoaceae).

Distribution: Worldwide.

Biology: *Coelioxys* species are kleptoparasitoids, mostly parasitizing *Megachile* species.

3. B-Tribe: Osmiini

Genus: Afroheriades Peters, 1970, *Noteriades* Cockerell, 1931, *Ochreriades* Mavromoustakis, 1956 and *Othinosmia* Michener, 1943 (Figure 38).

Source: https://www.invasive.org/browse/detail.cfm?imgnum=5554140#

Figure 38 Afroheriades Peters, 1970

Distribution: Aldabra, Angola, Botswana, Cameroon, Chad, Congo, Democratic Republic of the Congo, Ethiopia, Eritrea, Gabon, Guinea, Kenya, Lesotho, Liberia, Madagascar, Mozambique, Namibia, Seychelles, South Africa, Tanzania, Togo, Uganda, Zambia, Zimbabwe and Palaearctic region.

Biology: Construct nests by burrowing in the ground, construct aerial nests out of mud or resin, or nest in hollow sticks [21,22].

1.5. Objective

The objective of this bibliographical production is to know the biological, ecological and taxonomic characteristics of the Megachilidae family.

4. Methods

In terms of the type of research source, we worked with scientific articles published in national and international journals and other documents. This modality of production, in addition to being commonly the most valued in the set of bibliographic production, is the most easily accessed. Access to articles was through virtual libraries such as SciELO, ResearchGate, Hall, USP, UNB, CAPES, Qeios and LILACS.

4.1. Selected articles

4.1.1. Study 1

The objective was to carry out a survey of the melittophilous flora and associated bees in the Olho Dágua dos Pires area; located in the municipality of Esperantina/PI/Brazil.

The most representative families in a number of species were: Leguminosae (21 species); Asteraceae (10); Euphorbiaceae (6); Lamiaceae (5); Apocynaceae; Arecaceae; Bignoniaceae; Malvaceae and Solanaceae (3); Amaranthaceae; Bixaceae; Combretaceae; Commelinaceae; Myrtaceae and Passifloraceae (2).

In the present work, 31 species were identified;18 genera and five bee families represented by: Apidae (17 species); Anthophoridae and Megachilidae (4); Andrenidae and Halictidae (3). In the number of individuals per family, we have Apidae; 62; Andrenidae; 12; Megachilidae; 9; Halictidae; 8 and Anthophoridae 7; with a total of 98 individuals collected from these 68 in Cerrado vegetation and 30 in the semi-deciduous forest. Regarding the number of individuals collected per family, Apidae was the most abundant (63;27%); followed by Andrenidae (12;24%); Megachilidae (9;19%); Halictidae (8;17%) and Anthophoridae (7;14%).

The family with the highest species diversity was also Apidae (63;33%); accompanied by Megachilidae (13;33%); Halictidae and Andrenidae (10;00%) and the smallest Anthophoridae (3;33%). The greatest richness in genera was observed in Apidae (44;44%); followed by Andrenidae and Megachilidae (16;66%); Halictidae (11;11%) and the smaller Anthophoridae (5;55%) [23].

4.1.2. Study 2

The main objective of this work was to verify the changes that occurred in the species composition of the bee community in the Cerrado Reserve of Corumbataí-SP (Brazil).

A total of 923 individuals were captured on flowers during the collection period in the area, representing 5 families and 103 species of bees. Apidae was the best-represented family (68 species – 803 individuals), followed by Halictidae (21 species – 45 individuals), Megachilidae (7 species – 20 individuals), Colletidae (6 species – 32 individuals) and Andrenidae (1 species – 23 individuals).

The distribution of the number of individuals, throughout the collection period, demonstrated that Apidae, again, was the most abundant family that visited the flowers in almost the entire period; in Halicitidae, the highest abundance of individuals was found in November/2000. The Megachilidae and Colletidae families were better represented in February and April of 2001, respectively; in Andrenidae, the highest abundance of individuals in flowers was in January 2001.

Twenty-eight dominant bee species were determined in the area, being *Apis mellifera* (Linnaeus, 1758) and *Trigona spinipes* (Fabricius, 1793), represented a higher percentage of individuals; Apidae represented 78.5% of the dominant species; halictidae and Colletidae, 7.1%; Megachilidae and Andrenidae 3.5%. Species frequency distribution curves of bees by classes of individuals or "octaves of abundance" show a large number of species represented by a few individuals, between octaves 1 and 2, and a small number of species with many individuals, between octaves 7 and 8.

The results of the analysis of diversity, calculated by the Shannon-Wearner index (H) was 3.0, uniformity or equitability (Pielou index (J)) 0.63, and richness, calculated by the Jackknife index (d) 9,0 [24].

4.1.3. Study 3

Based on entomological collections already carried out between November 2005 and October 2006, the objective is to know the alpha diversity present in a fragment of Mixed Ombrophylous Forest, in the south of the State of Paraná (Brazil). Tenmolasses traps per collection area were also used, these are made up of a PET bottle containing molasses at 10%, distributed 10 at a distance of 10 meters from each other and at a height of 1.60 m from the ground. This trap is considered attractive or active because it contains a sugary substance. Two areas were selected to carry out the collections, the first, called area A, and B, has typical characteristics of an edge or ecotone area.

A total of 606 individuals were sampled, belonging to three Apoidea families: Apidae, Megachilidae and Halictidae, with 12 genera, of which 6 species were identified. Members of the Apidae family represented 92%, with 556 individuals, constant in all months of collection, followed by the family Halictidae with 31 specimens (5%) and Megachilidae with 19 specimens (3%).

The Megachilidae family, the second in the number of species, had 10 specimens of Megachilie sp3, this being the most numerous, followed by *Anthodioctes* sp., Megachilie sp.1 and Megachilie sp.2. Sampling areas, it is observed that in A the 114 individuals correspond to 19% of the total, and in B sampled 492 individuals (81%). The Apidae and Megachilidae families occurred in both areas studied, while the Halictidae family was restricted to area B. The two areas studied were not very similar (S=0.37). The richness of the areas is very close (A=2.91 and B=2.97). The diversity, in turn, presents the edge of the fragment as more diverse (0.47) in relation to the central area (0.31). Equitability, in the center of the fragment (A=0.37 and B=0.49) [25].

4.1.4. Study 4

In this context, work is being carried out at the Center for Research and Conservation of Nature Pró-Mata (CPCN – PUCRS), located on the east edge of the Planalto das Araucárias, in the municipality of São Francisco de Paula, RS, Brazil, aiming to study the effect of the of pollinating insects and their performance in seed production of *Adesmia tristis* Miotto & Leitão Filho, a native legume with forage potential.

The experiment area measures 15m x 30m and is divided into six plots (three with cut and three without cut). To assess the need for pollination, 100 buds were marked per plot (50 without protection and 50 protected). In the study of the yield components, the number of plants/m^2 (4 plants/m^2), the number of fruits and seeds/plant, through a square of 0.5m^2, the weight of 1000 seeds and seed yield per area.

For the survey of pollinating insects, a 100m transect was traversed within the area for a period of 30 minutes, at 9 am – 11 am – 2 pm and 4 pm/day, for 7 days. No protected flower bud produced fruit and of the total number of flower buds free of protection, only 32.67% formed *Hemicraspedium*. Seed yield ranged from 54.5 to 100.6 kg/ha, in the uncut and cut plots, respectively. Solitary bees of the Megachilidae and Andrenidae families were the most frequent and efficient pollinators [26].

4.1.5. Study 5

These bees, also known as “leaf-cutting bees”, stand out for the use of parts of leaves or petals, fragmented or whole, in the construction of their nests *Megachile nigripennis* Spinola, 1841, is little known from the bionomic point of view, despite the ecological potential in the pollination of several native and agricultural plants as has been verified for *Megachile* spp. Females patrol the area and inspect nest entrances of Anthodioctes megachiloides Holmberg, 1903 (Figures 39-40).

Sources: Photo 23932585, (c) Carlos G Velazco-Macias, some rights reserved (CC BY-NC), uploaded by Carlos G Velazco-Macias and https://uk.inaturalist.org/photos/23932585

Figure 39 *Megachile nigripennis* Spinola, 1841

Source: https://www.gbif.org/species/9090977

Figure 40 genus *Sapyga Latreille*, 1796 (Sapygidae)

Parasitoids (Chrysididae, Mutillidae) and beetles (Rhipiphoridae, Meloidae and Cleridae). Ants, such as *Crematogaster* spp., have been known to attack leafcutter bee nests. They often perch close to the entrance and wait for the host female to leave. In its absence, they enter the nest and lay eggs. The parasite's first larval stage approaches the host's egg before it hatches to attack it. Several cells examined contained both eggs: host and parasite; demonstrating that this parasite is successful in nest invasions [27].

4.1.6. Study 6

Bee Brick: Recycled concrete brick creates a safe place for lone bees Bee Brick: Recycled concrete brick creates a safe place for lone bees. One of the most complex relationships we have on the planet today is ours with bees. We admire them from afar and enjoy the result of their work – honey – but when the distance between us decreases, problems arise. For example, when they decide that tiles from one offer the perfect conditions to build their house.

Despite the fear that a large group of bees can provoke, it is important to note that this fear is misguided and even unwarranted. Bees are some of the most important caretakers and workers of our planet's ecosystems. Solitary bees, in particular, are known to be non-aggressive as they don't have a hive or queen to protect, so they don't sting potential threats.

Thinking specifically about protecting these solitary bees, providing a place where they can build their nest and helping our declining bee population, the British design studio Green & Blue created the Bee Brick, a concrete brick, made from 75% recycled material, with cavities so that rare blue *Calamintha* bees *Osmia calamintha* sp. nov. and bees of the Megachilidae family have a safe place to build their nests. The bee brick studio dedicates most of its projects to wildlife and nature initiatives. Designed for gardeners and wildlife enthusiasts, the bee brick can be integrated into any garden, brick shed, or outdoor space where bees frequent.

And in some places, this kind of care for bee life is just not optional. The English cities of Brighton and Hove require that all new buildings over five meters in height integrate bee bricks into their design, as well as spaces for swallows to also build their nests. As the bee brick is a functional concrete brick, it can be integrated into any brick structure in the same way a traditional brick is used for construction, while its cavities provide a safe space for solitary bees to nest. and multiply [28].

4.1.7. Study 7

The objective of this study was to carry out a survey of the bee fauna in a transition area between Cerrado and Atlantic Forest, in the south of Minas Gerais/Brazil. The work was developed from collections of bees in two transects, one in the area of (Cerrado and Mata Atlântica).

A total of 378 bees were collected, of which 199 were found in the Mata de Galeria area, and 179 in the Cerrado area, demonstrating a small difference between the percentage of specimens captured in each phytophysiognomy. Regarding the variation of specimens found in each season of the year, Spring and Summer add up to approximately 70% of the sample value. The bees collected belong to the families Andrenidae, Apidae, Colletidae, Halictidae and Megachilidae, of which the most abundant family was Apidae (n = 283), which is equivalent to about 75%.

A total of 52 genera were identified, 34 of them belonging to the Apidae family, 8 to Halictidae, 7 to Megachilidae, 2 to Colletidae, and 1 to Andrenidae, of which the most abundant genus was *Trigona* (n = 63), belonging to the Apidae family. It is noted that in the transects where the collections were carried out, there is a great diversity of bee genera, which were found during the four seasons of the year, with a greater number of specimens captured in the hot and rainy seasons [29].

4.1.8. Study 8

Anthidium manicatum (Linnaeus, 1758) (Cottontail bee).

This is a species native to North Africa, Europe and Asia, although it is currently distributed in other continents. It belongs to the Megachilidae family known for containing the leafcutter and carder bees of which it is a part (Figure 41).

Source: Illustration by Samantha Gallagher. University of Florida

Figure 41 Male *Anthidium manicatum* (Linnaeus, 1758)

Like the other species of this large family, the *Cotanilhosa* has a complex nesting ritual. The female looks for a hole in a tree, trunk, or cane and deposits an egg together with pollen and nectar that she has gathered in the countless hairs that she has under her abdomen. Then she covers this egg by building a chamber with materials collected from woolly plants, more precisely the down of these plants (Figure 42).

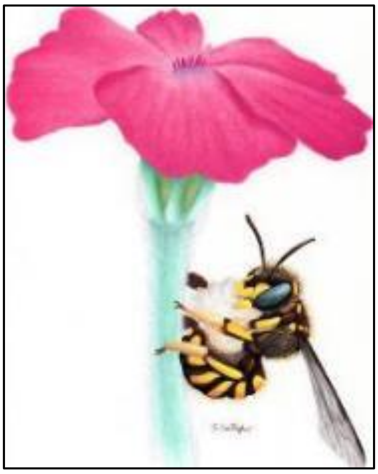
You can also use other materials such as mud, stones, or leaves like the leaf cutter species in this family. In a cavity a female can create several chambers with several eggs, this is then sealed at its opening to prevent predators or other females of this species from entering. The name cardador comes precisely from the fact that it uses the “wool” of some plants to protect the nest (Figure 43).

Sources: Illustration by Samantha Gallagher, University of Florida and https://entnemdept.ufl.edu/creatures/MISC/BEES/Anthidium_manicatum.html

Figure 42 Female *Anthidium manicatum* (Linnaeus)

Source: Illustration by Samantha Gallagher, University of Florida

Figure 43 Rendition of life stages (in order from left to right: pupa, larva, egg, and adult female) inside of a cavity nest of Anthidium manicatum (Linnaeus, 1758). Note the pollen-collecting hairs on the underside of the adult bee’s abdomen



Sources: Illustration by Samantha Gallagher. University of Florida and https://entnemdept.ufl.edu/creatures/MISC/BEES/Anthidium_manicatum.html

Figure 44 Female *Anthidium manicatum* (Linnaeus, 1758) gathering fibers from rose campion *Silene coronaria* (L.) (Caryophyllaceae)

Females exhibit polyandry, mating with many different males during their lifetime. Males are very territorial, aggressively guarding floral zones and mating with females that collect pollen in "their" gardens. In this species, males are larger than females, thus presenting sexual dimorphism. A larger male can patrol a larger flower zone and mate more often. Smaller males have to use other strategies (Figure 44) [30].

4.1.9. Study 9

Seventy-five percent (75%) of the food colonies depend on the pollination of insects such as bees. Bee day of the *Anthidium* genus (Megachilidae family) rests on a lavender this Saturday in an urban park in Madrid. The celebration of the day of the bees is approached with little enthusiasm by beekeepers, who face a situation of "ruin" after the loss, estimated, of 50% of the hives in the last year due to dryness production costs and warn that "there are no bees don't have biodiversity".

Seventy-five percent (75%) of the food crops depend on the pollination of insects such as bees, but many other agents such as Aracnida, Lepidoptera, Hymenoptera, or small mammals influence them. The removal in urban and peri-urban areas also makes this job difficult for insects and other arthropods. The bees play a "vital role" in the survival of two ecosystems and the increase in biodiversity, therefore it is necessary to "promote actions that protect pollinators and their habitats", urged the United Nations Organization for Food and Agriculture (FAO), which Celebrate your World Day on May 20.

These tiny creatures play a vital role in the survival of our ecosystems, guaranteeing with their meticulous work the reproduction of many plants, helping in the regeneration of forests and improving the quantity and quality of agricultural production," he explained to the United Nations agency.

Not surprisingly, 75% of food crops depend on pollination from insects such as bees, figures that are higher than 90% in the case of wild flowering plants. However, the population of bees and other essential pollinators has been in constant decline for decades due to the increase in intensive agricultural production in monoculture systems and the "excessive" use of pesticides [31].

4.1.10. Study 10

Currently, more than 20,000 species of bees are known, of which almost 85% have a solitary lifestyle. Despite the richness of solitary species, studies on the biological cycle and nesting habits of most of these bees are still scarce, limiting the understanding of their potential uses in the pollination of agricultural crops. To get an idea of the importance of solitary bees for agriculture, species of the genus *Xylocopa* Latreille, 1802 and genus *Centris* Fabricius, 1804 are pollinators of passion fruit and acerola plantations, two crops essentially dependent on cross-pollination. In Canada, the USA, Japan and European countries*, Megachile rotundata* (Fabricius, 1787) and species of the *Osmia* Panzer , 1806, belonging to the family Megachilidae, are managed for the pollination of pear, apple, almond, cherry, apricot, peach and alfalfa crops (Figures 45-48).

Source: https://entnemdept.ufl.edu/creatures/misc/bees/xylocopa.htm

Figure 45 Genus *Xylocopa Latreille*, 1802 (Insecta: Hymenoptera: Apidae: Xylocopinae)

Source: https://eol.org/pages/42313

Figure 46 Genus *Centris* (Insecta: Hymenoptera: Apidae)

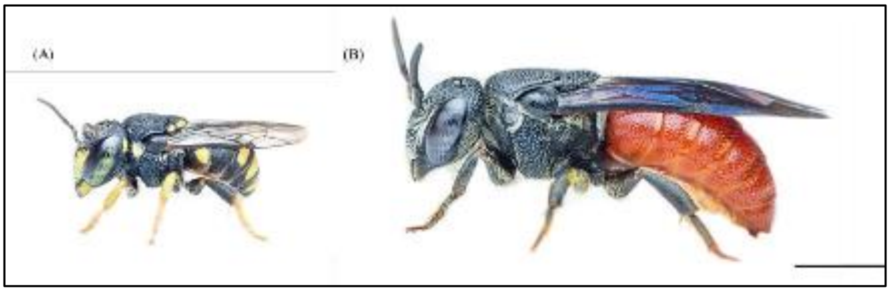
Source: https://animaldiversity.org/accounts/Megachile_rotundata/

Figure 47 *Megachile rotundata* (Fabricius, 1787)

Source: https://www.beesafari.net/post/the-many-mason-bees-of-my-garden

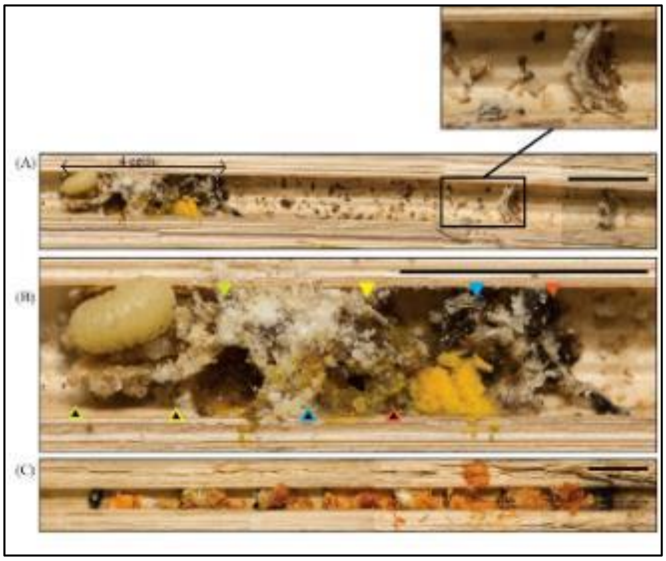
Figure 48 *Osmia* Pan 1806

The Megachilidae family is quite diverse and in Brazil, the Anthidiini tribe seems very promising for pollination studies, but it is still a group with little information available. In view of this, researchers from the Federal University of Ceará (UFC) and the University of São Paulo (USP) studied the life cycle of *Epanthidium tigrinum* (Megachilidae: Anthidiini) for 11 months in order to provide information on the behavior of the species for future pollination studies. agricultural. The study was carried out on the UFC campus in Fortaleza (CE) (Brazil) (Figures 49-50).



Source: https://www.semanticscholar.org/paper/The-bee-tribe-Anthidiini-in-Singapore-(-Anthophila-Soh-Soh/67da3f537f6fe41d5e9d20f8904057c997972564/figure/4

Figure 49 Anthidiini in Singapore (Anthophila: Megachilidae: Anthidiini)



Source: https://www.researchgate.net/figure/Nest-of-Anthidiellum-smithii-smithii-in-a-bamboo-culm-where-the-closing-plug-is-to-the_fig8_306009526

Figure 50 Nest of *Anthidiellum* sp. in a bamboo culm, where the closing plug is to the right end of the diagram. (A), The entire nest with four provisioned cells, clustered and two vestibular cells, (inset) close-up of the closing plug, comprising of the whitish substance and resin. (B), close-up of the clustered cells. Triangles with the black fill demark ate the start of each of the four cells respectively, and triangles otherwise so refer to the end of the cell. (C), Nest of *Heriades* Friese, 1914, from Pasir Ris Park with cells spaced out, and cell partitions made exclusively of resin. *Heriades* others had successfully emerged as adults

As the bee species *Epanthidium tigrinum* (Megachilidae: Anthidiini) builds nests in preexisting cavities, the researchers were able to study it from nests built in trap nests made with black cardboard paper, 12 mm long and 4.5 mm in diameter. These trap nests were distributed in six wooden blocks, which were placed in structures that protected them from rain and direct sunlight (Figure 51).

Source: https://scan-bugs.org/portal/taxa/index.php?taxon=242550

Figure 51 *Epanthidium tigrinum* (Schrottky, 1905) (Megachilidae*: Anthidiini*)

The females of *E. tigrinum* reproduced and built nests during the entire time of the experiment. The researchers found that females started collecting resources around 7:50 am, concentrating pollen and nectar collection in the morning and resin collection in the afternoon, and took an average of 15 days to complete the activity. nest construction. The resin is used by females as a building material. The average emergence time of the offspring was 43 days, the emergence ratio was 1.2 males to 1 female, and the larval mortality rate was only 18.5%. They also observed that the number of nests built per female ranged from 1 to 4, with an average length of 7.97 mm, and no parasite attack was observed [32].

4.1.11. Study 11

Insects are one of the main pollinating agents in the world and their extinction could lead to the end of life on the planet.

Honey and stinging – characterized by taste and pain – are the hallmarks of bees for the vast majority of people. However, the most important function of these insects in nature is their great pollinating capacity. The survival of many species, humans included, depends on it. "If bees disappeared from the face of the Earth, the human species would only have four more years to live. Without bees there is no pollination, that is: no plants, no animals, no men". This assertion, credited to the German physicist Albert Einstein, illustrates well the vital role played by these insects in the Earth's living wheel.

In this context, the current scenario is not one of tranquility. This has happened since, in 2011, the Food and Agriculture Organization of the United Nations (FAO) issued a warning about the consequences that the disappearance of bees can cause, including the lack of pollination in large crops. The disappearance of bee colonies, previously limited to Europe (where the phenomenon began to be noticed at the end of the 1960s) and North America, has lately also been observed in Africa (Egypt) and Asia (China and Japan).

Researchers from Cornell University, in the United States, estimate that one-third of the food we consume is directly dependent on the role of bees in nature and that they are responsible for pollinating 80% of existing crops. Monocultures, the intensification of the use of pesticides, and burning are likely causes of the accelerated decline of these insects. The domestication of bees for the production of honey is also mentioned since the descendants would no longer be able to survive in nature. The recent war in Iraq, with the use of explosives on a large scale, caused the decline of 90% of the colonies in that country.

Amazon Faced with this scenario, which points to insects as vital for maintaining biodiversity, a researcher from the National Institute for Research in the Amazon (Inpa) Márcio Oliveira, in partnership with researcher J. Christopher Brown, from the University of Kansas (USA), carried out research that relates agrarian colonization and associated deforestation in Rondônia with the disappearance of bees.

Entitled “The impact of agricultural colonization and deforestation on stingless bee composition and richness in Rondônia, Brazil”, the article, which contains the studies of researchers in Rondônia, was published in October in the journal Apidologie, one of the most important in the world. world about bees. The French journal is linked to the National Research Institute of France (Inra). The work shows that the researchers visited 187 locations in the state in one year and, through satellite image monitoring, identified the most deforested areas in Rondônia and then a connection was made with the disappearance of species in these regions.

“With the encouragement of the occupation of land in Rondônia in the 1980s, growth was accelerated and populations began to deforest to carry out agricultural activities. In the first areas that were occupied, there is a smaller number of bee species than in those occupied last. In the colonization areas close to indigenous reserves and conservation units, a greater number of species are found, which demonstrates the importance of these areas", explains researcher Màrcio Oliveira.

Asked about the existence of other areas of Brazil with the same problem, he says that research of this level has not yet been carried out outside Rondônia. "But the scale of forest deforestation, mainly in Pará, Maranhão and Mato Grosso, is worrying and could indeed lead to a scenario similar to that of Rondônia. This, in turn, is a unique case, as there were agrarian settlements there officials, who removed the forest cover to make way for agricultural production. That is, agricultural production was thought of, but not the bees that help, and a lot, in that same production", he says.

To partially reverse this situation, he recommends leaving a large part of the deforested and currently abandoned areas to regenerate, under official protection, as is done in preservation areas. "Bees have always been considered one of the most important organisms in nature. It is estimated that they are responsible, through pollination, for the production of fruits in about 800 foods consumed by man. That is, their disappearance or decrease could affect the production of cotton, coffee, oranges and many other fruits and grains consumed by man", he points out.

4.2. Genetic Improvement

Based in Manaus, Oliveira is a curator of the invertebrate collection at the Instituto Nacional de Pesquisas da Amazônia (Inpa), with experience in zoology, with an emphasis on taxonomy, biogeography, ecology and bee conservation. Graduated in biological sciences, with a doctorate and a postdoctoral degree in the United States, Márcio looks in retrospect to say that in large plantations the most effective pollination bees are the African ones, brought to Brazil in the 1950s with a view to genetic improvement from European ones, introduced by European immigrants from the end of the 19th century.

"If we think of native fruit trees and natural vegetation, it is the native bees that become effective. Pollination is one of the most important phenomena that exist because it is through it that pollen (male reproductive element) is taken to meet the oosphere (female reproductive element), forming from there the seed and its fruit. The wind, rain and birds also do this, but nobody does it better than insects, especially bees, considered one of the most important organisms in nature," he says.

The researcher adds that the alerts issued by the FAO are aimed at preserving bees. "Among the guidelines recommended by the UN body are a better knowledge of pollinators and the plants they pollinate and the protection of areas where they occur." [32].

5. Conclusion

Megachilidae is a family of bees that is diverse throughout the world. The bee belonging to this group have diversified nesting behavior, being able to build their babies in pre-existing cavities such as woods, rocks and alone. These bees can also use various materials in the construction of their children, such as petals, leaves, resin, soil particles, shells and plant trichomes

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