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Verification of the peculiarities of the Anthophoridae Family (Insecta: Hymenoptera)

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Abstract

Solitary behavior is characterized by the independence of females in building and provisioning their nests. There is no cooperation, or division of labor, between females of the same generation, or between mother and daughters. Most of the time, the mother dies before her offspring emerges, with no intergenerational relationships. There is a great diversity of nesting habits among solitary bees. Several species of the Megachilidae, Anthophoridae, and Apidae families nest in hollow branches of plants or pre-existing holes in wood. Others nest in cavities on the ground or in ravines or in protected places and few build exposed nests. The objective of this manuscript is to know the peculiarities of the Anthophoridae Family. The study proposed here constitutes bibliographical research in national and international publications that address the Anthophoridae (Insecta: Hymenoptera: Apoidea) in the field of Entomology. The bibliographical research was carried out using the descriptors Hymenoptera, wasps, and bees in the virtual library in Entomology and in the digital library of theses and dissertations of Universidade de São Paulo (BDTD). Concerned with drawing a public profile of quality research in the area, we sought, a literature review in the main journals in the area classified by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES). In order to complement this analysis with other types of documents such as books, scientific journals, and documents.

Keywords: Kleptoparasites; Nests; Solitary; Wasp

1. Introduction

1.1. Family Anthophoridae

Anthophoridae family is a very diverse group that includes most of the large bees, with solitary and parasocial species. Its species can nest in the ground or in wood trunks and, in general, females, when actively collecting pollen, do so by vibration, regardless of the type of anther. All species are solitary, although many nest in large aggregations. Almost all species nest in the ground; the larvae develop in cells with an impermeable coating, not making cocoons (Figures 1-3) [1,2,3].

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Sources: San Marcos Pass and https://www.flickr.com/photos/treebeard/14671911726

Figure 1 This is a large black carpenter bee genus Xylocopa Latreille, 1802, family Anthophoridae, order Hymenoptera hybrid "Waverly Sage" (*Salvia* "Waverly") in the Lamiaceae plant family growing in the garden today. The sun was in and out this morning - and when it's out, these bees get a bit groggy

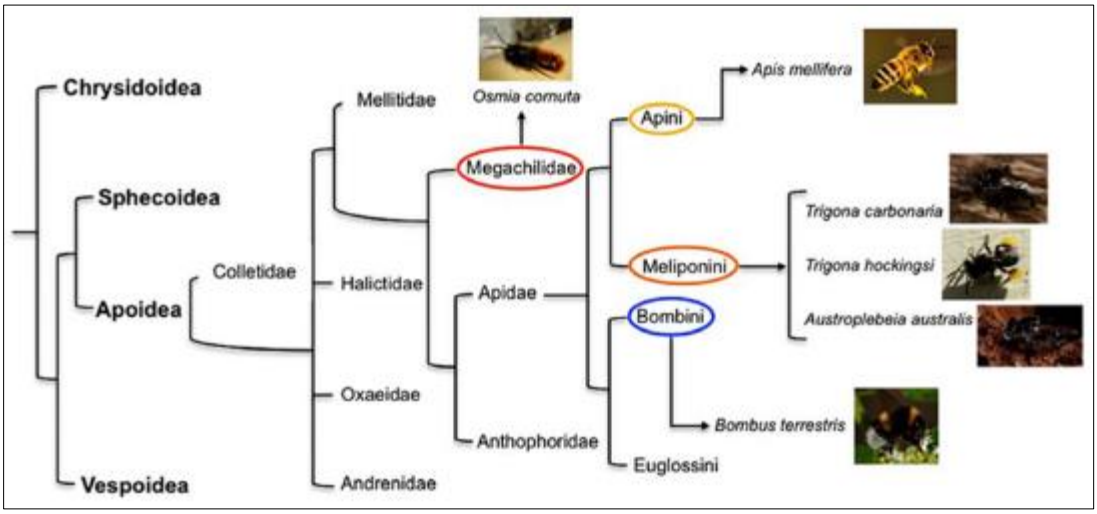
Source: Photo taken in Brisbane Jenny Thynnenand https://www.flickriver.com/photos/58356728@N07/6729550607/

Figure 2 Australian carpenter bee rescue *Xylocopa (Koptortosoma) lieftincki* Leys, 2000: Family Anthophoridae. Great Carpenter female

Source: https://www.dreamstime.com/royalty-free-stock-photo-teddy-bear-bee-profile-image14062675

Figure 3 *Amegilla (Asaropoda) batleyi* Leijs, sp. nov., Australian native bee, isolated on white, wingspan 21mm

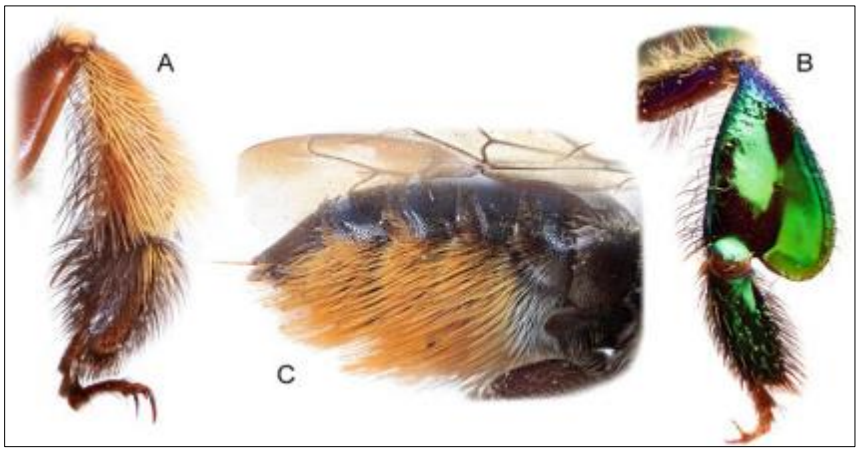
Species of this tribe are often called digger bees, although this common name is sometimes applied to individuals of the Centridini tribe as well. The study of bees has gained relevance in recent years due to the importance they play in nature as a honey producer and, mainly, as pollinating agents, both in agricultural and natural areas. Among these agents pollinators, highlight the bees of the genus *Xylocopa* Latreille, 1802, belonging to the Anthophoridae family. Popularly known as bumblebees, mangavas, or mangangas (Figure 4) [4,5,6].



Source: https://www.researchgate.net/figure/A-family-tree-for-the-Aculeata-hymenoptera-with-stings-showing-the-most-likely_fig1_259492593

Figure 4 Bees come in all shapes, sizes, and colors. According to The Bee: A Natural History written by our chief and resident bee expert, Noah Wilson-Rich, "Earth is home to more than 20,000 bee species, from fluorescent-colored orchid bees and sweat bees to flower-besting squash bees. Bees are a diverse species that plays an integral role in the life of the planet "family tree" for the Aculeata (Hymenoptera with stings) shows the most likely relationship between superfamilies (in Bold) and, for the superfamily Apoidea, the deduced lines of descent of some of the more common families of bees and tribes within the family Apidae. Highlighted are the tribes to which the species investigated for behavioral and brain asymmetries described in the current paper belong: in red the family Megachilidae (mason bee *Osmia* sp.), in yellow Apini (honeybee *Apis* sp.), in orange Meliponini (stingless bees *Trigona* spp., *Austroplebeia* sp.), and in blue Bombini (bumble bee *Bombus* sp.).

1.2. Description



Source: https://link.springer.com/referenceworkentry/10.1007/978-3-319-90306-4_14-1

Figure 5 (A) Wings present. Fore-wings with a conspicuous pterostigma, or without a pterostigma (generally not very conspicuous); with the venation well developed. Closed fore-wing cells 6–10. Submarginal cells 2 (a few), or 3 (mostly). Discoidal cells 2. (B-C) hind wings with closed cells. Hind femur without well-defined trochanters. Hind tibiae with spurs specialized for a cleaning role. Hind basitarsi are wider than the other segments. Ovipositor of females not visibly protruding modified as a retractable string

The characteristics used to define this group are subtle, but they are nonetheless very recognizable; they are generally large (up to 3 cm), very robust, heavily haired, with visibly protruding faces, and the apical position of the wings is full of microscopic papillae. The abdomen is usually banded, and in many species, these bands are metallic blue. The wings often appear disproportionately short compared to other bees, and the buzzing they make as they fly is often like a high-pitched whine. Males usually have white or yellow facial markings, and/or modified paws (Figures 5-9) [7,8,9].

Source: https://www.researchgate.net/figure/A-D-External-morphology-of-Anthophora-confusa-A-Dorsal-view-Male-B-female-C_fig2_305639815

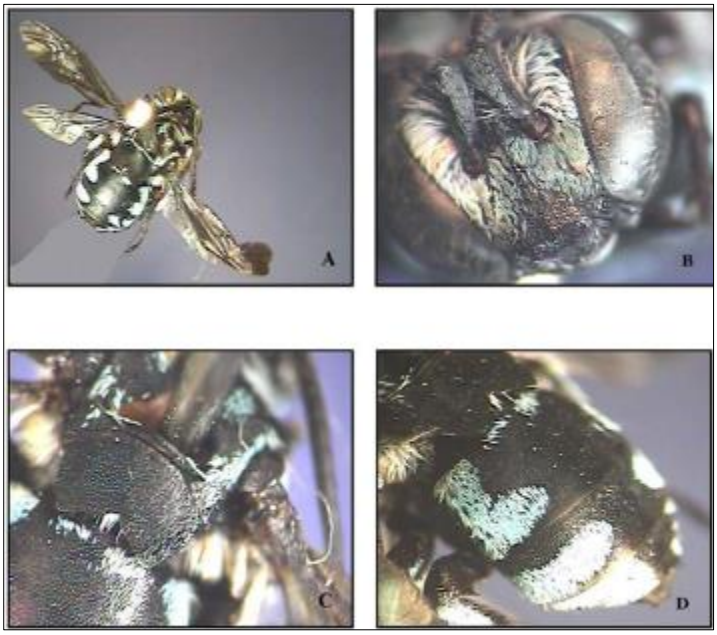
Figure 6 (A-D): External morphology of *Anthophora confusa* (Smith, 1854); (A). Dorsal view (Male); (B). female; (C). Face (Clypeus with dark and yellow coloration); (D). Leg with arolia

Source: https://www.researchgate.net/figure/A-D-External-morphology-of-Amegilla-Zonamegilla-cingulata-A-Dorsal-view-female_fig1_305639815

Figure 7 (A-D) External morphology of *Amegilla (Zonamegilla) cingulata* (Fabricius, 1775), (A). Dorsal view (female); (B). Male; (C). Face (Clypeus with the rectangular area); (D). Hind tibia with a mixture of white and black hairs

Source: https://www.researchgate.net/figure/A-D-External-morphology-of-Amegilla-Zonamegilla-cingulata-A-Dorsal-view-female_fig1_305639815

Figure 8 (A-D): External morphology of *Thyreus ramosus* (Lepeletier, 1841), (A). Dorsal view of females; (B). Dorsal view of male; (C). Metasomal segments (1st segment with L shape structure); (D). Scutellum with the broad incision

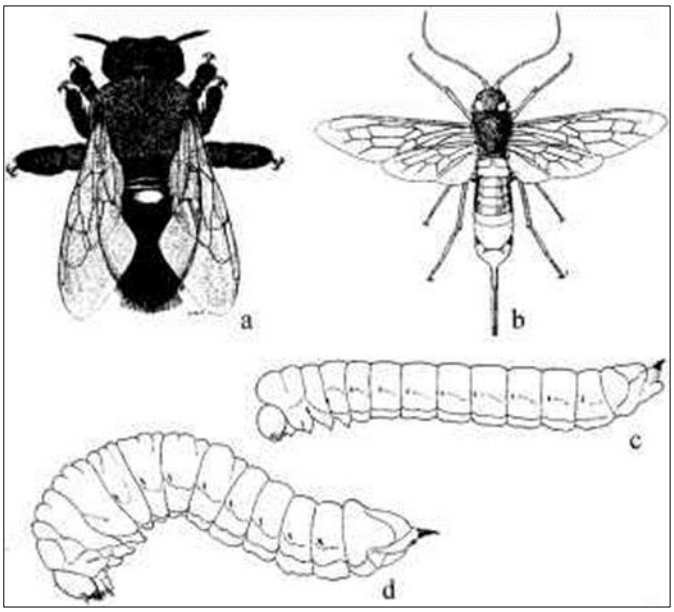


Source: https://www.researchgate.net/figure/A-D-External-morphology-of-Thyreus-himalayensis-A-Dorsal-view-female-B-clypeus_fig3_305639815

Figure 9 (A-D): External morphology of *Thyreus himalayensis* (Radoszkowski, 1893); (A). Dorsal view (female); (B). clypeus (slightly convex); (C), Scutellum (Bracket shape); (D), Metasoma (1st segment forming L shape)

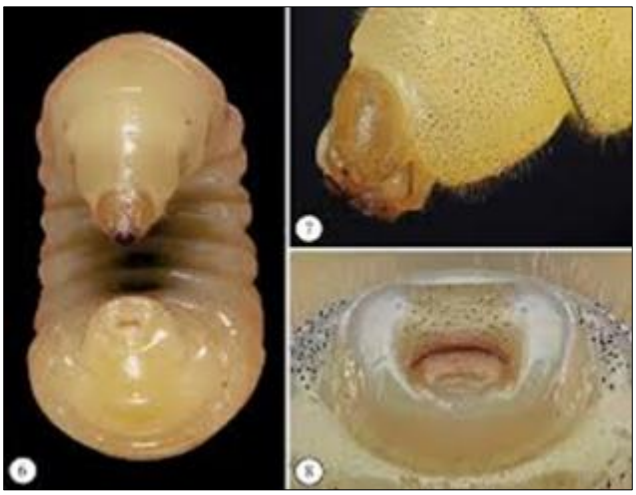
Larvae legless or the legs vestigial; socially parasitic on hosts selected by the mother and predacious (*Nomada*, Scopoli, 1770 and *Melecta* Latreille, 1802, feeding on stored food, eggs, and larvae in the cells of Andrenidae and other Anthophoridae, respectively), or feeding on material manufactured by the adults (Figures 10-11).

1.3. Biology, Ecology and habitat



Source: https://www.insectomania.org/urban-insects/anthophoridae.html

Figure 10 Hymenoptera Anthophoridae, Siricidae, Xiphydriidae. (a) *Xylocopa* sp. (Anthophoridae); (b) *Urocerus* sp. (Siricidae); (c) *Tremex* sp. larva (Siricidae); (d) *Xiphydria* sp. larva (Xiphydriidae)



Source: https://jhr.pensoft.net/article/61067/

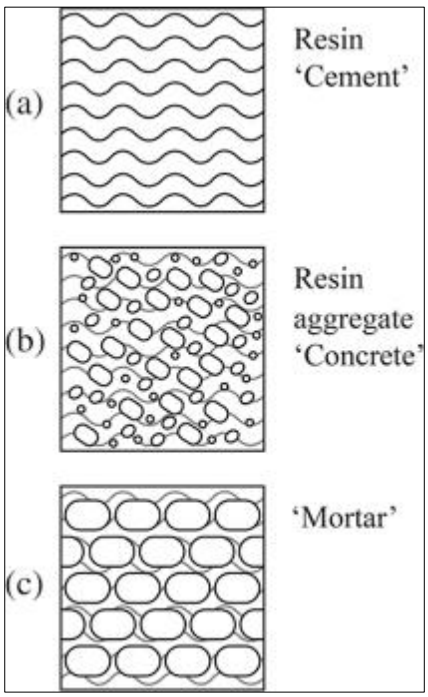
Figure 11 *Xylocopa*: (6, 7 and 8) Simultaneous percussion by the larvae of a stem-nesting solitary bee – a collaborative defense strategy against parasitoid wasp

Solitary behavior is characterized by the independence of females in building and provisioning their nests. There is no cooperation, or division of labor, between females of the same generation, or between mother and daughters. Most of the time, the mother dies before her offspring emerges, with no intergenerational relationships. There is a great diversity of nesting habits among solitary bees. Several species of the Megachilidae, Anthophoridae, and Apidae families nest in hollow branches of plants or pre-existing holes in wood. Others nest in cavities on the ground or in ravines or in protected places and few build exposed nests (Figure 12) [10,11,12].

Source: https://www.biofaces.com/post/196135/-xylocopa-frontalis-/

Figure 12 *Xylocopa frontalis* (Olivier, 1789), manga as, mangavas, or mang

The nest is supplied with nectar and pollen; some species also use oil collected from flowers (for example from plants of the Malpighiaceae family). The shape and arrangement of the brood cells are varied and can be a single cell at the end of a channel, a cluster in a protected location, or a linear sequence of cells, the number also varies, ranging from one to more than ten cells per child. The construction material used can be clay or sand added with some substance (for example oil or vegetable resin), leaves of plants carefully cut and united with resin and, or clay, pure resin, or the place where the nest is built receives only one waterproofing layer (of a glandular nature) that prevents moisture from reaching the immatures. There are also species that do not line the nesting site, the immatures remaining in direct contact with the nest walls (Figures 13-15) [13,14,15].



Source: https://resjournals.onlinelibrary.wiley.com/doi/10.1111/een.13103

Figure 13 Resin as utilized in bee nest construction is analogous to cement and related cement aggregates. (a) Resin – 'cement' is fluid when fresh and hardens over time with increasing viscosity; (b) Resin aggregate – 'concrete' results from the inclusion of coarse materials (e.g. gravel, leaf fragments, wood fibers) within the resin matrix; and (c) 'Mortar' consists of resin used as a filler material ('mortar') for stacked pebbles ('bricks')

Source: https://www.howtogettingridofbees.com/how-to-get-rid-of-ground-bees-naturally/

Figure 14 Building nests in the ground

Source: https://en-academic.com/dic.nsf/enwiki/2738288

Figure 15 Genus *Xilochopa*

There is no production of honey by these bees, as the female searches the flowers for the nectar (source of energy) she needs for herself and to supply the nest. Several species are seasonal, that is, they occur only at a certain time of the year when there is sufficient food availability and favorable conditions for nesting. The reproduction of several plant species directly depends on the visit of solitary bees to their flowers. Thus, some species of these bees are used by man for this purpose. For example, in Brazil, species of *Xylocopa* (Anthophoridae) are used for pollination of passion fruit, they are called bumblebees, mangabeys, or bumblebees, with other names depending on the region; however, this name is often given to any bee that is dark in color and of moderate size.

The Anthophila are a monophyletic group of vegetarian wasps we colloquially call bees among a grade of otherwise predatory families. Bees are among the most popular and familiar of insects, and in the case of one species – the western

honey bee *Apis mellifera* (Linnaeus, 1758) (Hymenoptera: Apidae)– the relationship with humans is ancient. Yet, this conspicuous species along with its familiar relatives among the orbiculate bees are a mere fraction of the total variety of bees and their important role in sustaining natural and agricultural ecosystems worldwide [16,17,18].

Objective

The objective of this manuscript is to know the peculiarities of the Anthophoridae Family.

2. Methods

The study proposed here constitutes bibliographical research in national and international publications that address the Anthophoridae Family in the field of Entomology. The bibliographical research was carried out using the descriptors Hymenoptera, wasps, and bees in the virtual library in Entomology and in the digital library of theses and dissertations of Universidade de São Paulo (BDTD). Concerned with drawing a public profile of quality research in the area, we sought, a literature review in the main journals in the area classified by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES). In order to complement this analysis with other types of documents such as books, scientific journals and documents.

3. Selected Manuscripts

3.1. Study 1

The digger bees make their nests in holes dug in the soil and the cells are lined with a fine wax similar to varnish. They can also use a tuft of grass or an abandoned mouse or bird nest. The queen modifies the nest for her needs, lining it with grass and moss and building a wax shell, where she lays pollen and a dozen eggs. Then she seals the shell with wax and builds an alveolus at the entrance to the nest to store honey.

The larvae that come out of the eggs feed on the pollen and honey that the queen puts in the shell through a hole. Larvae turn into pupae and 3 weeks later become workers. In bumblebee colonies, some workers also lay unfertilized eggs at the end of summer, from which males will hatch. Occasionally, bees do the same. The new bumblebee queens and males leave the nest and fly away to mate, and the females go in search of new colonies

The queen continues to build shells and is more and more dedicated to laying eggs. By the end of summer, the nest already has hundreds of bumblebees. Then the queen lays two special sets of eggs, drones, and queens. Only the young mated queens will survive to start new colonies in the spring [19,20,21,22].

3.2. Study 2

Xylocopa violacea (Linnaeus, 1758).

Carpenter bee, blue bumblebee, bumblebee

Conservation Status: LC - Least Concern

It is one of the largest bees in Europe, measuring 3 cm in length and 5 cm in wingspan. It is a lonely and noisy bee. The body is shiny black and the wings are iridescent, blue to brownish, with blue-purple metallic reflections. Males have orange antennae tips, made up of 11 segments and, unlike females, have no stinger; females have black antennae with 10 segments and have a stinger. Individuals are solitary, although females may live in small colonies with sisters and daughters.

The eggs are relatively large and are placed in individual compartments along with nectar and pollen, which will serve as food for the larvae. The new and only generation appears from June to August. This species hibernates during the winter. Males are territorial and can be aggressive.

It occurs in a wide variety of habitats, such as forests, woodlands, shrubby pastures, flowering meadows, orchards, or urban and suburban gardens. It feeds on the nectar and pollen of flowers, being an excellent pollinator. From April to June, it digs tunnels in dead or rotten wood in tree trunks or house beams (you can use existing tunnels) to make its nest.

It is distributed throughout the southwest of the Palearctic region, having begun to extend its distribution to the north, appearing in countries where it did not occur before (e.g. the United Kingdom). It is very common in the Mediterranean region. In mainland Portugal, it can be found throughout the entire territory [23,24,25].

3.3. Study 3

In the present work, we tried to discuss the relevance of the availability of nesting sites for bees in agricultural pollination in general. However, to detail and facilitate understanding, bees of the genus *Xylocopa* (stump bumblebees) were used as an example, whose presence in cultivated areas depends on the existence of an appropriate substrate to reproduce.

Bees popularly called stump bumblebees or simply bumblebees belong to the genus *Xylocopa* and there are 750 species described worldwide, grouped into 48 subgenera. In Brazil, there are cataloged fifty-two species of bumblebees distributed in 13 subgenera. Despite not forming colonies, most species of stump bumblebees have prolonged female longevity, overlapping generations, and tolerance to the presence of members of the same species in the nest. These characteristics are typical of species that are evolving towards eusociality, that is, to become social)

The stump bumblebees are essential bees for the pollination of several species of plants native to the caatinga, Atlantic forest, cerrado, Amazon forest, or coastal areas. They are also effective pollinators of several important crops, notably those with large flowers, in which smaller bees have difficulty touching the reproductive parts and acting as effective pollinators, such as several species of passion fruit (*Passiflora* spp.), (Brazil nuts) *Bertholletia excelsa* Humn. & Bonpl. (Lecythidaceae), (Pumpkin) *Cucurbita moschata* Duchesne (Curcubitaceae), (canavalia) *Canavalia ensiformis* (l.) (Fabaceae), (annatto) *Bixa orellana* L. (Bixaceae), (cowpea) *Vigna unguiculata* (L.) Walp (Fabaceae) (guava) *Psidium guajava* L. (Myrtaceae) and (tomato) *Lycopersicum esculentum* Miil. (Solanaceae).

The most frequent associations with the word “bee” are flowers, honey, work, Africanized bees, aggressiveness, wax (candles), social insects, beekeeping, propolis, and pollen. Some of the bee species appeared on Earth more than 100 million years ago, and since then there has been a very close interaction between flowers and bees. The flowers attract bees using perfumes and their showy petals, on which certain colored marks are sometimes found that indicate where the floral nectaries are, glands that produce a sugary substance, nectar, a sugary reward appreciated by visitors [26,27].

Flowers in general also produce large amounts of pollen, which are their male gametes, a source of protein for insects. In this way, the bees look for the flowers to feed there; through this flight from flower to flower, they carry the pollen grains with their bodies and fertilize the flowers. This association was very successful, and we find really specialized and extraordinary cases of pollination by bees. Although the wind can be a pollinating agent, flowers pollinated by insects produce better quality fruit, with more juice and better seeds. More than 3/4 of man's diet is based on plants pollinated by bees.

The most popular bees in the world are those also found in sweet bakery products, whose scientific name is *A. mellifera*. However, there are many different types of bees. It is estimated that there are more than 30,000 species of bees in the world. In Brazil, we must have around 5000 different species. One of the general characteristics of bees is their complete dependence on floral products.

We can address the diversity of bee species in many different ways. One of them is to separate the species that have a solitary habit, that is, the adults copulate, the females build a nest, and place there the necessary food for the development of their offspring (an egg placed on a mixture of pollen and nectar; the larva will feed on this mixture, and then complete its development by turning into a pupa and finally into an adult insect) and will never live with their children. Most bee species belong to this category.

The other extreme is occupied by highly social species, that is, species that live in very well-organized societies where there is a queen, responsible for reproduction, workers who take care of the other tasks of the nest, specialized care of the offspring, and overlapping of generations that can allow the same colony to live for more than 50 years. The social species are less numerous, around 1000 known until the. In tropical regions, we are still in the process of listing the bee species found in the various ecosystems. Therefore, in Brazil, around 40 faunal surveys have already been carried out with a similar methodology, which allows us to have a preliminary idea of our fauna. Bee communities are generally rich in a given location: in the gardens of the Universidade de São Paulo, Institute of Biosciences, in the heart of São Paulo, one of the largest cities today, for example, there are about 132 species of bees.

At the Boracéia Biological Station, in the Atlantic Forest of São Paulo, this number rises to 260. High biodiversity is one of our greatest assets. Here, however, a comment is in order: there is a lack of specialists to identify the species, and some of them have never even been described. It is common to find in specialized works references such as species 1, species 2, 3 and 4 awaiting more detailed studies. The analysis of bee communities in tropical areas faces the difficulty of taxonomic impediments, that is, we need to train and employ specialists in this field.

The importance of knowing the community of bees in a place and their relationship with flowers is great: they are the potential pollinators of our natural areas and regional agriculture. Bees can be specialists in certain flowers or botanical families, collecting them with maximum efficiency and operating as specialized pollinators, or generalists, that is, they visit many botanical species and pollinate them with less efficiency than specialists, but do not depend exclusively on them. for your survival. Social species, which live year-round, are generalists.

However, the plants visited by each species of the local community will vary with the relative abundance of nests and flowering, although there are preferences of certain species of bees for species or families of plants. In nature, there is a balance of predominance of specialists and generalists in certain flowerings. Once these mechanisms are known, these bees are intensely studied and created by man to increase the production of agricultural crops and food.

Thus, studying where they make their nests, what are the premises to build them, the geographic distribution ranges (generally shaped by temperature, relative humidity, and type of vegetation), and their floral preferences, that is, where they collect their food, constitute if in the first step for programs of environmental restoration or creation of these bees. Currently, digitized meteorological stations, satellite images, and environmental data control equipment (data loggers) provide us with data on the abiotic needs of species. These studies also take us to metabolism physiology laboratories and biochemical studies of enzymes that act in bee flight. The analysis of the plants visited can be done indirectly through pollen analysis of the honey and pollen collected by the bees and stored in the nests; they are the basis for assessing the relative ecological importance of social species in ecosystems, in addition to being fundamental for environmental restoration programs.

3.3.1. The bees off Brazil

The Anthophoridae family is extremely diverse. They are generally solitary, but many species live in aggregation, building nests close to each other. Among the Anthophoridae.

The Anthophoridae family is extremely diverse. They are generally solitary, but many species live in aggregation, building nests close to each other. Among the Anthophoridae are:

- **Center.** Group of oil-collecting bees. *Centris* Fabricius, 1804 and *Epicharis*, Klug, 1807 are abundant in the humid tropics, however, *Centris* extends south into temperate regions of South America. 36 species of *Centris* occur in the Cerrado of Minas Gerais.
- **Eucerini.** Some species of Eucerini, such as *Gaesischia* (Gaesischia) *fulgurans* (Holmberg, 1903)*, Melissodes (Ecplectica) nigroaenea* (Smith, 1854)*, Melissoptila* sp., *Thygater* spp. are quite common in the south and southeast of Brazil.
- **Exomalopsin**. It's a pretty diverse group. Many genera and subgenera are restricted to temperate regions of South America, where many endemic species are found. Within the Exomalopsini tribe, we have other oil-gathering bees, for example, *Lanthanomelissa* Holmberg, 1903, M*onoeca* Lepeletier & Serville, 1828, *Paratetrapedia* Moure (1992)*,* and *Tapinotaspis* Holmberg, 1903*.* Species of *Paratetrapedia* are numerous in the Atlantic Forest of the south and southeast region.
- **Emphorini.** Exclusive bee tribe of the American continent. They occur in open areas and in lowlands. The most common and widely distributed species are *Ancyloscelis* Latreile, 1836, *Melitoma* Lepeletier & Serville, 1828 and *Ptilothrix* Smith 1853.
- **Xylocopini**. This tribe includes carpenter bees of the genus *Xylocopa* that make nests in wood. Popularly also known as mamangavas, they are good pollinators of passion fruit flowers.
- **Parasites.** There is a great diversity of parasitic bees among the Anthophoridae, with different parasitism strategies {28,29,30].

4. Conclusion

Anthophoridae family is a very diverse group that includes most of the large bees, with solitary and parasocial species. Its species can nest in the ground or in wood trunks and, in general, females, when actively collecting pollen, do so by

vibration, regardless of the type of anther. All species are solitary, although many nest in large aggregations. Almost all species nest in the ground; the larvae develop in cells with an impermeable coating, not making cocoons.

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