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(RESEARCH ARTICLE)

Study of the reproductive behavior and parasitism of the Sphecidae Family (Insecta: Hymenoptera)

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Abstract

Females of Sphecidae are usually solitary hunters; however, they are found various levels of social behavior, including at least one example of eusociality. Females can establish their nests excavating sand, soil, and wood, in pre-existing cavities or even build using clay, waxes and other materials of plant origin. These wasps use the stinger to paralyze the game and to lay eggs under the body of the prey. The aim of this manuscript is to report the reproductive behavior and parasitism of the Familia Sphecidae. For this, a bibliographic survey of Sphecidae was carried out in the years 1963 to 2021. Only complete articles published in scientific journals and expanded abstracts presented at national and international scientific events were considered. Data were also obtained from platforms such as Academia.edu, Frontiers, Qeios, Biological Abstract, Publons, Dialnet, World, Wide Science and Springer.

Keywords: Female; Poison; Prey; Solitary hunters; Eusociality

1. Introduction

1.1. Literature

Few studies on the sphephiform wasp fauna using approaches functional ecological systems are found in the literature and each author defines guilds differently, using concepts and methods different from those used in this work, in addition to not being statistical tools were used in the definition of guilds (Figures 1, 2 and 3) [1,2,3].

Source: Determined by Salvador Vitanza

Figure 1 Specimen of Sphecidae Family

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Source: https://br.depositphotos.com/stock-photos/sphecidae.html

Figure 2 Specimen of Sphecidae Family

Source: https://www.gettyimages.pt/fotos/sphecidae

Figure 3 Specimen of Sphecidae Family

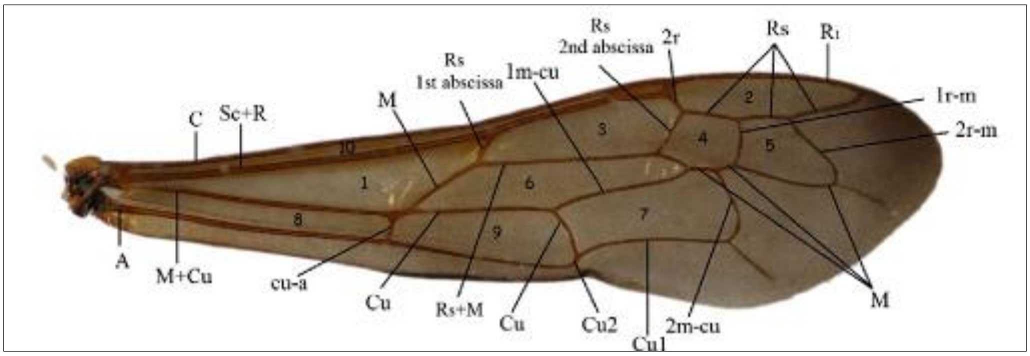
1.2. Morphology

Spheroids have the following characteristics:

- Antennas with 13 articles in the male, 12 in the female.
- Simple, poorly developed body hair (not branched or feathered).
- Pronotum short and transverse (Figures 4, 5, 6, 7, 8 and 9).

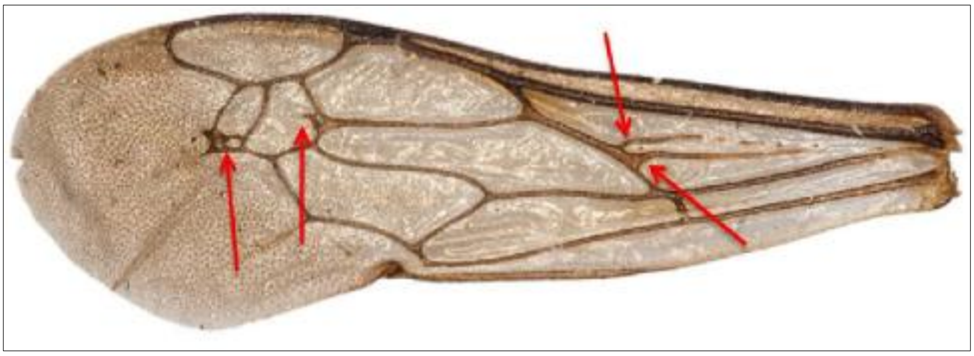
Source: DOI:10.15625/0866-7160/v41n2se1&2se2.14165

Figure 4 *Isodontia aurifrons* (Smith, 1959): A) Head, frontal view; b) Antenna; c) Mesosome, dorsal view; d) Mesosome, lateral view; e) Petiole; f) Habitus, side view



Source: DOI: 10.2478/s11756-019-00254-7 and Corpus ID: 129945868

Figure 5 Right forewing of *Sceliphron curvatum* (F. Smith, 1870) representing names of cells and veins. Cell names (1–10): 1. Medial, 2. Marginal, 3. Submarginal I, 4. Submarginal II, 5. Submarginal III, 6. Discoidal I, 7. Discoidal II, 8. Submedial, 9. Subdiscoidal, 10. Costal. Vein names: A. Anal, C. Costal, Cu. Cubital, M. Medial, R. Radial, Rs. Radial sector, Sc. Subcostal



Source: DOI:10.2478/s11756-019-00254-7 and Corpus ID: 129945868

Figure 6 Various anomalies in the forewing of *Ammophila sabulosa* (Linnaeus, 1758) male. Extra veins inside the medial cell, a spur inside the second submarginal cell, two extra cells inside the third submarginal cell and two small spurs protruding outside of the cell from M vein and 2r-m vein

The burrowing species have fossorial structures formed by bristles modified from the anterior tarsi and some burrowing species may present also a pygidial plate over the last gastral tergum. The excavation modalities are quite varied among species. Some species have only one form. of excavation, unlike others that combine several forms [4,5,6,7,8].

Source: https://www.scielo.br/j/paz/a/kHnBSrKDxv5tRsjGzkwbX3c/

Figure 7 Holotype female of *Pisoxylon roosevelti* Antropov, 1998. (A) Head, frontal view. (B) Habitus, dorsal view. (C) Specimen labels. (D) Habitus, side view

Source: https://www.scielo.br/j/paz/a/kHnBSrKDxv5tRsjGzkwbX3c/

Figure 8 Head, frontal view. (A) *Trypoxylon roosevelti* (Antropov, 1998), female from Manaus, Amazonas, Brazil. (B) *T. roosevelti*, male from Rio Branco, Acre, Brazil. (C) *Trypoxylon basirufum* sp. nov., female holotype. (D) *T. basirufum* sp. nov., male paratype from Antonina, Paraná, Brazil. Scale = 1 mm

Source: file:///C:/Users/User/Downloads/Paper23-2019-Phametal..pdf

Figure 9 *Isodontia aurifrons* (Smith, 1859): A) Head, frontal view; b) Antenna; c) Mesosoma, dorsal view; d) Mesosoma, lateral view; e) Petiole; f) Habitus, lateral view

1.3. Food

Flowers, juices, insects and spiders are food for their young. Nests of birds and social wasps can also house the clay cells of species of the genus *Sceliphron.* Nesting on the ground, on cliffs near streams and even on rougher terrain also occur (Figures 10 and 11) [9,10,11].

Source: Photograph by Erin C. Powell, University of Florida

Figure 10 Female *Sceliphron caementarium* (Drury, 1773), on her mud nest

Source: Photograph by Erin Powell, University of Florida

Figure 11 Female *Sceliphron caementarium* (Drury, 1773)

1.4. Biology

The Sphecidae Family has two basic strategies, both lethal, but allowing greater or lesser development of the host after the onset of parasitoid: (1) idiobiontia; and (2) cenobiontia (or konobiontia) (Figures 12, 13 and 14).

Source: Photograph by J. L. Castner, University of Florida

Figure 12 A blue metallic mud dauber *Chalybion californicum* (de Saussure 1867) on a *Sceliphron caementarium* (Drury, 1773) nest

Source: Photograph by Lyle Buss, University of Florida

Figure 13 A nest of an organ pipe mud dauber, *Trypoxylon politum* (Say, 1837)

Source: Photograph by Lyle Buss, University of Florida

Figure 14 A male organ pipe mud dauber, *Trypoxylon politum* (Say, 1837)

Females are usually solitary hunters; however, they are found various levels of social behavior, including at least one example of eusociality. Females can establish their nests excavating sand, soil, and wood, in pre-existing cavities or even build using clay, waxes and other materials of plant origin. These wasps use the stinger to paralyze the game and to lay eggs under the body of the prey (Figures 15, 16, 17, 18 and 19).

Source: Photograph by Erin Powell, University of Florida

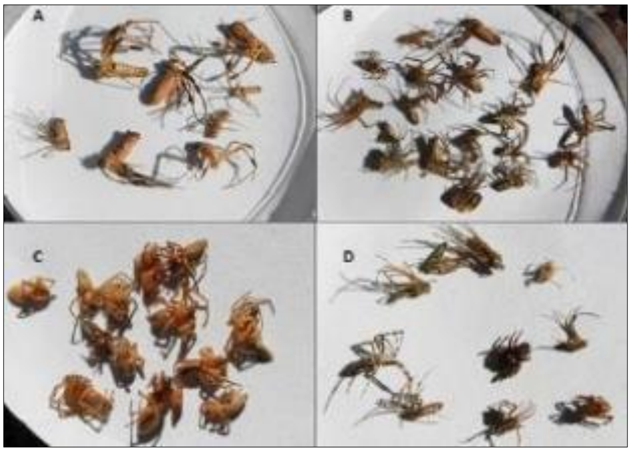
Figure 15 Female *Sceliphron caementarium* (Drury, 1773) with a paralyzed spider in her mandibles. She is preparing to push it inside the mud nest

Source: Photograph by Erin Powell, University of Florida

Figure 16 Female *Sceliphron caementarium* (Drury, 1773) gathering a mud ball to construct her nest

Source: Photograph by Erin Powell, University of Florida

Figure 17 Paralyzed spider prey (Family: Araneidae) packed into a cell of *Sceliphron caementarium* (Drury, 1773)



Source: Photographs by Erin Powell, University of Florida

Figure 18 Spider prey from the nests of four different individual female *Sceliphron caementarium* (Drury, 1773). Each photo (a-d) depicts the prey from a different female wasp highlighting the fact that individuals specialize on different types of spider prey. a. spiders in the Family Araneidae *Trichonephila clavipes* (Linnaeus, 1767), b. Araneidae, c. Anyphaenidae, d. Araneidae, A Oxyopidae, Eutichuridae, and Salticidae

Source: Photograph by Erin Powell, University of Florida

Figure 19 Cell contents of a *Sceliphron caementarium* (Drury, 1773) nest

Females can establish their nests excavating sand, soil, wood, in pre-existing cavities or even build using clay, waxes and other materials of plant origin. these wasps use the stinger to paralyze the game and to lay eggs under the body of the prey.

A third, less common type is kleptoparasitism or "brood parasites" (Brood parasite). The female kleptoparasites oviposit in the nests of other species, usually phylogenetically close, the 10 their larvae kill the victim's eggs and consume the prey used for the supply [12,13,14].

1.5. Ecology

Species that utilize pre-existing cavities may simply occupy cavities like abandoned beetle galleries, which divide cells. Others species can modify the cavities by enlarging them, for example, by excavating the dead wood or dry pith of branches (Pemphredonini and Crabronini) other species they build totally exposed clay nests (Figure 20) [15,16,17].

Source: https://translate.google.com.br

Figure 20 Nesting of *Chalybion turanicum* (Gussakovskij, 1935) in the Crimea. 1 – The nesting site (arrow indicates the entrance to the room with the nests). 2 – A female with a victim. 3 – A cluster of nests of *Sceliphron destillatorium* (Illiger, 1807) with a female of *C. turanicum* arrived with a victim. 4 – Another cluster of nests of *S. destillatorium* with a perching male of *C. turanicum*

1.6. Reproduction

Females are hunters. They usually capture and paralyze insects and spiders to serve them in a feast for their offspring. In each brood, unlike other insects, the female produces few eggs (about 15), but ensures the development and survival of each individual until adulthood. So much so that after providing the "food", they close the children in brood cells, with which she will no longer have contact. The process is as follows: egg – larva – pre-pupa – pupa – and adult. Nests consist of excavating burrows in the ground, building with clay or plant fibers. But a large number of wasps of this order nest in holes in wood, inside abandoned galleries of beetle larvae or digging the pith of dead branches (Figures 21, 22, 23, 24 and 25) [18,19.20].

Source: Photograph by Lyle Buss (ljbuss@ufl.edu), University of Florida

Figure 21 From left to right: The pupal case, pupa, pre-pupal larva, and last instar of *Sceliphron caementarium* (Drury, 1773)

Source: Photograph by Erin Powell, University of Florida

Figure 22 From top to bottom: A pupa within a pupal case, a larva that has begun to spin the pupal case, and a last instar larva of *Sceliphron caementarium* (Drury, 1773) that has consumed all the spider prey

Source: Photograph by Erin Powell, University of Florida

Figure 23 Young pupa of *Sceliphron caementarium* (Drury, 1773) with cast larval skin at the tip of the abdomen

Source: Photo by: Jonas Pederassi

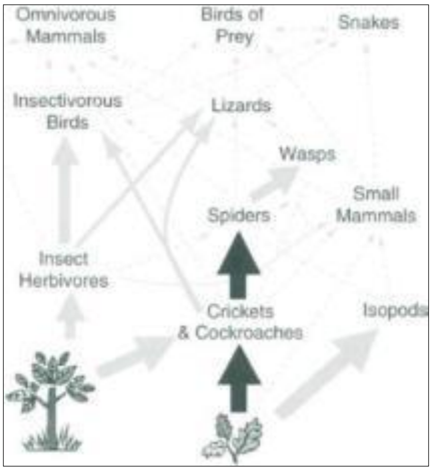
Figure 24 Sequence of the copulation phase: (A) beginning of aedeagus intromission. Copulation during nest digging – female carrying a clod of sand. (B) Connubium, gaster's contraction movements. (C) Connubium, gaster's bending movements. (D) Successful copulation – clasping of clasping organs. Male with the body vertically inclined and female self-cleaning.

Source: https://stringfixer.com/pt/Black_and_yellow_mud_dauber

Figure 25 Family Sphecidae feeding

1.7. Hosts

In addition, by using certain insects to feed their larvae, they help to control pests that attack crops. This process is called biological control.



Source: https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/sphecidae

Figure 26 Food web relationships of desert riparian floodplain excluding large mammals. Black solid arrows indicate energy flow pathways examined in this chapter. Gray solid arrows indicate energy flow pathways known to exist via direct observation. Gray dashed arrows indicate hypothesized energy-flow pathways

Source: https://bugguide.net/node/view/2139015

Figure 27 Sphecidae parasitizing spiders

Each genus is more or less specialized in one type of prey:

Spider: *Miscophus* and *Trypoxylon* (Figure 27).

Coleoptera: *Entomognathus, Cerceris, Rhopalum, Dictyoptera* and *Tachyspex* (Figure 28).

Source: http://www.waspweb.org/apoidea/Sphecidae/index.htm

Figure 28 Family Sphecidae parasitizing Coleoptera larvae

Diptera: *Crabro, Crossocerus, Ectemnius, Lindenius, Mellinus, Oxybelus* and *Rhopalum* (Figure 29).

Source: https://www.scielo.br/j/ne/a/fHs4nSN9LtxPWdZkCPWx7BB/?format=pdf&lang=en

Figure 29 *Stictia carolina* (Fabricius 1793) female taking a horse fly (Tabanidae) into her nest (U.S.A). Some populations of this species use skippers (Lepidoptera) and cicadas (Homoptera) as prey

1.7.1. Ephemeroptera

Heteroptera: *Astata, Dinetus* and *Lindenius.*

Source: https://www.scielo.br/j/ne/a/fHs4nSN9LtxPWdZkCPWx7BB/?format=pdf&lang=en

Figure 30 *Rubrica nasuta* (Christ, 1791) female taking a fly (Stratiomyidae) into her nest (Colombia). Some individuals of this species have been found to occasionally use Lepidoptera and Odonata as prey

Homoptera: *Alysson, Crossocerus, Diodontus, Gorytes, Passaloecus, Psen, Psenulus, Pemphredon, Stigmus, Rhopalum* and *Argogorytes.*

Lepidoptera*: Ammophila, Crossocerus, Lestica* and *Podalonia* (Figure 30).

Hymenoptera: *Cerceris, Lindenius* and *Philanthus.*

Orthoptera: *Tachyspex*.

Psocoptera: *Rhopalum.*

Thysanoptera: *Spilomena.*

Odonata: *Bembix* (Figure 31).

Source: https://www.scielo.br/j/ne/a/fHs4nSN9LtxPWdZkCPWx7BB/?format=pdf&lang=en

Figure 31 *Bembix variabilis* Smith, 1856. a female taking a damselfly (Odonata) into her nest (Australia). In most parts of its range, this species uses Diptera as prey

Trichoptera: *Crossocerus* [18, 19.20, 21].

Mantodea (Figures 32 and 33).

Source: Photographer Konrad Wothe / Minden Pictures / Nature in Stock

Figure 32 Sand wasp (Sphecidae) with bush cricket prey (Mantodea) Peloponnese, Greece

Source|: https://www.cherrug.se/nature/Hymenoptera%20-%20Hymenopterans%20 %20Steklar/Sphecidae/Ammophila%20sabulosa/index.html

Figure 33 *Ammophila sabulosa* (Linnaeus, 1758)

1.8. Use in biological control

Larra luzonensis Rohwer, 1919 (Larrinae) and *Ampulex compressa* (Fabricius, 1781) (Ampulicinae) native to the Philippines, were introduced to the Hawaiian Islands in 1931 to control mole crickets (*Gryllotalpa*) and crickets (Gryllidae). *Larra bicolor* Fabricius, 1804 was successfully introduced to the island of Puerto Rico in 1936 against a mole cricket (*Scapteriscus*) (Figures 34, 35, 36, 37, 38, 39 and 40) [21,22,23].

Source|: https://eol.org/pages/2760613/media?license_group=cc_by_sa

Figure 34 *Larra luzonensis* Rohwer, 1919 (Larrinae)

Source**:** wasp attacking a mole cricket (Lyle Buss, University of Florida)

Figure 35 Animal battle: jewel wasp *Ampulex compressa* (Fabricius, 1781) (Ampulicinae) x cockroach

Source: Photograph by Andrei Sourakov, Florida Museum of Natural History

Figure 36 Adult *Larra bicolor* Fabricius, 1804 preparing to oviposit on a mole cricket

Source: Photograph by Andrei Sourakov, Florida Museum of Natural History

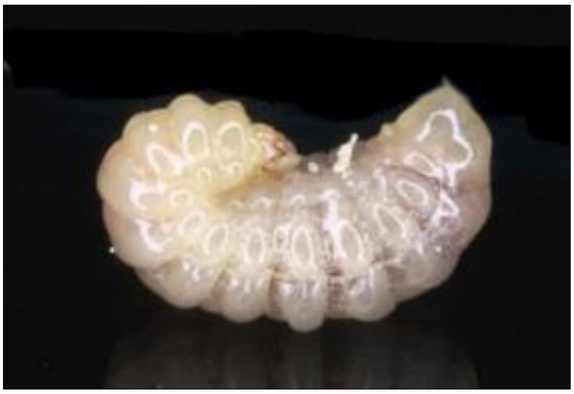
Figure 37 An adult *Larra bicolor* Fabricius, 1804 stinging a mole cricket

Source: Photograph by Andrei Sourakov, Florida Museum of Natural History

Figure 38 The ovipositor of an adult *Larra bicolor* Fabricius, 1804 is plainly seen as the wasp lays an egg while the mole cricket is paralyzed

Source: Photograph by Andrei Sourakov, Florida Museum of Natural History

Figure 39 A fully grown larva of *Larra bicolor* Fabricius, 1804 near pieces of the mole cricket on which it developed



Source: Photograph by Andrei Sourakov, Florida Museum of Natural History

Figure 40 A fully grown larva of *Larra bicolor* Fabricius, 1804

1.9. Taxonomy, fossil and Phylogeny

There are 9,744 species of sfeciform wasps in the world, and approximately 82 extinct species. About 1,900 species are cataloged in the Neotropical Region, with more than 640 species recorded in Brazil. estimate numbers between 2,500 and 3,500 species in the Neotropics and in a rough estimate puts numbers between 1,500 and 3,000 wasp species esfeciformes in Brazil.

These 44 species are segregated into 12 groups. The *Pilosum* group contains 6 species: *Pison pilosum* Martynov 1923, *Pison aureofaciale* Strand, 1910, *Pison vincenti* Menke, 1988, *Pison gnythos* Menke,1988, *Pison oaxaca* Menke, 1988 and *Pison sphaerophallus* Menke, 1988, with the first 3 forming the complex *Pilosum*. In Brazil there are records of *Pison* *pilosum* F. Smith, 1873, in Santa Catarina, São Paulo, Rio de Janeiro and Pará; by *P. sphaerophallus* in Pará and of *P. aureofaciale* in Bahia, and possibly in Santa Catarina.

1.9.1. Subfamilies

Ammophilinae, Chloriontinae, Sceliphrinae and Sphecinae (Figures 41, 42, 43, 44, 45 and 46A).

Source: http://www.waspweb.org/apoidea/Sphecidae/index.htm

Figure 41 Subfamily Ammophilina

Source: http://www.waspweb.org/apoidea/Sphecidae/index.htm

Figure 42 Subfamily Chloriontinae

Source: http://www.waspweb.org/apoidea/Sphecidae/index.htm

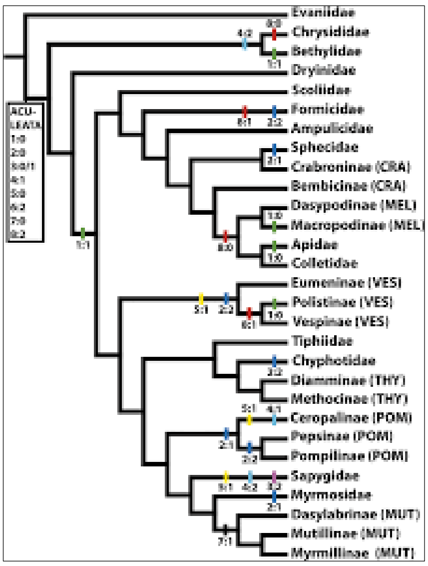
Figure 43 Subfamily Sceliphrinae

Source: http://www.waspweb.org/apoidea/Sphecidae/index.htm

Figure 44A Subfamily Sphecinae

Source: https://www.amberinclusions.eu/extremely-rare-big-ensign-wasp-evaniidae-fossil-insect-firs-example-in-baltic-amber-new-spec-7686

Figure 44B Altic amber stone with fossil inclusion - Extremely rare wasp. Sphecidae. First example in Baltic amber. New gen., new sp. nov. It weighs 117 grams. Measurements of stone 97x91x25mm, length of wasp body ~15mm, max ~27mm



Source: https://www.senckenberg.de/wp-content/uploads/2019/09/08_ASP_77-2_Kumpanenko_325-338.pdf

Figure 44C Evolution of characters of the 3rd valvula in Aculeata. Mapped on the tree from Branstetter et al. (2017) modifed according to Waichert et al. (2015) and Brothers & Lelej (2017). Character numbers and states; ground plan states indicated at base of Aculeata (inside rectangle). Only unambiguous character changes shown; for individual character evolution trees, see S2 fles Character Trees. — Abbreviations: CRA = Crabronidae; MEL = Melittidae; MUT = Mutillidae; POM = Pompilidae; THY = Thynnidae; VES = Vespidae

The described fossil species of *Pison* are: *Pison cockerellae* Rohwer (1908), *Pison oligocenum* Cockerell, (1908) (= *oligocaenum* Cockerell, 1909), *Pison electrum*, Antropov & Pulawski, (1989) and *Pison antiquum*, Antropov & Pulawski (1996) which was found in amber dated from the Oligocene to the Upper Eocene, approximately 25 to 40 million years old (Figures 44B and 44C) [24,25,26,27,28,29,30].

Objective

The aim of this manuscript is to report the reproductive behavior and parasitism of the Family Sphecidae (Insecta: Hymenoptera).

2. Methods

The method used to prepare this mini review was Marchiori 2021 methodology [31].

3. Studies conducted and selected

3.1. Study 1

Caementarium sceliphron (Drury, 1773), also known as the yellow-legged mud-dauber wasp, black-and-yellow mud dauber (within the US), or black-waisted mud-dauber wasp (outside the US), is a species of sphecid wasp. There are about 30 other species of Sceliphron that occur throughout the world, although in appearance and habits they are quite similar to *S. caementarium* (Figure 45).

Source: https://stringfixer.com/pt/Black_and_yellow_mud_dauber

Figure 45 *Sceliphron caementarium* (Drury, 1773) collecting mud

Source: https://stringfixer.com/pt/Black_and_yellow_mud_dauber

Figure 46 *Sceliphron caementarium* (Drury, 1773) with a mud charge, just before takeoff

Black and yellow mud dauber. **Species**: *Sceliphron caementarium.* **Binomial name:** *Sceliphron cemetery* (Drury, 1773). **Synonyms:** *Pelopoeus caementarium* (Drury1773), Cementaria sphex Drury, 1773. *Sphex caementarium* Drury, 1773. *Sphex caementarius* Drury, 1773 (Figure 46).

3.1.1. Distribution and habitat

Sceliphron caementarium widespread in Canada, the United States, Central America, South Africa, and the West Indies, and has been introduced to many Pacific islands (including Australia, Hawaii, and Japan), Peru, and Europe, where it became established in some countries of the Mediterranean Basin (Croatia, France, and Corsica, Italy, Cyprus, Malta, The Canary Islands, and Madeira) and Austria, and Ukraine.

This species is found in a wide variety of habitats such as rock ledges, man-made structures, puddles and other water banks, cypress domes, on long-leaved pines (*Pinus palustris* Mill) (Pinaceae) and on oaks.

3.1.2. Description

Female *S. cementarian* feeding on nectar (Figure 47).

Source: https://stringfixer.com/pt/Black_and_yellow_mud_dauber

Figure 47 *Sceliphron caementarium* (Drury, 1773) with partially yellow petiole from Austin, TX

The sceliphron caementary can reach a length of 24–28 millimeters (0.94–1.10 in.). Its petiole is usually black and is about half the length of the entire abdomen; however, the population in the southwestern desert usually has a yellow petiole. The thorax shows several yellow markings, while the abdomen is normally black, with a yellow propodeum (typical of women). The eyes are black, the antennae are black, and the legs are yellow with black trochanters and femurs. In the United States, it is the only species with paws marked in yellow. The wings are of a yellowish color (Figure 48).

Source: Salvador Vitanza

Figure 48 Hymenoptera-Sphecidae-*Sceliphron caementarium* (Drury, 1770 -Black and yellow mud dauber (C)

3.1.3. Biology

Black and yellow mud daubers are solitary parasitoid wasps that build nests out of mud. These sphecyd wasps collect mud balls in puddles and pool edges to build nests. Often, nests are built in shady areas within formations protected from the weather or other environmental elements (Figures 49A and 49B).

Source: https://stringfixer.com/pt/Black_and_yellow_mud_dauber

Figure 49A *Sceliphron caementarium* (Drury, 1773). A nest containing the mud-covered cells

Source: Photographs by Erin Powell and A. Powell, University of Florida

Figure 49B Nests *of Sceliphron caementarium* (Drury, 1773) built on various household items in Florida. A female southern house spider *Kukulcania hibernalis* (Hentz, 1842) (Araneae: Filistatidae)) with *S. caementarium* prey

These sites can be naturally occurring or man-made structures. Some examples are: under and inside various types of bridges, barns, garages, outdoor porches or under eaves of houses. Nests comprise up to 25 individual cylindrical cells arranged vertically. After breeding and initial brood cover, this spheid wasp uses more mud as a medium to cover and protect the entire cell cluster, forming a smooth appearance and uniform nest. The entire nest can span an area equal to or larger than the size of an average human fist (Figures 50 and 51).

Source: https://stringfixer.com/pt/Black_and_yellow_mud_dauber

Figure 50 *Sceliphron caementarium* (Drury, 1773) paralyzed spiders used as larval provisions collected from a nest

Source: https://stringfixer.com/pt/Black_and_yellow_mud_dauber

Figure 51 *Sceliphron caementarium* (Drury, 1773) it's making a mud ball and then it's going to fly with it

After building a nest cell, the female wasp captures several spiders. The captured prey is pricked and paralyzed before being placed in the nest (usually 6 to 15 per cell), and then a single egg is laid on the prey within each cell. The wasp then seals the cell with a thick mud plug. After finishing a series of cells, she leaves and does not return. The larva forms a cocoon and pupae. Eventually, the hatching larva will eat the prey and emerge from the nest (Figure 52).

Source: Photograph by Erin Powell, University of Florida

Figure 52 From top to bottom: A pupa within a pupal case, a larva that has begun to spin the pupal case, and a last instar larva of *Sceliphron caementarium* (Drury, 1773) that has consumed all the spider prey

Adults can be seen in midsummer feeding on nectar on flowers, especially Queen Anne's lace (*Daucus carota* L.) (Apiaceae), turnip and turnip (*Sium suave* Walter, *Sium latifolium* L., *Berula erecta* (Huds.) (Apiaceae). They have a low reproductive rate. Stings are rare due to their generally peaceful nature; however, nests are defended aggressively.

A common species of cuckoo wasp, *Chrysis angolensis* Radoszkowski, 1881 (Hymenoptera: Chrysididae), is often a kleptoparasite in *Sceliphron* nests and is just one of many different insects that parasitize these mud babes (Figure 53).

Source: Salvador Vitanza

Figure 53 *Chrysis angolensis* Radoszkowski, 1881 (Hymenoptera: Chrysididae)

3.1.4. Poison

Although they are common components of venoms, serotonin, histamine, acetylcholine and kinins are absent from *S. caementarium* venom (Figure 54) [32,33,34,35,36,37,38,39,40,41].

Source: https://www.healthline.com/health/sweat-bee-stings#first-aid

Figure 54 These solitary wasps get their name from the mud they use to make their nests

3.2. Study 2

3.2.1. Twasp sphex

Infallible hunters

Like all hunting wasps, the sphex leaves inside the nest, next to the egg, a reserve of food, that is, other animals, destined for the development of the larva. These animals are not killed, but simply paralyzed so that the food is not spoiled. For this, the hunting wasp stings the prey always in the same way: a sting in each of the nervous ganglia that command the movements (Figure 55).

Source: https://www.achetudoeregiao.com.br/animais/vespa_sphex.htm

Figure 55 As the number and location of ganglia varies depending on the prey, each wasp species hunts a single prey species

Sphexes are "specialized" in grasshoppers and crickets. But from one species of spex to another, the prey is easy or difficult to carry the victim to a very distant burrow, which they dig in advance.

Each lair has three or four chambers, each with an egg and its provisions. On the contrary, spexes that hunt large prey have to drag them along the ground: only after having paralyzed their victim do they dig a burrow in the vicinity that has only one chamber (Figure 56) [42].

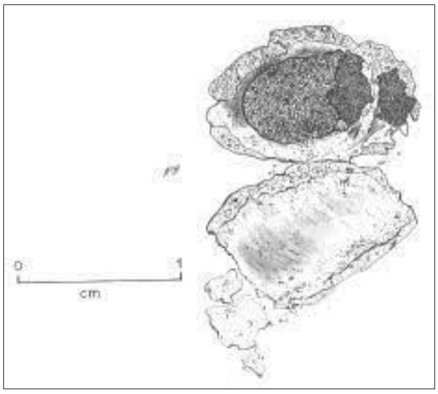
Source: https://www.achetudoeregiao.com.br/animais/vespa_sphex.htm

Figure 56 Features: Length: 23mm (female) the male is smaller 30 to 40 eggs

3.3. Study 3

The objective of the present study was to observe nests, cells, cocoons and droppings characteristic of *Pison* (*Pilos* Group), as well as the action of natural enemies in similarly shaped nests, and the spider families found in of these nests.

The study was carried out in the area of the vivarium (from the Biosciences Institute of UNESP, Campus de Clear River. Nests of similar shapes were collected from January 1998 to March 2000 (n=21) The nests were observed under a stereomicroscope and the contents were described regarding the specimens found and preliminarily identified (Figure 57).



Source: http://biologico.agricultura.sp.gov.br/uploads/docs/arq/V68_2/pinto.pdf

Figure 57 Cocoon of *Pison aureofaciale* Strand, 1910 (*Pilosum* group) made of mineral fragments, inside the cell of open clay

Pison specimens were identified as *Pison aureofaciale* Strand, 1910, this being the first record of their presence in the State of São Paulo, and there is no further information about their nests, cells, cocoons and the action of their natural enemies, and the information now presented to the species, as well as the families of spiders found in their nests.

Specimen 1 emerged from nest 14 collected in the garden, on the underside of a leaf of *Strelitzia reginae,* Ait. (Musacea) (Paradise Bird) and 2 specimens from nest 16 collected in a window, partially sheltered from the sun and rain, were identified as *P. ureofaciale* and are incorporated.

During the work, 3 more male specimens were collected no substantial differences were found between the cocoons and droppings of the building wasps nests 14 and 16. The other nests were located in different places such as steel cabinets, walls, wooden crates and windows, sheltered from the sun and rain. These nests are built with clay and have a variable number of cells, sometimes only one and more commonly, from 3 to 6, linked between itself, sometimes forming two rows, one of the nests had cells arranged in a single column (Figure 58).

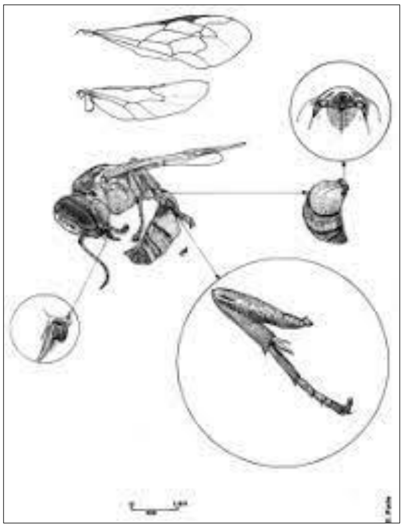


Figure 58 Male specimen of *Pison aureofaciale* Strand, 1910 (group *Pilosum*) with the details: a) notched jaw b) hind leg with 2 spines on the tibiac) gaster with the tergum I hump d) Wings: anterior with 3 submarginal cells; and the back with the 2 rows of hamuli

Peculiar are the cocoons, made up of fragments of mineral origin and have few threads incorporated externally and macroscopically they show to be constituted by two portions (zones), with different color, texture and thickness, a external and one internal. Quartz grains (sand) delicately arranged one on top of the other, forming a single layer of grains, cemented by clay minerals mixed with iron oxides and hydroxides (hematite, goethite and colloidal iron).

Peculiar are the cocoons, made up of fragments of mineral origin and have few threads incorporated externally and macroscopically they show to be constituted by two portions (zones), with different color, texture and thickness, a external and one internal. Quartz grains (sand) delicately arranged one on top of the other, forming a single layer of grains, cemented by clay minerals mixed with iron oxides and hydroxides (hematite, goethite and colloidal iron) The activity of the construction of the last 3 cells of nest 1 in which the presence of the klepto-parasitoid Chrysididae was observed. The analysis of the cell content of the 21 nests of *P. aureofaciale* collected, Chrysididae (Hym.: Chrysidoidea), *Mellitobia* sp. (Chalcidoidea, Eulophidae) Mutilidae (Hym.: Tiphioidea), *Crematogaster* sp. (Hym.: Formicidae, Myrmycine) *Solenopsis* sp. (Hym.: Formicidae, Myrmicinae) and spiders: Salticidae, Araneidae and Therididae and Thomisidae (*Tmarus* sp.) [43].

3.4. Study 4

In this study we intend to present a list of sfeciform wasp species from the Serra da Bodoquena region from 2006 to 2014.

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

Figure 59 Genera *Trypoxylon* Latreille, 1796

For the sampling of the wasp fauna, three different techniques were used: A the entomological net in active search among the trails in the vegetation and during the entire period it remained in the field; four Malaise traps were exposed during five consecutive days with 96.2º alcohol randomly distributed within the vegetation; and Moërick traps (yellow trays, prepared with water and detergent, placed on the litter) arranged in 15 points about 10 m apart and each point with three trays exposed for 48 hours.

A total of 297 individuals were collected in 41 genera and 90 wasp species sfeciforms. The genera *Trypoxylon* Latreille, 1796 and *Liris* Fabricius, 1804 do not were morpho speciated due to the large number of species present in the genera and due to the lack of taxonomic review of these groups, for this reason we prefer to underestimate the number of species (Figures 59 and 60).

Source: https://www.biodiversity4all.org/taxa/250754-Liris

Figure 60 Genera *Liris* Fabricius

These two genera together with the genus *Eremnophila* Menke, 1964 were the most abundant genera sampled in his work. The most species abundant were: *Eremnophila binodis* (Fabricius, 1798) with 30 records among 21 males and nine females sampled with netting only, followed by *Eremnophila melanaria* (Dahlbom, 1843) with 17 individuals registered all with the puçá except one collected by trap from Moërick, eight males and nine females; *Sceliphron asiaticum* (Linnaeus, 1758) with 11 individuals, seven females and four males all sampled with netting, and *Tachytes chrysopyga* (Spinola, 1842) with 11 individuals one female of ten males all sampled with the Moërick trap (Figures 61, 62, 63, 64 and 65).

Source: https://www.marylandbiodiversity.com/view/6431

Figure 61 Genera *Eremnophila* Menke, 1964

Source: Bhrenno Maykon Trad

Figure 62 *Eremnophila binodis* (Fabricius, 1798)

Source: https://commons.wikimedia.org/wiki/Category:Eremnophila

Figure 63 *Eremnophila melanaria* (Dahlbom, 1843)

Souce: https://stringfixer.com/tags/asiaticum

Figure 64 *Sceliphron asiaticum* (Linnaeus, 1758)

Source: http://v3.boldsystems.org/index.php/Taxbrowser_Taxonpage?taxid=994210

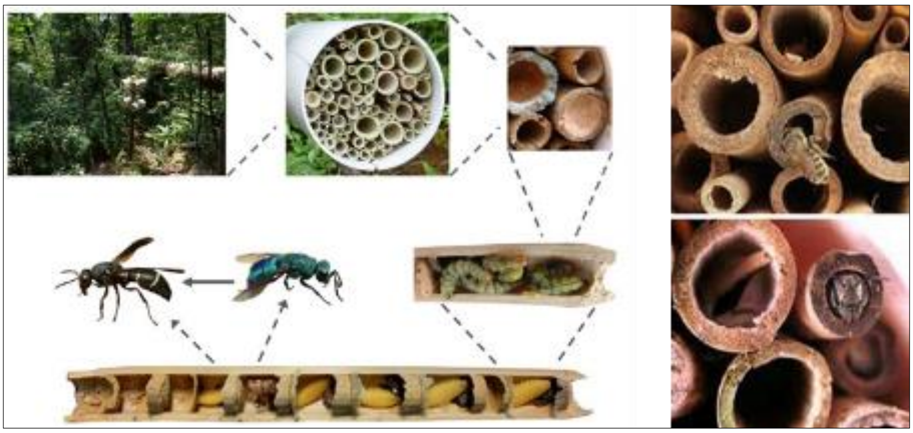
Figure 65 *Tachytes chrysopyga* (Spinola, 1842)

For the species *Clytemnestra paraguayana* R. Bohart, 2000, *Stenogorytes megalommiformis* (Strand, 1910) and *Trypoxylon marginatum* Cameron, 1912 are not found occurrence records in Brazil. A total of 190 individuals of 56 species were recorded with the puçá, 74 individuals of 22 species with the Moërick trap and 33 individuals of 24 species with the Malaise. Only 10 species were observed in more than one sampling method and only bicolor larra aff. was captured by the three sampling methods [44].

3.5. Study 5

The objective of this work is to present the diversity, seasonal abundance and structure of solitary wasps' nests which nest in pre-existing cavities, through the use of trap nests, in the region of Ituiutaba, MG.

Nests Traps. Two basic types of trap nests (=NA) were used: (1) bamboo buds (=B) closed in one of the ends by the node itself, with diameters ranging from 10 to 26 mm and lengths of 90 to 250 mm; (2) tubes made with black cardboard, closed in one of the ends with the same material, being that the smaller tubes (=TP) had 6mm diameter and 58mm length and the largest (TG). These tubes were introduced into holes made in 10 plates of wood: in 5 of them a total of 390 TP were placed and, in the other 5. These plates, along with the B (n=100), were placed on shelves under a penthouse built near the stream of Coffee (Figure 66).



Source: https://staabmichael.wordpress.com/2018/09/06/all-you-possibly-ever-wanted-to-know-about-trap-nests/

Figure 66 Structure of nests traps

Representatives of two wasp families used NA (n= 296), being Sphecidae with 60% of the genera, 67% of the species and 80% of the nests, more abundant than Eumeninae. The nests occurred more frequently during the hot and rainy season (September to April), February being the busiest month for the Sphecidae and January for the Eumeninae. In general, TG (n=136; 57.6%) by Sphecidae and TP (n=47; 78.6%) by Eumeninae were the most used NA.

Source: https://bugguide.net/node/view/1242668/bgpage

Figure 67 *Trypoxylon lactitarse* Saussure, 1857

Source: https://www.scielo.br/j/ne/a/qf8V8vt8Tw6CnnMDCYnNVng/abstract/?lang=en

Figure 68 *Podium denticulatum* Smith F. Smith, 1856

Nestings in the three types of NA were observed only in *Trypoxylon* sp.1 aff. Sharp, with higher frequency in PT (n=12; 80.0%); in two types of NA nested *Trypoxylon lactitarse* Saussure, 1857, *Trypoxylon rogenhoferi* Kohl, 1884, *Podium denticulatum* Smith F. Smith, 1856 (Vespidae) *Pachodynerus nasidens* (Latreille, 1812) (Vespidae) (in TG and B) and *Pachodynerus brevithorax* (de Saussure 1852) (Vespidae) and *Pachodynerus praecox* (de Saussure, 1856) Saussure

(Vespidae) (in TP and TG). *Trypoxylon lactitarse* was the only species that nested throughout the year while *P. praecox* was the one, among others, that it nests only in the cool and dry season (Figures 67 and 68).

The cells were constructed in linear series and provisioned with paralyzed prey: spiders (*Trypoxylon*), cockroaches (*Podium*), caterpillars of Lepidoptera (*Pachodynerus* and *Monobia*) and crickets and hopes (Isodontia) (Figure 69).

Source: https://bugguide.net/node/view/1563123/bgimage

Figure 69 *Pachodynerus nasidens* (Latreille, 1812) (Vespidae)

3.6. Study 6

Since 1984, significant outbreaks of the grasshopper *Rhammatocerus schistocercoides* (Rebn, 1906) have been reported in the state of Mato Grosso in Brazil. The species was until recently considered harmless. It now causes great concern to local farmers. The determinism of these outbreaks has long been unclear. In 1992, as part of a multidisciplinary project, we carried out a research project aimed at clarifying the determinism of the populations of this locust and establishing the scientific bases of the locust problem in Mato Grosso (Figure 70).

Source: https://www.flickr.com/photos/118387022@N02/12715939964

Figure 70 *Rhammatocerus schistocercoides* (Rebn, 1906)

Source: https://www.shutterstock.com/pt/image-photo/wasp-prionyx-sp-on-white-background-152187212

Figure 71 Genera *Prionyx*

Prionyx is a cosmopolitan gem, known for its wide geographic distribution, location of most of its 56 species, 13 of which occur in the Neotropics. It is a gemstone of difficult characterization due to its morphological diversity. The body length of the species that compose it varies from 6.5 to 35 mm; the basic color is black, but often the gaster (the globular part formed by the last segments of the abdomen) is completely or partially red (Figure 71).

These wasps build, in most cases, solitary nests, with the exception of *Prionyx spinolae* (Smith, 1856) whose nests are colonial and can group together a hundred of individuals. Some species of *Prionyx* are considered important natural enemies migratory locusts *Schistocerca gregaria (*Forskâl, 1775) (Figure 72).

Source: http://taxondiversity.fieldofscience.com/2020/05/prionyx.html

Figure 72 *Prionyx spinolae* (Smith, 1856)

As reported for other members of this group, *Prionyx thomae* (Fabricius, 1775) captures its prey before building its nest first and only look for prey afterwards. The wasps accompany the swarms of locusts which, at the hottest hours, are constantly on the rise.

When the wasp captures a cricket, it introduces its stinger into the softer parts of the body, at the level of the intersegmental membranes of the abdomen. The effect of the venom seems almost immediate, the prey immobilizing a few seconds after the bite (Figure 73).

Source: https://www.flickr.com/photos/acbc/2607553310/

Figure 73 *Prionyx spinola* (Smith, 1856) preparing to attack the prey *Rhammatocerus schistocercoides* (Rebn, 1906)

The wasp then pulls its prey to the ground, straddling the cricket's back, holding it with its mandibles and forelegs, progressing with its middle legs and posterior. This displacement frequently leaves a characteristic furrow over a distance variable up to a few meters, having located a suitable location, the wasp leaves the locust and starts digging a nest in the sandy ground. During this transport, it is not uncommon to observe competition with other wasps trying to appropriate the prey. It can also happen that the wasp, without apparent motive, abandons the cricket after having shot it for several meters forelegs. With its hind legs, it pushes the earth backwards. The wasp may stop burrowing several times to walk or fly around the opening of the nest, while the prey remains motionless in the vicinity (Figure 74).

The nest excavated by *P. thomae* is small, with only one cell and houses a single prey. The channel leading to the cell is approximately 5 to 8 em long; It is dug diagonally into the ground to a depth of 4 to 5 em. The wasp's egg, yellowish-white in colour, is deposited on the upper border of the membrane of the posterior coxa of the locust, thus guaranteeing the future larva, after hatching, access easily inside the body of the prey. All the observations made revealed a identical position of the egg. After one to two minutes, the wasp comes out of the hole and quickly plugs the orifice by pushing sand down with its legs [45,46].

Source: https://mdc.mo.gov/blogs/discover-nature-notes/creepy-critters-2

Figure 74 *Prionyx spinola* (Smith, 1856) attacking the prey *Rhammatocerus* schistocercoides (Rehn, 1906) and taking the grasshopper to the nest

4. Conclusion

Considering the lack of specialists to work with all groups of invertebrates, the basic knowledge about taxonomy and biology of some groups still presents many gaps.

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