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Parasitoids of Agricultural Importance Collected at Atlantic Forest Biomes in Brazil: A Bibliographic Summary

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ABSTRACT

Its ecological processes evolved from the eocene, when the continents were already relatively willing as they are today. Currently, the Atlantic Forest has only 7% of its original área. Parasitoids are organisms that cause the death of their hosts to complete their development and act as parasites only in the larval stage, when they develop in only one host, with adults having a free life. The objective of the six studies was to verify the groups of parasitoids present in Atlantic Forest Biomes in Brazil with a bibliographic summary. The Hymenoptera Parasitica were collected in the Atlantic Forest biome from 2002 to 2021.

1. Introduction

1.1 Atlantic Forest

Its ecological processes evolved from the eocene, when the continents were already relatively willing as they are today (Figure 1). Currently, the Atlantic Forest has only 7% of its original area ^[2].

Considered one of the richest biomes on the planet, that is, with greater biodiversity, the Atlantic Forest is the second largest forest in extension in Brazil, consisting of plateaus and mountains ^[2].

Its area covers the east, southeast and south of Brazil and, in addition, a part of Paraguay and Argentina ^[2].

Among the Brazilian states, it is present in 17 of them: Alagoas, Bahia, Ceará, Goiás, Mato Grosso do Sul, Minas

Gerais, Paraíba, Paraná, Pernambuco, Piauí, Sergipe, Rio Grande do Norte, Rio Grande do Sul, São Paulo, Espírito Santo, Rio de Janeiro and Santa Catarina.

The climate of the Atlantic Forest is predominantly humid tropical, influenced by the humid air masses coming from the Atlantic Ocean ^[2].

1.2 Characteristics of Parasitoids

In agrosystems, such as coffee, cotton, soy, sorghum, beans and wheat, dozens of families of parasitoids are found responsible for the cultivation of pests and have a high diversity of hosts, such as aphids, flies, caterpillars and mealybugs. Most parasitoids belong to the group of insects, mainly to the orders Diptera (flies) and Hymenoptera (wasps).

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Figure 1. Overview of Mata Atlantica, Brazil.

Source: pensamentoverde.com.br



Figure 2. Parasitoides (Hymenoptera). Source. researchgate.net

Parasitoids are organisms that cause the death of their hosts to complete their development and act as parasites only in the larval stage, when they develop in only one host, with adults having a free life (Figure 2).

The objective of the six studies was to verify the groups of parasitoids present in Atlantic Forest Biomes in Brazil.

1.3 Characteristics of the Families of the Main Groups of Parasitoids Present in the Studies

Braconidae are small and active insects that, like other parasitoids, have larval stages that develop on or inside other arthropods, usually insects. They have a variable

degree of host specificity and most of their species attack phytophagous insects, mainly Lepidoptera, Diptera or Coleoptera. Some species attack eggs, pupae and even adults from their hosts.

Ceraphronidae is a small family of hymenopteran insects, with 14 genera and about 360 known species. Many species still remain to be described. It is a little known group as a whole, although it is thought that they are mostly parasites, especially flies.

Diapriidae is cosmopolitan, with three subfamilies, 194 genera and 2080 described species. Diapriinae, Belytinae and Ambositrinae occur in the Neotropics. Belytinae and

Ambositrinae parasitize immature Mycetophilidae and Sciaridae (Diptera) and Diapriinae parasitize mainly Diptera, with some species associated with ants.

Encyrtidae is a large family of parasitic wasps, with about 3710 species described in about 455 genera. Most larvae are primary parasitoids in Hemiptera, although other hosts are attacked.

Eulophidae is one of the most numerous families of Chalcidoidea, comprising almost 5,600 species in about 326 genera and five subfamilies. A large number of species of Eulophidae parasitize insect larvae that develop in plant tissues, such as miners, broachers and gallers.

Ichneumonidae is a family of hymenopteran insects. These are important parasitoids of other insects. Common hosts are larvae and pupae of Coleoptera, Hymenoptera and Lepidoptera.

Figitidae is the family with the greatest diversity of species within the Cynipoidea according to the current classification this family includes twelve subfamilies, the Eucoilinae being one of the most diverse with about 85 genera and approximately 1,000 species. In general, the representatives of this subfamily are cenopionite endoparasitoids of Muscomorpha (Diptera) larvae.

Platygastridae are parasitoids of Cecidomyiidae some are idiobiont parasitoids of Coleoptera Homoptera, Coccoidea and Aleyrodidae.

Scelionidae, attacking the eggs of many different types of insects, spiders, butterflies and many are important in biological control. Several genera are wingless, and a few attack aquatic insect eggs underwater.

Pteromalidae presents pupal parasitoids associated with flies from the families Muscidae, Calliphoridae, Sarcophagidae, Drosophilidae, Chloropidae and others.

2. Methodology

The Hymenoptera Parasitica were collected in the Atlantic Forest biome from 2002 to 2021. The survey was carried out Atlantic Forest Biome in Brazil using the Online Scientific Electronic Library (SciELO).

3. Studies Carried out

Study 1.

In the study by Silva et al (2016) in two areas of the Atlantic Forest, the parasitoids were obtained using Malaise traps and Moericke traps as shown in Figure 3. The results obtained are shown in Table 1. In the two areas studied, family Platygastridae was the most frequent.



Figure 3. Malaise trap.

Four hundred and thirty individual parasitoid were collected (BPWR) and 203 individuals were collected. Malaise trap captured a mean of 13.8 ± 3.46 individuals, significantly more than the Moericke traps (5.5 ± 1.15) ($H = 4.84$; $d.f. = 1$; $P < 0.05$)^[5].

Table 1. Percentage of families of parasitoids in the Páchecos Bahado Wild Life.

Taxonomic Group	OR – Percentage	BPWR- Percentage
Braconidae	11.0	18.0
Encyrtidae	0	15.0
Ichneumonidae	21.0	0
Platygastridae	30.0	26.0

Study 2.

In the research by Azevedo et al. (2002) the sampling of the hymenopteran parasitoids were performed using Malaise traps and Moericke traps (Figure 4). They collected four thousand five hundred and ninety-five specimens, belonging to twenty-eight families. As shown in Table 2, the family Braconidae was the most abundant^[1].



Figure 4. Moericke trap

Table 2. Percentage and number of parasitoid hymenopterans in an Atlantic Forest área.

Taxonomic Group	Percentage	Number of specimens
Braconidae	22.5	1034
Eulophidae	14.32	658
Scelionidae	13.12	606
Total	-	2.298

The relative abundance of the parasitoid hymenopteran families found in was as follows: 34.99% for Chalcidoidea (16 families/1608 individuals); 23.48% for Ichneumonoidea (2/1079); 20.41% for Platygasteroidea (2/938); 10.05% for Cynipoidea (1/462); 5.74% for Proctotrupoidea (1/264); 2.57% for Chrysidoidea (3/118); 2.33% for Ceraphronoidea (1/107); 0.37% for Evanioidea (1/17) and 0.04%. The families Braconidae, Eulophidae, Scelionidae, Pteromalidae and Figitidae had the highest relative abundance, with 1.034 individuals (22.50% of the total), 658 (14.32%), 603 (13.12%), 536 (11.64 %) and 462 (10.05%), respectively.

Study 3.

The collection of parasitoid hymenopterans was performed using Moericke traps. Seven thousand two hundred and eight specimens were collected. The most abundant familie was Platygastriidae (Table 3) [3]. They are generally idiobionts, attacking the eggs of either beetles or Hemiptera.

The families that showed the highest relative abundance were Platygastriidae 1.193 of the total collected parasitoid hymenopterans, Scelionidae 1.062, Braconidae 954, Eulophidae 878, Ceraphronidae 79, Diapriidae 714, Figitidae 604 and Encyrtidae 418.

Table 3. Percentage of families of parasitoid hymenopteran collected.

Taxonomic Group	Percentage
Braconidae	13.2
Ceraphronidae	11.1
Diapriidae	9.9
Encyrtidae	5.8
Eulophidae	12.2
Figitidae	8.4
Platysgaridae	16.6
Scelionidae	14.7

Study 4.

In the present study, one thousand and three hundred individuals. Diapriidae was the most frequent [6].

The relative abundance of the parasitoid hymenopteran families found in was as follows: 34.99% for Chalcidoidea (16 families/1608 individuals); 23.48% for Ichneumonoidea (2/1079); 20.41% for Platygasteroidea (2/938); 10.05% for Cynipoidea (1/462); 5.74% for Proctotrupoidea (1/264); 2.57% for Chrysidoidea (3/118); 2.33% for Ceraphronoidea (1/107); 0.37% for Evanioidea (1/17) and 0.04% for Vespoidea (1/2). The families Braconidae, Eulophidae, Scelionidae, Pteromalidae and Eucoilidae had the highest relative abundance, with 1.034 individuals (22.50% of the total), 658 (14.32%), 603 (13.12%), 536 (11.64 %) and 462 (10.05%), respectively [5].

Table 4. Percentage of families of parasitoids collected.

Taxonomic Group	Percentage
Braconidae	15.00
Diapriidae	45.92
Ichneumonidae	12.92
Platysgaridae	6.15
Perilampidae	0.62
Pelecinidae	0.15

Study 5.

The adults were obtained using traps known as McPhail traps. Fruits were placed in trays containing sand to pupa-

te the larvae. They were collected in closed containers for the emergence of adults and / or parasitoids.



Figure 5. McPhail Trap

Source: For Agriculture, Rs 150 /piece Harmony Ecotech Private Limited | ID: 22473045891 indiamart.com

The *Anastrepha fraterculus* (Wiedemann) (Diptera: Tephritidae), species were the most parasitized with six parasitoid species and also with a larger number of individuals 83.08%. In relation to the parasitoids *Doryctobracon areolatus* (Szépligeti) (Hymenoptera: Braconidae) it was the species that presented greater abundance with 115 individuals and the highest percentage of parasitism with 68.05%.

Doryctobracon areolatus stands out for its aggressiveness in parasitism of fruit fly larvae.

The percentage of parasitism on fruit fly larvae / pupae was calculated [% Parasitism = (N°. of emerged Parasitoids / N°. of pupils obtained) x 100].

The percentage of parasitism in fruit flies of the parasitoids *D. areolatus*, *D. brasiliensis* (Szépligeti), *Opius bellus* Gahan, *Utetes anastrephae* (Viereck) (Braconidae) and *Aganaspis pelleranoi* (Brèthes) (Figitidae) Pteromalidae sp1. presented 3 7.94%, 0.23%, 0.45, 2.76%, 1.45 and 30.31%, respectively.

D. areolatus, *D. brasiliensis*, *O bellus*, *U. anastrephae*, *A pelleranoi* and Pteromalidae sp1. presented a percentage of 68.05%, 1.76%, 3.55%, 21.89% and 4.14%, respectively.

Eugenia uniflora Juss (Mirtaceae) the specie presented the following pupae of *Anastrepha* (n) 1309, VP1 (%) 18.02 and infestation index (p / kg) 683.6. The percentage of parasitism was 11.38%. It obtained a greater abundance with the following parasitoids: *D. areolatus*, *D. brasiliensis*, *O. bellus* and *U. anastrephae*. The percentage of parasitism was 11.38^[4].

Braconidae (Opiinae) are the main natural control agents of *Anastrepha*, as they oviposit third-instar host larvae to emerge from the host's pupae.

4. Conclusions

Parasitoids are important natural regulators of insects and are prominent groups of natural enemies in the agricultural system. They are also considered as bioindicators of biodiversity.

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