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(REVIEW ARTICLE)

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Diversity and behavior of Eucharitidae Family (Hymenoptera: Eucharitidae) parasitoids of ants (Hymnoptera: Formicidae)

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Abstract

Eucharitidae wasps are specialized parasitoids of ants, and it is decided that each species generally parasitizes ants of a single genus. This group has developed. This parasitism takes place throughout the course of the year, but especially during hot and humid months. However, the number of parasitism seems to depend above all on the size of the colony of ants and on the number of pupae that they serve by guests. The purpose of this article is to obtain information on the characteristics and taxonomy of the Family Eucharitidae (Insecta: Hymenoptera). In this study, quantitative and conceptual aspects were used. To this end, a bibliographic survey of Eucharitidae was carried out in the years 1941 to 2021. Only complete articles published in scientific journals and expanded abstracts presented at national and international scientific events, Doctoral Thesis and Master's Dissertation were considered. Data were also obtained from platforms such as: Academia.edu, Frontiers, Qeios, Pubmed, Biological Abstract, Publons, Dialnet, World, Wide Science, Springer, RefSeek, Microsoft Academic, Science and ERIC.

Keywords: Specificity; *Solenopsis; Orosema; Kapala*; Trees

1. Introduction

Eucharitidae are found almost worldwide. There are currently over 500 species described. Particular groups of Eucharitidae are parasitoids of specific groups of ants typically exhibiting host specificity at the level of ant Subfamily. (Figures 1, 2, 3 4A and 4B) [1].

Figure 1 Specimens of Eucharitidae Family; (Source: https://www.biodiversity4all.org/taxa/245001-Eucharitidae)

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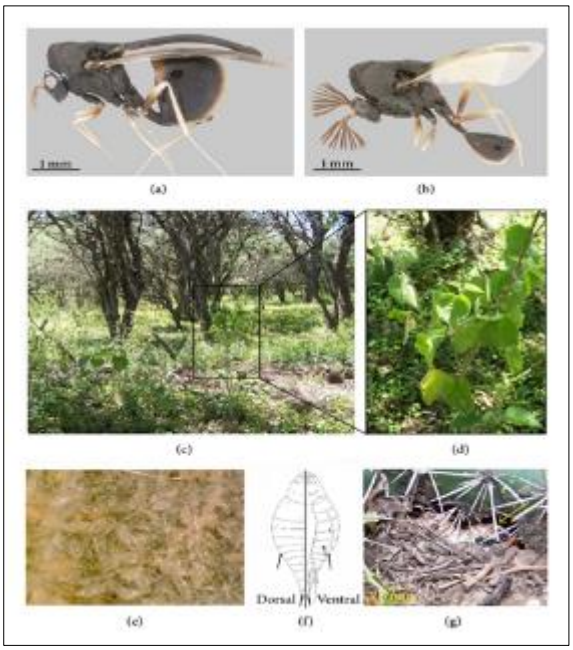

Figure 2 *Dicoelothorax platycerus* Ashmead 1904: (a) habitus (female); (b) habitus (male). Biology and immature stage of *D. platycerus*: (c) habitat; (d) *Pseudabutilon virgatum* (Cav.) (Malvaceae); (e) underside of leaf of *Paspalum virgatum* L. (Poaceae) with eggs; (f) planidium (dorsal and ventral); (g) nest entrance of *Ectatomma brunneum* Smith, 1858 (Hymenoptera, Formicidae, Ectatomminae); (Source: https://www.hindawi.com/journals/psyche/2013/926572/)

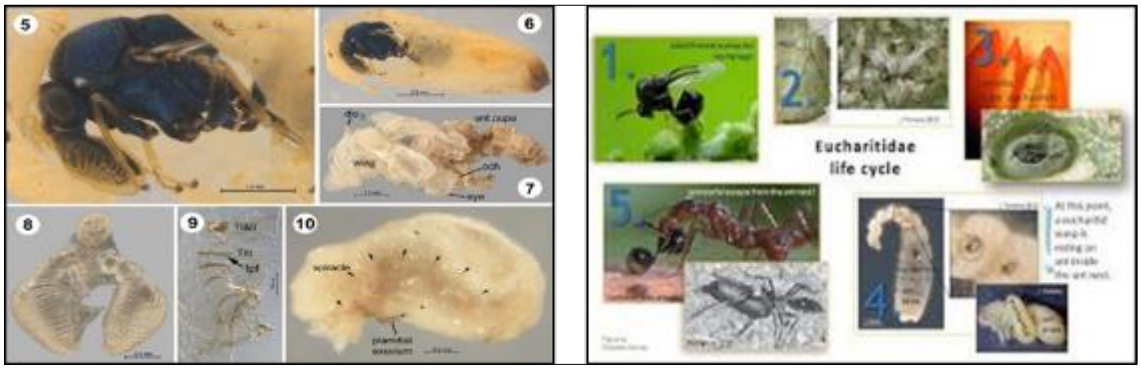

Figure 3 5–8 Male: 5 head and mesosoma in place in cocoon 6 adult in place in cocoon 7 exuvium of body and host ant remains 8 exuvium cap from face and antenna, anterior 9 planidial exuvium taken from last-instar larva 10 last instar larva, lateral. Abbreviations: dlp2, dorsolateral process; T, tergum; (Source: https://www.hindawi.com/journals/psyche/2013/926572/)

Eukaryotic wasps are specialized parasitoids of ants, and it is decided that each species generally parasitizes ants of a single genus. This group has developed. This parasitism takes place throughout the course of the year, but especially during hot and humid months. However, the number of parasitism seems to depend above all on the size of the colony of ants and on the number of pupae that they serve by guests (Figures 5A and 5B) [2, 3, 4].

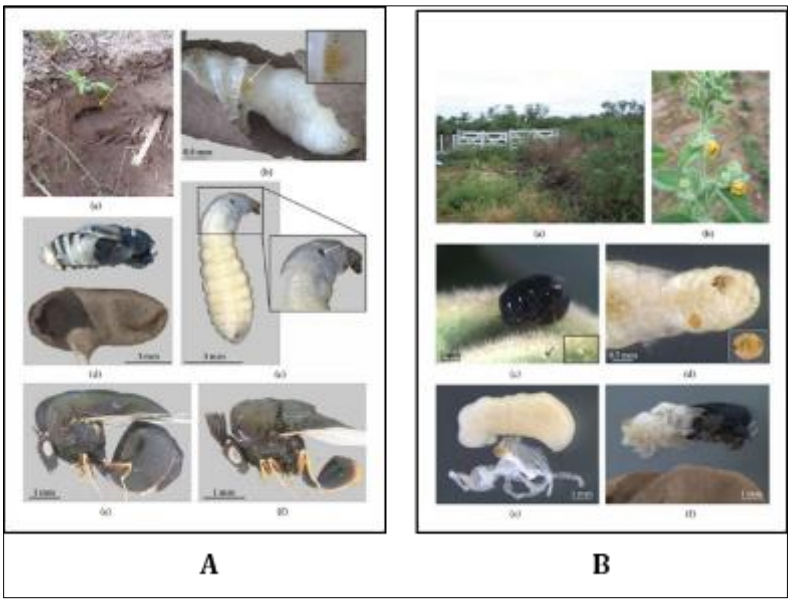

Figure 4A Biology and immature stage of *Dicoelothorax platycerus* Ashmead, 1904 (Chalcidoidea, Eucharitidae): (a) brood chamber (indicated); (b) prepupa parasitized (2nd instar larva indicated and magnified); (c) ant larva parasitized (attached planidium magnified and indicated); (d) pupa extracted with ant cocoon (female, lateral); (e) habitus (female); (f) habitus (male). Figures 2(a), 2(b), 2(c), and 2(d) are extracted from. Figure 4B Biology and immature stage of (a) habitat; (b) *Sida cordifolia* L. (Malvaceae); (c) female of *Megacyllene latreillei* (Laporte & Gory, 1836) ovipositing on leaf of *S. cordifolia* (eggs indicated and magnified); (d) parasitized prepupa (1st instar larva indicated and magnified); (e) third instar (with remains of ant pupa); (f) pupa extracted from ant cocoon (male, lateral); (Source: https://www.hindawi.com/journals/psyche/2013/926572/)

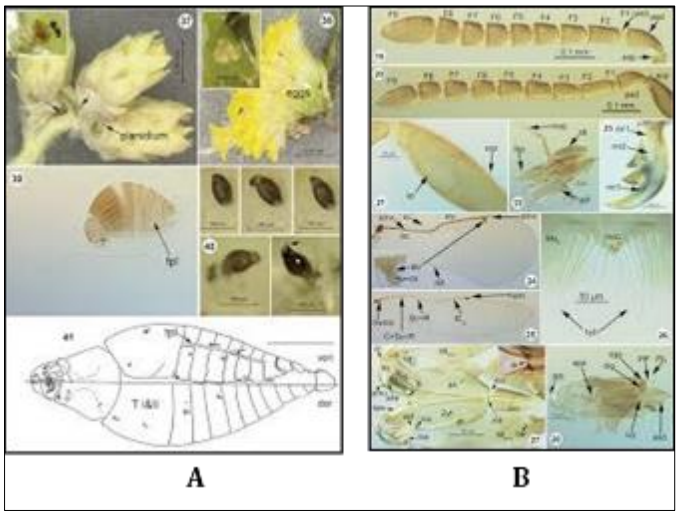

Figure 5A 37 planidia and eggs with developed planidia in trichome mass at base of flowers of *Helichrysum*, inset of female on flower head; 38, eggs under involucral bracts of *Nidorella*, inset is enlargement of undeveloped eggs; 39, egg with mature planidium; 40, single planidium, resting in upper left with remaining images of movement after disturbance, arrow pointing to expanded postlabial complex; 41, first-instar ventral (ven) and dorsal (dor); (Source: file:///C:/Users/Sti/Downloads/35079.pdf)**; 5B** 19, antenna lateral, ♀; 20, antenna lateral, ♂; 21, scape subventral, pedicel in upper left, ♂; 22, labial complex, ♀; 23, right mandible, ♀; 24, fore wing, inset enlargement of stigmal vein, ♀; 25, hind wing, ♀; 26, hypopygium, ♀; 27, ovipositor, inset is dorsal aspect of apical connection of articulating bulb; 28, male genitalia; (Source: file:///C:/Users/Sti/Downloads/16598.pdf)

Size are 2-5.5mm long and have metallic or black colors. The antennae of most species have 13 segments or less, but some have as many as 26. The outstanding anatomical features are: The prepectus is in the same plane and fused with the pronotum. The pronotum is small and hidden dorsally by the head. The gaster is generally small and with a very

long petiole. The marginal vein of the forewing is moderately long; postmarginal veins are extremely short. Size between 2 and 5.5 mm in length (Figure 6) [5,6,7,8].

Figure 6 A selected 9 of the 14 genera of the *Kapala* Clade. These wasps shown are all females. Their scutellar spines are outrageous! It's hypothesized that the spines help protect their wings when they are leaving the nests of their ant hosts; (Source: https://www.elizabethmurray.us/eucharitid-ant-parasitoids.html)

1.1 Life cycle

Eukaryotic females lay rows of eggs in plant tissue such as leaves and stems, at a distance from ant colonies. The eggs are white, translucent, 0.19 mm long and 0.08 mm wide. They are elliptical, with one side flattened. When the eggs mature they become darker, brown, and after ten days the larvae hatch (Figure 7A).

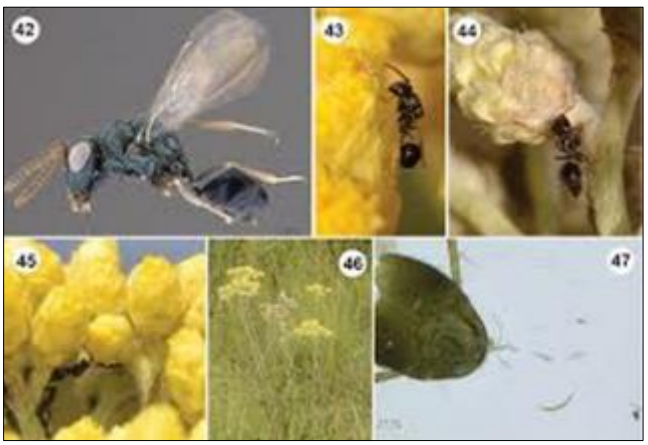

Figure 7A 1. 37, planidia and eggs with developed planidia in trichome mass at base of flowers of *Helichrysum*, inset of female on flower head; 38, eggs under involucral bracts of *Nidorella*, inset is enlargement of undeveloped eggs; 39, egg with mature planidium; 40, single planidium, resting in upper left with remaining images of movement after disturbance, arrow pointing to expanded postlabial complex; 41, first-instar ventral (ven) and dorsal (dor); (Souce: file:///C:/Users/Sti/Downloads/35079%20(4).pdf)

The larvae have good mobility and find a way to be transported by ants to the colony. This type of larvae is called planidium. They measure 0.13 mm and are capable of moving several centimeters on a leaf but do not leave the group of eggs. After six or seven days they attach themselves to an ant that returns to the anthill; sometimes they mount on other insects using them as intermediate hosts. Once in the anthill, they migrate to an ant larva. Some species are internal parasites, others are external, but all finish their development as ectoparasites. These larval stages lack the legs and mobility of the early stage (Figure 7B).

Figure 7B Life cycle; (Source: https://www.elizabethmurray.us/eucharitid-ant-parasitoids.html)

They feed on the host in a limited way until it enters the pupal stage; they then proceed to eat all or most of the pupa. There is usually only one parasite per ant, but in some cases there is superparasitism in which two or up to four wasps emerge from a single host. Once as the adult wasp emerges, the ants take care of it and feed it as if it were part of the colony. In some cases, worker ants have been observed helping the wasps emerge from the pupae. Wasps do not cause aggression because they have acquired the smell of the anthill. The protection lasts for a while, but when the scent begins to dissipate the wasps rush out of the anthill before being attacked and then proceed to mate.

Adults emerge from the nest in the morning; males come out first. In most cases, the males remain close to the anthill, forming swarms less than a meter high. As soon as the females emerge, mating takes place. In some cases, as in the *Kapala termi*nalis Ashmead, 1892 species, the males wait patiently in the foliage in the vicinity. In many cases the males initiate mating before the females have had a chance to fly, and even in certain cases mating takes place within the anthill. After mating, the females lay eggs that same day. Each female can lay between 1,000 and 10,000 eggs (Figure 8) [8,9,10,11].

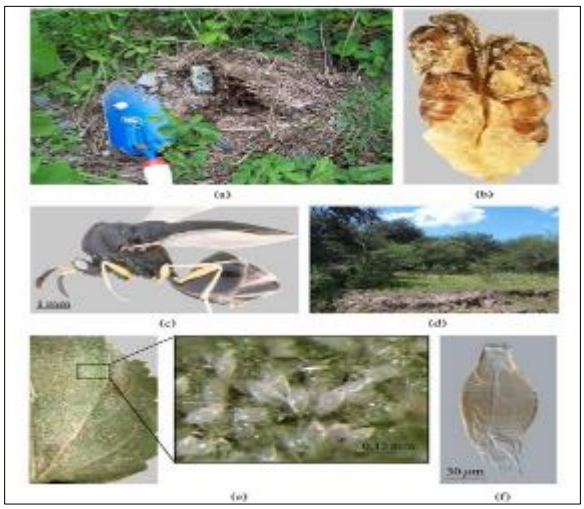

Figure 8 Biology and immature stage of (a) ant nest of; (b) two pupae extract from same ant cocoon (females). (c) habitus (female). Biology and immature stage o: (d) habitat; (e) underside of leaf with eggs (magnified area with eggs); (f) flatness; (Source: https://www.hindawi.com/journals/psyche/2013/926572/)

1.2 Subfamilies

The number of subfamilies of Eucharitidae has changed several times, but the most accepted classification includes 3 subfamilies: Oraseminae, Eucharitinae, and Gollumiellinae.

1.2.1 Oraseminae

Orasema simplex Heraty, 1993

Oraseminae wasps parasitize ants of the genus *Pheidole* (Myrmicinae) and also *Solenopsis* from southern South America and the Caribbean fire ant *Wasmannia auropunctata* (Roger 1863) (Formicidae: Myrmicinae). They are found in tropical regions such as Costa Rica, Ecuador, Brazil and Argentina. They are also native to Texas, Florida, Massachusetts, Delaware, and Colorado (Figure 9).

Figure 9 *Orasema simplex* Heraty, 1993 (Oraseminae); (https://en.wikipedia.org/wiki/Orasema)

The female makes an incision on the edge or underside of a leaf where she lays an egg. In some cases they use the shoots or stems of plants. They sometimes lay eggs on plants that do not are visited by ants and in such cases the larvae need to climb an intermediate insect which is later attacked by the ants, and thus reaches the host. On average, development from larva planidium to pupa it takes 8.2 days.

1.3 Taxonomy

1.3.1 Eucharitinae

Eucharitinae are parasites of the Ectatommatinae, Ponerinae, and Formicinae families.

The female Eucharitinae lays up to 4,500 eggs immediately after emerging from the anthill. She lays her eggs in groups of eight to fifteen on plant shoots, on the underside of leaves, or on the skin of fruits. Larvae mount on an ant and do not use intermediate hosts. Some species of the genus *Kapala* are capable of jumping up to 10 mm. They are ectoparasites or external parasites of ants and acquire the scent of their hosts as protection (Figure 10).

Figure 10 *Kapala* (Eucharitinae); (Source: https://ceb.wikipedia.org/wiki/Kapala_terminalis)

1.4 Gollumiellinae

Gollumiellinae is a small subfamily. Its taxonomy is a bit uncertain. They have the peculiarity of adhering their eggs to the substrate and connecting them with a stringy secretion that remains erect. This attracts *Paratrechina* ants. The larvae of this family burrow in the thorax of their host and feed there. The rest of their life cycle is similar to that of other Eucharitidae. There is also an Australian subfamily, Akapalinae, which may be a sister taxon to these three subfamilies (Figure 11).

Figure 11 Gollumiellinae; (Source: https://br.pinterest.com/pin/500955158553723499/)

List of Genres: *Dilocantha, Isomerala, Kapala, Lophyrocera, Obeza, Orasema* and *Pseudochalcura* [11,12,13].

1.5 Biologic control

Eukaryitid wasps are good candidates for biological ant control because each species ordinarily specializes in a species or genus of ants. They have the disadvantage that they can cause damage to the plants where they lay their eggs; for example, damage to the leaves of tea plants reduces their economic value. Furthermore, some eukaryotes have no major effect on ant populations. Sometimes *Orasema* species are used to control ants, *Solenopsis* and *Wasmannia* among others, because they do not cause the environmental damage of pesticides. At least two species can serve as biological controls for ants that have been introduced and have become invasive species, for example in North America (Figures 12 and 13) [12,13,14,15].

Figure 12 True bug *(Dindymus* sp, Pyrrhocoridae Family, Hemiptera Order) on leaf with prey (Eucharatid (parasitic) wasp, Hymenoptera order, Eucharitidae Family); (Source: https://br.pinterest.com/pin/500955158553723499/)

1.6 Phylogenia

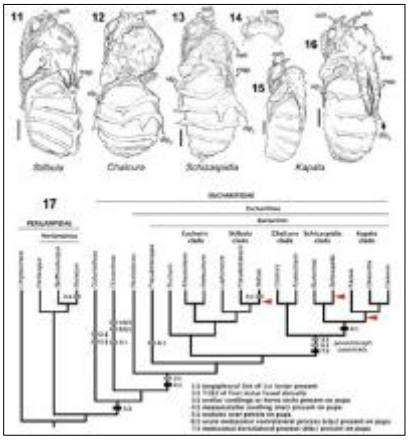

Figure 13 Pupae of Eucharitini described herein: 11 *Stilbula* 12 *Chalcura* 13–14 *Schizaspidia* (14 head in dorsal view) 15–16 *Kapala*: 15 lateral view 16 dorsolateral view 17 characters of immatures mapped onto pruned phylogeny.

DELTRAN optimization (favoring parallelisms). Red triangles refer to independent derivations of the mesocutellar processes (msp); (Source: https://www.researchgate.net/figure/Figures-11-17-11-16-pupae-of-Eucharitini-described-herein-11-Stilbula-12-Chalcura-13-14_fig3_345025905)

Objective

The purpose of this article is to obtain information on the characteristics and taxonomy of the Family Eucharitidae (Insecta: Diptera).

2. Methods

The method used to prepare this mini review was Marchiori 2021 methodology [16].

3. Studies conducted and selected

3.1 Study 1

Eucharitidae is a family of parasitoids found in almost every corner of the world, but with a higher incidence in the tropics. They are small wasps (Hymenoptera) from a large group of some of the most notable parasitoids: the superfamily Chalcidoidea. Eucharitidae are specialized in ants, Formicidae. The female oviposites in plant tissues, it can be in the leaf, in the fruit, it can be close to the floral nectars, where ants visit. The larvae that hatch from the eggs are quite active, about 1 mm.

The newly emerged larva must find a way to enter an anthill, for which it must associate with a specific forage ant through foretic behavior, including attachment to an intermediate host. Eucharitinae larvae can jump and attach themselves to an ant. Inside the anthill, the tiny larva looks for an ant larva and clings to it. In order not to suffer attacks, both the larva and the adult can imitate chemical odors similar to those of ant larvae.

The Eucharitidae larva develops as a coinobiont, ectoparasitoid, that is, it allows the host to continue developing, and remains on top of it, it does not feed on the ant larva immediately, it waits until it pupates. When the ant larvae pupate, the Eucharitidae larvae migrate to the ventral surface and begin to feed. It then matures, puffs up and emerges as a winged adult and flies away from the nest. The adult can be carried by an ant, as if it were garbage (Figure 14) [17].

Figure 14 Life cycle of a typical eucharitid wasp. (a) Female *Dilocantha lachaudii* Heraty, 1998, ovipositing on *Lantana camara* L. (Verbenaceae). (b) *D. lachaudii* female with eggs scattered on leaf surface. (c) Planidium (white pointer) attached upon an *Ectatomma tuberculatum* (Olivier 1792) (Hymenoptera: Formicidae) larva. Insert: SEM picture of a planidium. (d) Two *D. lachaudii* swollen planidia (white pointers) feeding upon an *E. tuberculatum* larva. (e) 2nd instar larva (white pointer) relocated after host pupation. (f) Two *D. lachaudii* pupae from a single host pupa. The host cocoon

has been removed. (g) *E. tuberculatum* worker transporting a recently emerged *D. lachaudii* female; (Source Photos: J.-P. Lachaud and G. Pérez-Lachaud.)

3.2 Study 2

This is a well-known family, as they parasitize ant offspring. Eucaritid females lay their eggs far from the host's nest, in or on plant tissue (leaves and buds) and the very active, minute, strongly sclerotized first instar larva is called "planidium" and is responsible for gaining access to the brood of host ants using various foretic behaviors, including attachment to an intermediate host as in some orasemin species and possibly in *Gollumiella antennata* (Gahan, 1940) or, more generally, foraging.

Inside the nest, the planidia attaches to an ant larva: the planidia eucaritine attaches itself externally to the host larva. All Eucharitidae develop as koinobiont, larval-pupal ectoparasitoids. In the molting of the host larva, the planidium migrates to the ventral region, just below the legs, of the newly formed ant pupa for further development that is only completed when the host pupa parasitoid develops per host. In almost all cases, the adults appear among the ants' offspring and, even if in some cases they are well treated inside the nest by their hosts (as is the case with *Orasema coloradensis* Wheeler, 1907, which is transported, cared for and even fed by the workers of *Pheidole bicarinata* Forel, 1886 (Formicidae), they need to leave the host nest to reproduce. Ants show only moderate aggression to newly emerged Eucharitidae suggesting passive or active chemical mimicry of host ants. Parasitism is very variable and localized in time and space (Figure 15) [18].

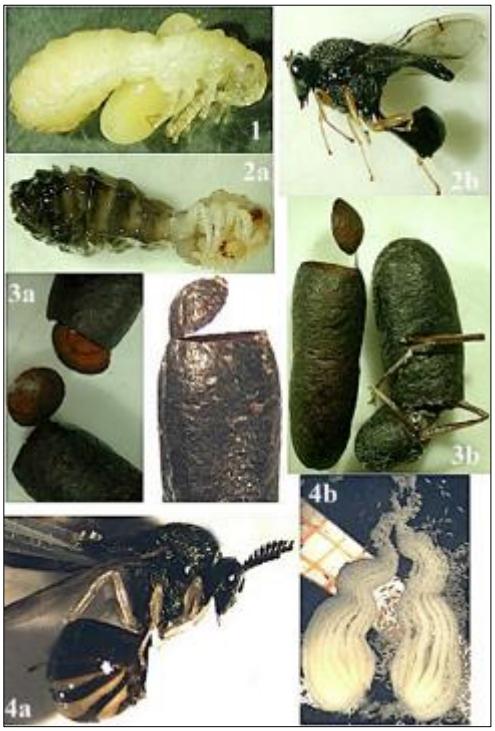

Figure 15 Larva (second instar) of *Schizaspidia diacammae* n. sp. (Eucharitidae: Eucharitinae: Eucharitini) feeding on the thorax of an ant pupa. The host cocoon has been removed. 2. Parasitized ant pupa (a) and adult male wasp (b) extracted from *Diacamma* cocoons (Hymenoptera: Formicidae). 3. *Diacamma* cocoons from which parasitoid wasps exited, showing the distinctive operculum cut at one extremity (a). In contrast, non-parasitized cocoons are cut midway by the ants (b, on right). 4. *Physogastric* female (a) of *S. diacammae* that exited from a *Diacamma* cocoon. Intersegmental membranes are exposed in dorsum of abdomen. *Physogastry* was confirmed by dissection (b) more than 10 ovarioles in each ovary, all packed with fully developed oocytes (scale: square = 1mm); (Source: https://www.researchgate.net/figure/Larva-second-instar-of-Schizaspidia-diacammae-feeding-on-the-thorax-of-an-ant-pupa-The_fig1_280528715)

3.3 Study 3

The Eucharitidae *Orasema xanthopus* (Cameron, 1913) and the ant *Solenopsis daguerrei* (Santschi, 1930) are natural enemies of the fire ants *Solenopsis* (Figures 16, 17 and 18).

Figure 16 *Solenopsis invicta* (Buren, 1972) (Hymenoptera: Formicidae); (Source: https://repositorio.unesp.br/bitstream/handle/11449/87691/souza_rf_me_rcla.pdf;jsessionid=8A90760E91791D75A6E641610C748232?sequence=1)

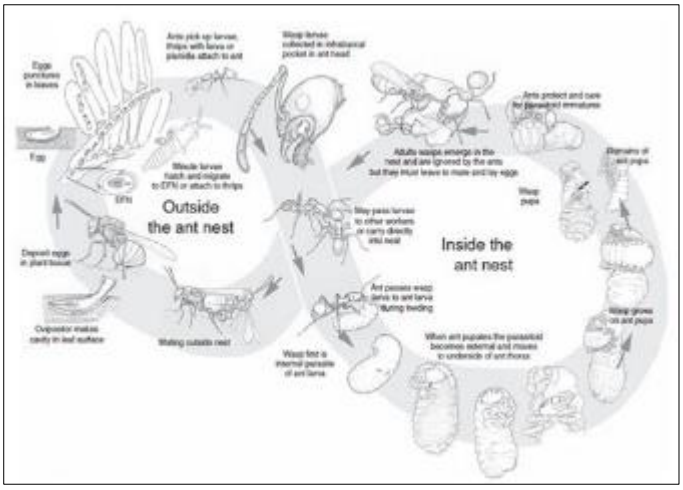

Figure 17 The life cycle of a typical Orasemine wasp. On the left are shown behaviors occurring outside the ant nest: mating, oviposition and planidial acquisition by the ants (EFN, extrafloral nectary). On the right are shown behaviors occurring within the ant nest: attachment to the ant larva, development on the ant pupa, pupation and eclosion; (Source: https://www.antwiki.org/wiki/Eucharitid_Wasps)

Hundreds of fire ant nests were opened in 2001 in the territories of *Solenopsis saevissima* (Smith, 1855) (Hymenoptera: Formicidae) and *Solenopsis invicta* (Buren, 1972) (Hymenoptera: Formicidae) to determine the presence or absence of these natural enemies.

Figure 18 *Orasema xanthopus* (Cameron, 1909) (Hymenoptera: Eucharitidae); (Source: https://commons.wikimedia.org/wiki/File:Orasema_xanthopus.jpg)

Several individuals of *Orasema xanthopus* (Cameron, 1909) (Hymenoptera: Eucharitidae) and *Solenopsis daguerrei* (Santschi, 1930) (Hymenoptera: Formicidae) were collected with an aspirator and preserved in 70% alcohol. *O. xanthopus* and *S. daguerrei* were identified. Six females of *O. xanthopus* were observed attacking two colonies of *S. saevissima*. The inclusion of *S. saevissima* in the host list of *O. xanthopus* [19].

3.4 Study 4

This work aimed to carry out a rapid ecological assessment of the wasp fauna of the PNSD, to support the development of a management plan for the aforementioned park. More specifically, it intends to evaluate the wasp richness (Chalcididae, Eucharitidae (*Kapala* and *Lophyrocera*) Evaniidae, Mutillidae, Pompilidae, Crabronidae and Vespidae) of different vegetation types in Serra do Divisor National Park (PNSD) from a rapid ecological assessment (Figure 19).

Figure 19 *Orosema, Lophyrocera* and *Kapala; (*Source: https://twitter.com/hashtag/rgbif)

A total of 366 specimens of 40 genera and 84 species were collected from the different PNSD sites. The most representative families in terms of individual abundance were: Evaniidae (44%), Vespidae (21.6%) and Mutillidae (14.5%). The most representative species were Crabronidae (25%), Vespidae (23.8%) and Mutillidae (17.9%). The richest genera in species were *Ephuta* (Mutillidae) (15.5%), *Trypoxylon* (Crabronidae) (10.7%) and *Conura* (Chalcididae) (7.1%). *Evaniella* sp. and *Semaeomyia* sp. (Evaniidae) were responsible for about 39% of the individuals collected. The vast majority (97.6%) of species were represented by 20 or fewer individuals (Figure 20).

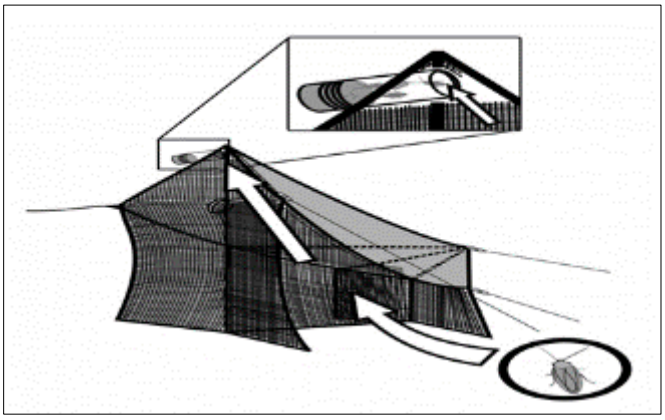

Figure 20 Malaise Trap used at work; (Source: https://canal.cecierj.edu.br/recurso/9416)

Of the total species, 57 (68%) were collected exclusively from a single sampling site. However, some species were collected from most sites. *Evaniella* sp. and *Semaeomyia* sp. (Evaniidae) occurred in 92% and 83% of the sites, respectively; *Ephuta flavidens* Say, 1836 (Mutillidae) and *Angiopolybia pallens* (Lepeletier, 1836) (Vespidae) by 75%.

The sites that presented the greatest richness were N6 (S = 25) and S6 (S = 24). There was a positive correlation between abundance of individuals collected in the sites and richness ($r_s = 0.92$; $gl = 11$; $p = 0.000019$) and between richness and the number of unique species ($r_s = 0.85$; $gl = 11$; $p = 0.000499$).

In general, the sites located in the northern region of the PNSD presented higher values of abundance, richness and exclusive species. The expected species richness curve (ES) for the northern region as a function of the sample size obtained by rarefaction was higher than that obtained for the southern region.

Similarity values between sites in relation to species composition were generally very low and less than 40%. The sites in the southern region were more similar to each other (average similarity = 22%) than to those in the northern region (average similarity = 16.2%) and those in the northern region to each other (average similarity = 16.1%).

There was no significant correlation between floristic richness and wasp richness (rs = 0.41; g.l. = 6; p = 0.3552), considering only 7 sites where floristic surveys were carried out concomitantly with wasp sampling [20].

3.5 Study 5

Parasitic Hymenoptera represent the richest group of Hymenoptera species and insects are common and abundant in all terrestrial ecosystems and develop as parasitoids of many insects, playing an important role in the regulation of pest populations.

Identify the parasitoides Hymenopteras (Chalcidoidea) associated with a vegetable garden and a remnant of primary forest in Rio Branco, Acre. The collections were carried out in an Organic Garden (Horta do Brasileirinho) and in a remnant of primary forest (Parque Zoobotânico of the Federal University of Acre – UFAC) in the municipality of Rio Branco, Acre. The material was collected in both areas using apparatus composed of Moericke traps (yellow plates 15 cm in diameter and 5 cm in height) in which a mixture of 2 L of water, 2 mL of detergent and 2 mL was deposited of formaldehyde. Collections were carried out every two weeks, with 20 traps at ground level (Figure 21).

Figure 21 Moericke traps; (Source: https://simonleather.wordpress.com/2015/01/12/entomological-classics-the-moericke-yellow-pan-trap/)

A total of 593 individuals were collected, 360 were quantified in the forest area and 233 in the organic cultivation area. The insects are distributed in 7 families, they are: Aphelinidae, Encyrtidae. Eucharitidae, Eulophidae, Mymaridae, Trichogrammatidae, Chalcididae. The families Encyrtidae, Aphelinidae, Eulophidae were more abundant, representing most of the material collected in both areas.

A total of 593 parasitoid hymenoptera were collected, 360 insects were collected in the native forest area and 233 in the organic farming area. Agricultural practice influences the abundance and diversity of the parasitoid hymenoptera fauna. In general, the abundance of micro hymenoptera in the organic vegetation area was greater than in the forest area [21].

3.6 Study 6

3.6.1 Eucharitidae

All Eucharitidae, whose host is known, parasitize ants. For the poneromorphs, the works published so far show that the subfamilies most attacked are the Ponerinae and Ectatomminae. The Eucharitidae, unlike most of the parasitoid wasp families, do not deposit their eggs in the host's nest. Females use their thick ovipositor to lay eggs (Individually or en masse) in incisions made in the leaves, flowers or fruits of different plants families, such as Asteraceae and Malvaceae. After hatching, the larvae called "planidia" are very small, usually smaller than 0.13 mm, but very active and with structures flow rates that enable the jump. To get to the ants, that are their ultimate host, these larvae release hand of different behaviors: both can be taken to the nest if the ants carry the fruits in which they are deposited or, more commonly, adopting a phoresic behavior - using a charger that could be another parasitoid, some insect that serves as prey for its host ant or some other myrmecophile.

However, most plains will use workers of their host ant that are foraging, as it is likely that ants be somehow attracted by the larvae of the parasitoids. From laboratory studies, note that ants of the *Camponotus* Mayr genus are attracted by the liquid released by the newly hatched larvae, which resulted in the transfer of several plans to the ants' mouthparts, which carry them to the nest.

On the other hand, the parasitoid eggs are carried by ants of the *Paratrechina* genus Motschulsky, as they mature, as there are an apical secretion in these eggs that could be a valuable nutritional source for ants. Once inside the nest, the planidio attaches to a larva, but does not develop until it reaches the larval stage.

Eucharitidae planidia can be either ectoparasitoids or endoparasitoids of the ant. host: Gollumiellinae and Oraseminae are endoparasitoids, while Eucharitinae are ectoparasitoids. The small size of the planidia has been used as a justification to explain your entry and permanence in the nest without the ants realize. So, they develop as coinobionts, through three instars that feed on the ventral and thoracic region of host pupae usually just a parasitoid develops for each pupa, but there can be both multiparasitism and superparasitism.

Parasitoids normally emerge from the pupae within the nest of their hosts and may come out on their own, or be carried out of the colonies by the ants as if they were garbage. If the parasitoids remain inside the colony for a few hours, the ants show only moderate aggressiveness to them which may be a result both morphological adaptations and chemical mimicry of the parasitoids.

Species of the *Dilochanta* genus, for example, have a depression in the scutellum that can be associated with secretions that probably have some relationship with the absence of aggression to the parasitoids in their first hours of life of the nest. A single case of Eucharitidae emerging outside the their hosts' nest has been registered in Brazil, who observed parasitized *Dinoponera lucida* Emery, 1901 (Formicidae: Ponerinae) pupae being carried outside the nest where the parasitoids emerged.

Once outside the host colony, the adult parasites usually mate soon after the emergency (within a few hours). Individuals of some species do not feed and live only a few days, so they are rarely able to disperse through greater distances. For a long time it was believed that the relationship between Eucharitidae and Formicidae was species-specific, but several studies have shown that some of these wasps can attack different genera and even different subfamilies of ants (Figures 22A, 22B and 23).

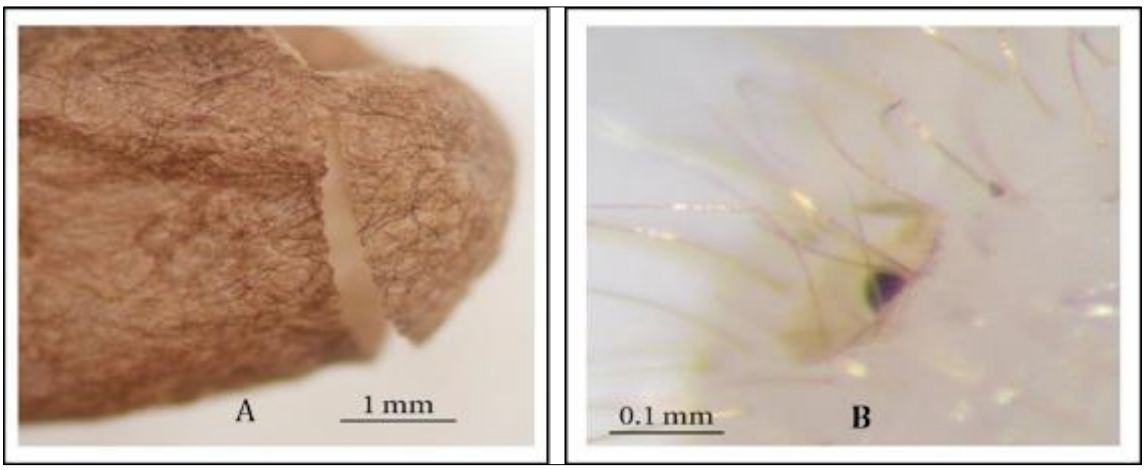

Figure 22 A Operculum made by *Kapala iridicolor* (Cameron, 1905) wasp on emergence from the host cocoon. (a) View of the cocoon with operculum. (b) Host remains (only the ant cuticle is left). Figure 22B First larval stage (planidium) of *Kapala iridicolor* (Cameron, 1905) on its *Ectatomma ruidum* (Roger, 1860) (Hymenoptera: Formicidae) larval host. (a) Position of planidia (black dots) and scars (gray dots) on the host larva (modified from. (b) Planidium with scar (sclerotized ring) around it. (c) Extreme back side view of a planidium on the interior of a partially sclerotized ring. (d) Scar without planidium. (e) Planidium joined to the host without formation of a sclerotized ring; (Source: https://www.researchgate.net/figure/First-larval-stage-planidium-of-Kapala-iridicolor-on-its-Ectatomma-ruidum-larval-host_fig2_258382171)

Kapala iridicolor (Cameron, 1905), for example, has been observed parasitizing species of *Ectatomma* Smith, *Gnamptogenys* Roger, and *Pseudoponera* Emery (Hymenoptera: Formicidae). At the However, it is interesting to note

that species of Eucharitidae normally attack closely related ant genera and there is a certain specificity between subfamilies of Eucharitidae and Formicidae: Oraseminae are parasites of Myromycine, while Eucharitinae are parasites of Ponerinae or Formicae. Finally, the effects of wasps on your hosts are still not clearly quantified, although adults and the larvae have been recorded in nests of ants throughout the year, with parasitism rates that can reach 25% of the total pupae [22].

Figure 23 *Kapala iridicolor* (Cameron, 1905); (Source: https://commons.wikimedia.org/wiki/File:Kapala_iridicolor.jpg)

4. Conclusion

Eucharitidae Family wasps are specialized parasitoids of ants, and it is decided that each species generally parasitizes ants of a single genus. This group has developed. This parasitism takes place throughout the course of the year, but especially during hot and humid months. However, the number of parasitism seems to depend above all on the size of the colony of ants and on the number of pupae that they serve by guests.

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