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(REVIEW ARTICLE)

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Inventory on the family Trigonalidae (Insecta: Hymenoptera)

Carlos Henrique Marchiori *

Instituto Federal Goiano, Biology, Parasitology, Goiânia, Goiás, Brazil.

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Abstract

What little is known about the biology of the Trigonalidae Family indicates a remarkably unlikely life story: in nearly every known species, females place thousands of tiny eggs, either "squeezing" them around the edges or injecting them inside the leaves. The egg must then be consumed by a caterpillar. Once inside the caterpillar, the trigonalid egg hatches and attacks any other parasitoid larvae (including its siblings) on the caterpillar, or waits until the caterpillar is killed and fed to a wasp larva, which then attacks. The aim of this manuscript was to carry out an inventory of the Family Trigonalidae (Insecta: Hymenoptera) related to its biogeography, bioecology, habitat, geographic distribution, taxonomy, life cycle, phenology and taxonomic and conceptual aspects of the Family, Subfamilies and Species. For this, a bibliographic survey of Trigonalidae was carried out in the years 1905 to 2021. Only complete articles published in scientific journals and expanded abstracts presented in national and international scientific events 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: Hyperparasitoid; Primary parasitoids; Larvae; Scarce biology; Eggs

1. Introduction

* Corresponding author: Carlos Henrique Marchiori
Instituto Federal Goiano, Biology, Parasitology, Goiânia, Goiás, Brazil.

Figure 1 Specimen of Trigonalidae Family

Source: https://pt.wikipedia.org/wiki/Trigonalidae

A B

Figure 2A and 2B Specimens of Trigonalidae Family
Source: https://pt.wikipedia.org/wiki/Trigonalidae

Trigonalidae (sometimes incorrectly spelled "Trigonalyidae") is one of the more unusual families of Hymenopteran insects, of undetermined affinity within the suborder Apocrita (although it is sometimes believed to be related to Evanioidea), and currently placed in a single superfamily, Trigonaloidea and the only extant taxon in the superfamily. The other putative related taxon is an extinct family called Maimetshidae, although this group is sometimes included in Megalyridae, making Trigonalidae the only member of Trigonaloidea (Figures 1, 2A, 2B and 3 [1].

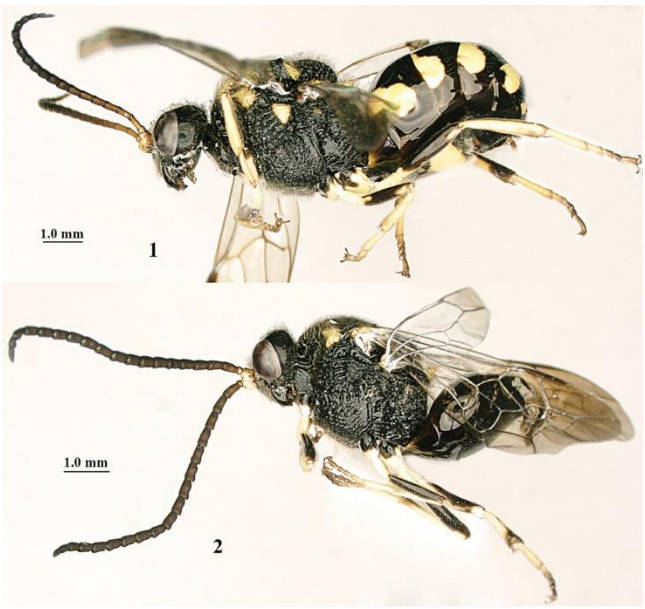

Figure 3 1 female holotype, lateral habitus 2 male paratype, lateral habitus

Source: https://zookeys.pensoft.net/article/13366/

1.1. Diagnostic characters

Antenna with 15 to 27 articles; fore wing with 10 closed cells; hind wing with 2 closed cells; jaws generally asymmetrical, with 3 teeth on the left side and 4 on the right side; tarsi with plantar lobes; 1st segment of the conical

metasoma, tergum and sternum not fused; pedunculated metasoma; short ovipositor. They measure from 5.0 to 13.0 mm and are black, brown or yellow (Figures 4, 5, 6, 7 and 8) [1,2,3].

Figure 4 Female, Japan (Kyushu, Kobayashi). 23 wings 24 laterais habitus 25 dorsal mesosoma 26 laterais metasoma 27 ventral metasoma 28 laterais antenna

Source: https://zookeys.pensoft.net/article/13366/element/2/13/

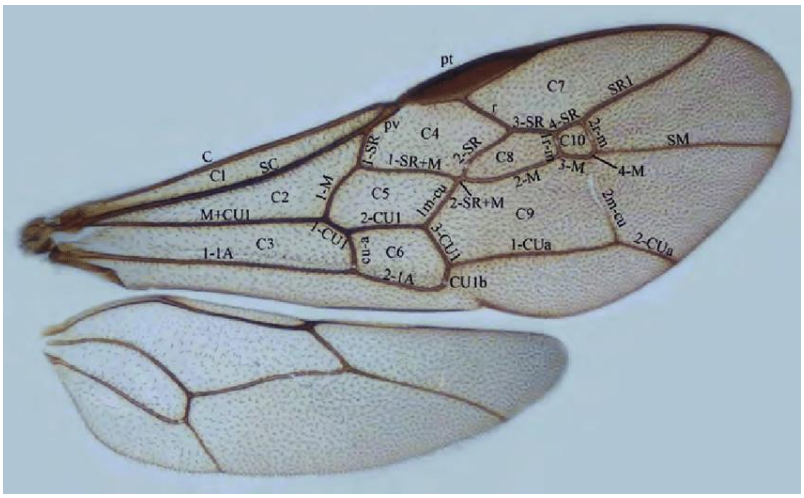

Figure 5 Wings of Trigonalyidae. C1 costal cell C2 medial cell C3 submedial cell C4 first submarginal cell C5 disc cell C6 subdiscal cell C7 marginal cell C8 second submarginal cell C9 second disc cell C10 third submarginal cell en pterostigma pv parastigmal vein

Source: https://www.researchgate.net/figure/Wings-of-Trigonalyidae-C1-costal-cell-C2-medial-cell-C3-submedial-cell-C4-first_fig1_260760880

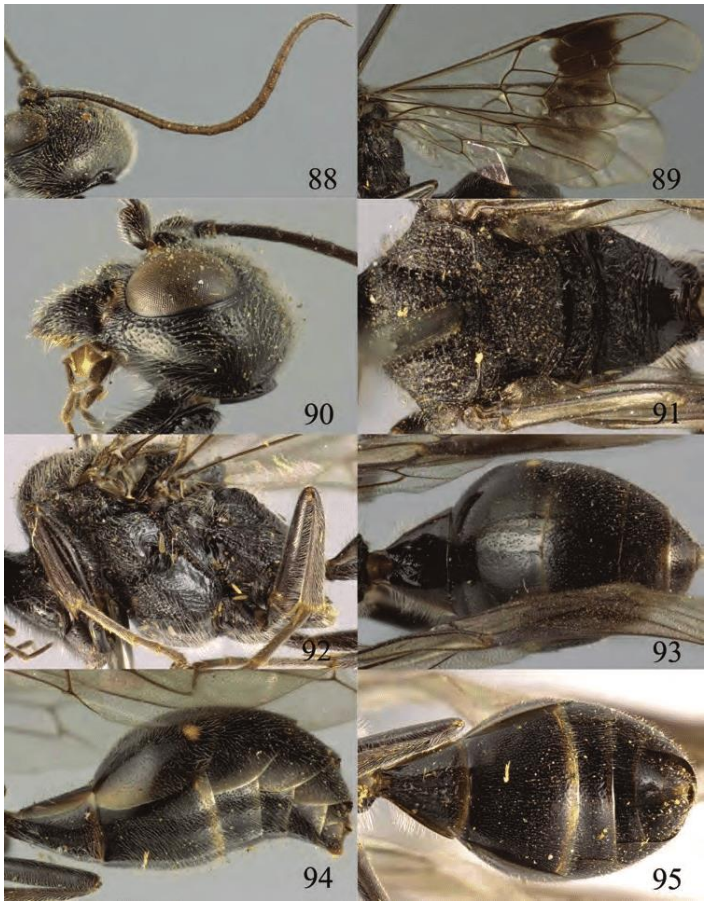

Figure 6 Holotype, female. 88 Antenna 89 fore and hind wings 90 head lateral 91 mesosoma dorsal 92 mesosoma lateral 93 metasomas dorsal 94 metasoma lateral 95 metasoma ventral

Source: https://www.researchgate.net/figure/Figures-88-95-Jezonogonalos-nigrata-sp-n-holotype-female-88-Antenna-89-fore-and_fig13_260760880

Figure 7 *Taeniogonalos flavoscutellata* (Chen, 1949), lectotype, female. 361 Habitus lateral 362 head anterior 363 head dorsal

Source: https://www.researchgate.net/figure/Figures-361-363-Taeniogonalos-flavoscutellata-Chen-1949-lectotype-female-361_fig57_260760880

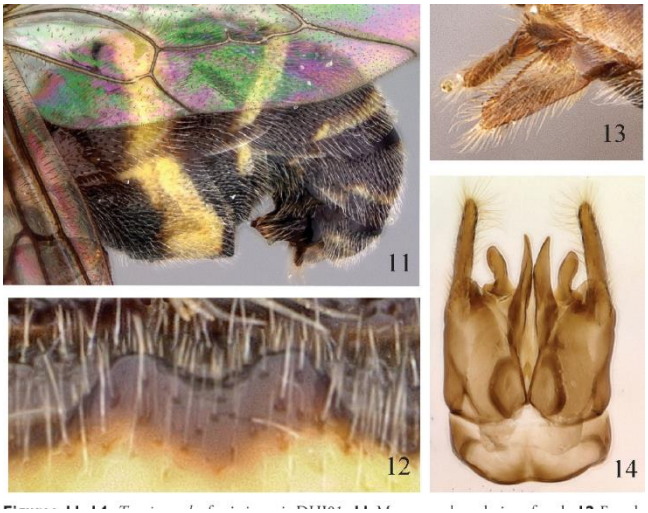

Figure 8 *Taeniogonalos fasciatipennis* (Cameron 1897) DHJ01. 11 Metasoma, lateral view, female 12 Female armature, sternum 2, ventral view 13 Male paramere, lateral view 14 Male genitalia

Source: https://www.semanticscholar.org/paper/Hyperparasitoid-wasps-(Hymenoptera%2C-Trigonalidae)-Smith-Janzen/7efe8557715b0a560025cad4ddc1cf88c5683fc2

1.2. Biology

Hyperparasitoids of Ichneumonoidea endoparasitoids of Tachinidae (Diptera), or parasitoids of Vespidae. The female lays eggs on leaves. The eggs are ingested along with the leaf by a caterpillar larva (Lepidoptera or Symphyta). The trigonalid larva will develop only if the caterpillar is parasitized by an ichneumonid or braconid, or if it is transported by a wasp to its nest (Figures 9 and 10) [4,5,6, 7,8].

Figure 9 *Taeniogonalos fasciatipennis* (Cameron 1897), female. 8 *T. fasciatipennis*, lateral view 9 *T. fasciatipennis*, dorsal view 10 *T. fasciatipennis*, lateral view. Hyperparasitoid wasps (Hymenoptera, Trigonalidae) reared from dry forest and rain forest caterpillars of Guanacaste Conservation Area, Costa Rica

Source: https://jhr.pensoft.net/article/1609/

Figure 10 *Lycogaster apicipennis* Cameron 1897 female, side view. hyperparasitoids of Ichneumonidae (Hymenoptera) and Tachinidae (Diptera) that parasitize caterpillars (Lepidoptera), have been reared during the ongoing caterpillar inventory of Area de Conservación Guanacaste

Source: https://jhr.pensoft.net/article/1609/

What little is known about the biology of the Trigonalidae Family indicates a remarkably unlikely life story: in nearly every known species, females place thousands of tiny eggs, either "squeezing" them around the edges or injecting them inside the leaves. The egg must then be consumed by a caterpillar. Once inside the caterpillar, the trigonalid egg hatches and attacks any other parasitoid larvae (including its siblings) on the caterpillar, or waits until the caterpillar is killed and fed to a wasp larva, which then attacks (Figure 11).

Figure 11 The hyperparasitoid *Taeniogonalos gundlachii* (Cresson 1865) (Hymenoptera: Trigonalidae) from Tachnidae Family

Source: David Moskowitz, Gregory Paulson

If the caterpillar is not attacked by another parasitoid or fed to a wasp, the trigonalid larva does not develop. Therefore, they are parasitoids or hyperparasitoids, but in a way that is practically unique among insects, in that the eggs must be swallowed by a host, and even more unusually, as there may be an intermediate host. Some species are known exceptions, which directly parasitize flies [9,10,11].

1.3. Life cycle is complex

Females usually lay large numbers of small eggs on the surface of leaves. To start their development, these eggs need to be ingested by phytophagous insect larvae, normally lepidopterans. Most likely, when social wasps pick up infected caterpillars and take them to their nests to feed their immature ones, the caterpillar with the trigonalid larvae is ingested by the wasp larvae. Endoparasitic trigonalids then feed on the immature wasp, which represents its definitive host (Figures 12 and 13) [12,13].

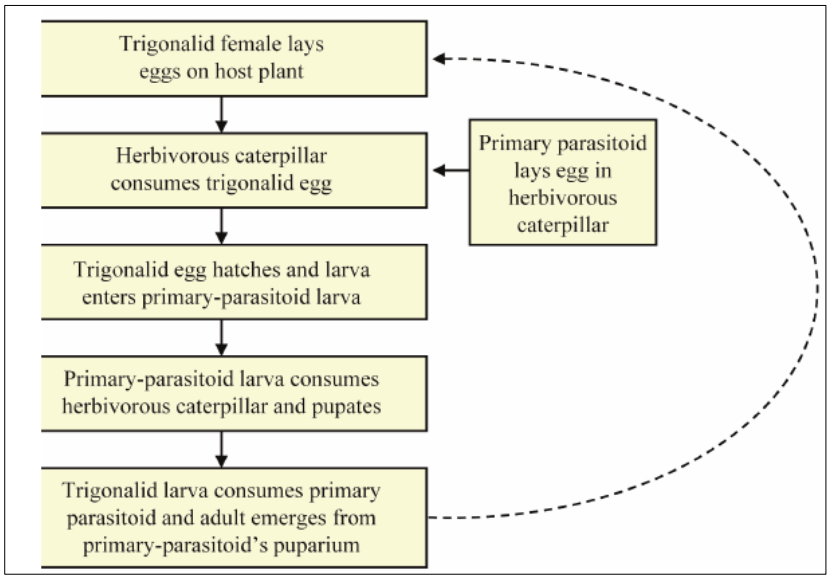

Figure 12 A diagram describing the life stages of the trigonalid hyperparasitoid *Orthogonalys pulchella* (Cresson 1867)

Source: https://www.researchgate.net/figure/A-diagram-describing-the-life-stages-of-the-trigonalid-hyperparasitoid-Orthogonalys_fig1_221959174

Figure 13 *Pseudogonalos hahnii* (Spinola, 1840) (Hymenoptera: Trigonalidae) emerging *Papilio machaon* Linnaeus, 1758 (Lepdoptera: Papilionidae) pupa. 13 June 2015. Kirov region, Russia

Source: Photo: Vladimir Bryukhov

1.4. Taxonomy

Subfamilies: Orthogonalinae and Trigonalinae (Figures 14 and 15).

Figure 14 Subfamily Orthogonalinae

Source: Source: Photo: Vladimir Bryukhov

Figure 15 Subfamily Trigonalinae

Source: https://www.researchgate.net/figure/Figures-1-3-Lycogaster-flavonigrata-female-1-Lateral-2-Head-front-3-Apex-of-second_fig2_278028618

1.5. Parasitism

The genus *Seminota* Spinola, 1840 includes six species in the Neotropical region two of which have been reported from Brazil, *Seminota marginata* (Westwood, 1874) and *Seminota haste* (De Geer, 1773). Weinstein and Austin (1991) report the association between *Seminota* species and social wasps of the genera *Polistes* Latreille, 1802; *Apoica* Lepeletier, 1836; *Pseudopolybia* Dalla Torre, 1894 and *Parachartegus* Inhering, 1904. The first to report the association between the parasitoid *S. marginata* and the larvae of the following species of social wasps: *Polistes versicolor* (Olivier, 1791), *Polistes cinerascens* (Saussure, 1857), *Polistes melanosoma* (Saussure, 1853), *Polistes canadensis* (Linnaeus, 1758) and *Apoica pallida* (Olivier, 1791). The association of S. marginata with *Apoica flavissima* was reported for the first time (Van Der Vecht, 1937. [12,13].

Genus: *Labidogonalos, Lycogaster, Nomadina, Seminota, Taeniogonalos, Trygonalys* and *Xanthogonalos* (Figures 16, 17, 18A, 18B and 18B). [12,13].

Figure 16 *Seminota* Spinola, 1840

Source: https://www.gbif.org/species/4679769/treatments

Figure 17 Genus *Lycogaster*, female. 1 Lateral. 2 Head, front 3 Apex of second sternite, ventral

Source: https://www.researchgate.net/figure/Figures-1-3-Lycogaster-flavonigrata-female-1-Lateral-2-Head-front-3-Apex-of-second_fig2_278028618

Figure 18A *Taeniogonalos* female. 8 Lateral 9 Head, front 10 Metasoma, lateral

Source: https://www.gbif.org/species/4679769/treatments

Figure 18B *Trigonalys erythrocephala* Santos et Aguiar, sp. no. Holotype female. 3 Lateral habitus 4 Head, antero-ventral, 5 Head, antero-dorsal, to show ocelli 6 Head, dorsal 7 Mesothorax, dorsal 8 Propodeum and base of petiole, dorsal 9 Apical segments of metasoma, latero-ventral, left, showing metasomal armature and ovipositor; arrow indicates position of longitudinal carina 10 Pronotum, left 11 Left hind thigh, to show lateral longitudinal carinae (arrows) and dorso-mesal strigation 12 Apical tergites, to show abnormal development of tergites

Source: https://jhr.pensoft.net/articles.php?id=1592

1.6. Phylogeny

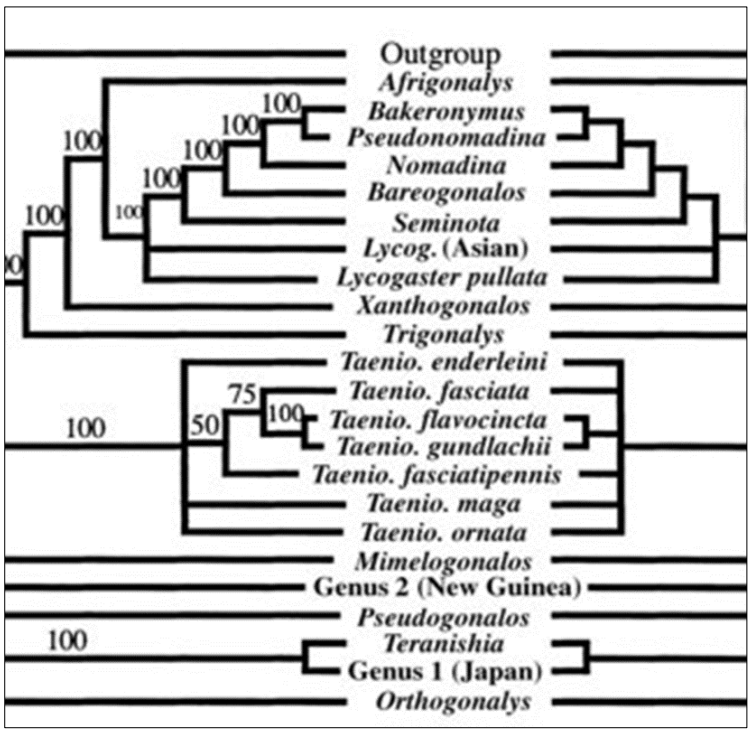

Figure 18C 5. Majority rule and strict consensus of twelve most parsimonious trees generated from successive approximations character weighting (Farris, 1969), starting with thirty-two trees

Source: file:///C:/Users/Sti/Downloads/Trigonalidae_SysEnt%20(1).pdf

Objective

The aim of this manuscript was to carry out an inventory of the Family Trigonalidae (Insecta: Hymenoptera).

2. Methods

The method used to prepare this mini review was Marchiori 2021 methodology [14].

3. Studies conducted and selected

3.1. Study 1

3.1.1. Orthogonalys Schulz

(Life: Kingdom: Metazoa (animals); Phylum: Arthropoda; Class: Hexapoda; Order: Hymenoptera; Superfamily: Trigonaloidea; Family: Trigonalidae; Subfamily: Orthogonalinae)

Orthogonalys Schulz 1905. Type species: *Orthogonalys boliviana* Schulz 1905

Tapinogonalos Schulz 1907 (synonymy by Carmean & Kimsey 1998)

Satogonalos Teranishi 1931 (synonomy by Tsuneki 1991) (Figures 19, 20, 21, 22, 23 and 24) [15,16,17,18].

Figure 19 *Orthogonalys brevis* Smith & Tripotin, 2012

Source: Photographs © Simon van

Figure 20 *Orthogonally nova* Bischoff, 1933

Source: Photographs © Simon van

Figure 21 *Orthogonalys gigantea* Benoit, 1951

Source: Photographs © Simon van

Figure 22 *Orthogonalys maculata* Bischoff, 1933

Source: Photographs © Simon van

Figure 23 *Orthogonalys parahova* Smith & Tripotin, 2012

Source: Photographs © Simon van

Figure 24 *Orthogonalys seyrigi* Bischoff, 1933

Source: Photographs © Simon van

Distribution: Worldwide, except for Western Palaearctic and Australasia.

Biology: Parasitoid of Tachinidae (Diptera) parasitizing Lepidoptera larva.

3.2. Study 2 *Afrotropical Trigonaloid*

3.2.1. Biology

Hyperparasitoids of Lepidoptera and Symphyta caterpillars. Thousands of tough, minute eggs are laid on leaves, which are then eaten by caterpillars. The trigonalid larvae hatch inside the caterpillar and either consume any parasitoid larvae that are already there or wait until the caterpillar is parasitized and then consume the parasitoid without eating the primary host (Figure 25) [19,30,31,32,33].

Figure 25 Afrotropical Trigonaloid

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

3.3. Study 3

3.3.1. General characters of parasitic Hymenoptera

I) Suborder Symphyta: sessile abdomen; ditrochon trochanter; wings with complex nerve system; eruciform and phytophagous larvae; ovipositor serrated, slightly protruding.

3.3.2. Trigonaloid superfamily

Trigonalidae (sometimes incorrectly spelled Trigonalyidae) is one of the more unusual families of hymenopteran insects, of indeterminate affinity within the suborder Apocrita (though sometimes believed to be related to the Evanioidea), and presently placed in a unique superfamily, **Trigonaloidea**, and the only extant taxon in the superfamily.

3.3.3. Family Trigonalidae

Trigonalidae Family contains few species, but distributed by the whole world. They are solitary endoparasitoids of social wasps (Vespoidea) or hyperparasitoids of Ichneumonidae and Tachinidae in caterpillars of Lepidoptera and larvae of Hymenoptera Symphyta. The female puts thousands of eggs on the vegetation. These eggs, which (Figure 26).

Figure 26 Sociobiology or biosociology is the study of the social behavior of animals using concepts from psychology, ethology, evolution, sociology and population genetics. The term was popularized by Edward Osborne Wilson in his book Sociobiology (Vespidae and Trigonalidae)

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

remain viable for several months, they only hatch when they are swallowed by a caterpillar, when the first instar larva penetrates the intestinal epithelium and enters the hemocoel, where it can find and penetrate a primary parasitoid not known yet how the first instar larva of wasp parasitoids manages to reach the host. It is assumed that the caterpillar fragments, with which the wasp feeds immature forms, which contain parasitoid eggs.

3.4. Study 3

Chapter 3: Laumann RA, Sampaio MV. Control of arthropod pests with parasitoids.

From the book: Biological control of agricultural pests Fontes MG, Valadares-Inglis MC. 1st ed: Brasilia: Embrapa. 2020

Information taken from the Table 2 (page 72) with the title: Orders and families of parasitoid insects with greater representation, in relation to the number of species, geographic distribution, biological control characteristics and relevance for hosts. representation, in relation to the number of species, geographic distribution, biological control characteristics and relevance for hosts.

Results obtained, respectively. Trigonalidae Family: Number of species 90/. Way of life no direct parasitism/. Egg ingested by the primary host/. They later live as hyperparasitoids/. Hosts: They initially attack Lepidoptera larvae and later the parasitoids of these larvae, mainly Hymenoptera and Tachinidae (Diptera) (Figures 27, 28 and 29) [25,25,26,27,28,29,30,31].

Figure 27 *Trigonalis hahnii*, Spinola 1840 ((Trigonalidae)

Source: https://www.diptera.info/forum/viewthread.php?thread_id=65139&pid=276259

The host spectrum of parasitoids is broad, because they can use insects of all known orders as hosts. All the stages of the life cycle of insects can be parasitized, from eggs to adults. Idiobiont parasitoids usually parasitize eggs, pupae or adults, but can also parasitize larvae of insects with complete metamorphosis (holometabolites) of the last instars of insects with complete metamorphosis (holometabolites). In turn, cenobiont parasitoids can parasitize all stages of the life cycle of a host and allow its development until the adult stage, thus we found a variation in the type of parasitism of these insects, which can be classified as egg, larva, pupa or adult parasitoids.

When the host changes stage during the development of the parasitoid, we have, according to the stage parasitized and the stage from which the adults emerge, parasitoids of egg-larva, egg-nymph, egg-pupa, egg-adult, larva-pupa, larva-adult.

Figure 28 Emergence of *Trigonalis hahnii* Spinola 1840 (Trigonalidae)

Source: https://www.diptera.info/forum/viewthread.php?thread_id=65139&pid=276259

(1) Taxonomic classification of families according to Sharkey (2007). (2) Species mainly from tropical regions. (3) Species from tropical areas of the Southern Hemisphere. (4) Species mostly from tropical and subtropical regions. (5) Species mainly from tropical and subtropical regions. (6) Cosmopolitan species. (7) Species mainly from temperate regions. Additional list of families with fewer species or with a systematic position not yet fully resolved (estimated number of species).

Hymenoptera: Austroniidae (3), Heloridae (< 10), Pelecinidae (10), Peradeniidae (2), Proctorenyxidae (2), Roproniidae (18), Vanhorniidae (5), Monomachidae (20), Maamingidae (2), Ibaliidae (15), Liopteridae (3), Rotoitidae (2), Tanaostigmatidae (90), Tetracampidae (50), Mymarommatidae (< 10), Embolemidae (< 20), Plumariidae (< 20), Sclerogibbidae (10), Scolebythidae (3), Rhopalosomatidae (~35), Bradynobaenidae (155), Sapygidae (~80) and Trigonalidae.

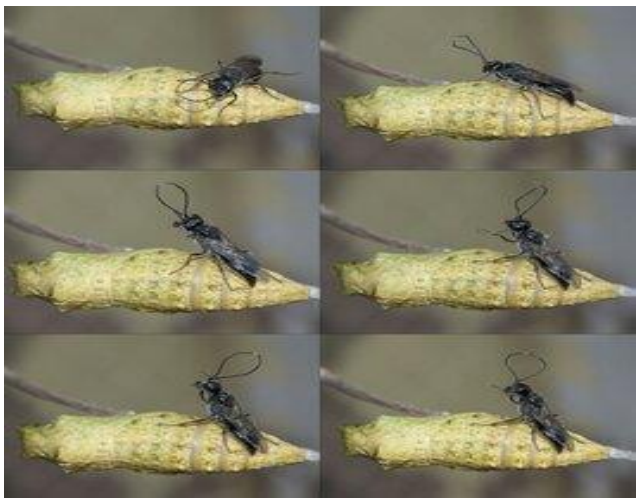

Figure 29 Stages of parasitism of *Trigonalis hahnii* Spinola 1840 (Trigonalidae)

Source: https://www.diptera.info/forum/viewthread.php?thread_id=65139&pid=276259

Diptera: Anthomyiidae (43), Cecidomyiidae (6), Chironomidae (2), Chloropidae (6), Cryptochetidae (25), Empididae (4), Mycetophilidae (4), Muscidae (13), Phaeomyiidae (4), Rhinophoridae (90), Sciomizydae (6), Coleoptera: Cleridae (26), Curculionidae (3), Passandridae (10), Rhipiceridae (50), Scarabaeidae (10), Lepidotpera: Pyralidae (1) [25,25,26,27,28,29,30,31,32].

Source: Adapted from Goulet and Huber (1993), Godfray (1994), Feener and Brown (1997), Gauld and Bolton (2002), Fernández and Sharkey (2006) and Quicke (2015)

3.5. Study 4

3.5.1. Lycogaster apicipennis (Cameron)

Trigonalys apicipennis Cameron 1897: 269.

Figure 30 *Lycogaster apicipennis* (Cameron, 1897)

Source: https://treatment.plazi.org/GgServer/html/92DEA545A884035A8848006292096E4B

This is the only species of *Lycogaster* known from Central America. It is distinguished by its spindle-shaped antennae, without tyloids, and with the basal 3 flagellomeres reddish brown. The head and thorax are mostly black with only the tegula and spot on upper mesopleuron yellow, and the head and body are covered with golden-yellow hairs. The wings are yellowish, darker anteriorly and at apices, with the veins yellowish and stigma black (Figure 30) [33].

Distribution

Costa Rica, Mexico (Carmean and Kimsey 1998) (Figure 31).

Figure 31 *Lycogaster apicipennis* (Cameron, 1897) female, lateral view

Source: https://www.researchgate.net/figure/Lycogaster-apicipennis-female-lateral-view_fig3_260418595

3.6. Hosts and biology

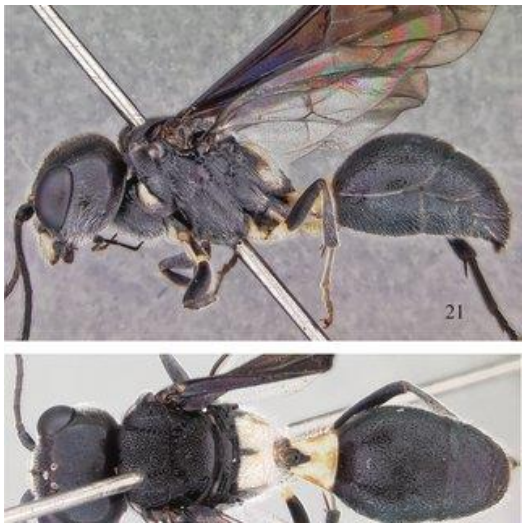

Figure 32 *Lycogaster apicipennis* (Cameron, 1897) female, lateral view

Source: https://www.researchgate.net/figure/Lycogaster-apicipennis-female-lateral-view_fig3_260418595

The caterpillar inventory has reared *Trigonalys apicipennis* Cameron 1897 10 times (between 1990 and 2008), and always in lowland dry forest. Six rearing have been from *Enicospilus flavostigmus* Hooker sp. nov. (Hymenoptera: Ichneumonidae) parasitizing *Boriza crossaea* Druce, 1894 (Lepdoptera: Notodontidae), once from *E. flavostigma* parasitizing *Dicentria rustica* Schaus, 1911 (Lepdoptera: Notodontidae), two from *Cubus validus* (Cresson, 1865) (Hymenoptera: Ichneumonidae) parasitizing *Omiodes cuniculalis* (Guenée, 1854) (a large leaf-rolling Lepdoptera:

Crambidae), respectively, and once from *Bassus brooksi* Sharkey, 1998 Sharkey parasitizing *Epargyreus* in the Lepdoptera: Hesperiidae) (Figure 32) [33].

If these primary parasitoid genera are viewed as the possible host universe, 2,377 caterpillars attacked by them yielded 10 *Lycogaster apicipennis* 0.42%. Alternatively, if we use the genera of the host caterpillars (*Boriza, Dicentria, Omiodes, Epargyreus*) in the inventory as the available universe, 17,007 reared wild caught caterpillars yielded these ten *L. apicipennis* 0.059% [33].

This is a low density hyperparasitoid. The first six rearing (1990-1995) were all from *Enicospilus flavostigmus* sp. nov. parasitizing *Boriza crossaea* Druce, 1894 (Lepdoptera: Notodontidae) large primary parasitoid *B. crossaea* (Figure 33A) [33].

Figure 33A *Trigonalys maculifrons* Sharp.1895, female, dorsal view

Source: https://jhr.pensoft.net/article/1609/

Trigonalys maculifrons Sharp 1895

3.7. Description

This species is mostly yellow with various black maculations on the head and body. The specimens reared from Costa Rica resemble this species with very similar black markings on the head and mesosoma. The black on the metasoma (Figure 33B).

Figure 33B *Trigonalys maculifrons* Sharp, 1895 (Hyperparasitoid)

Source: https://jhr.pensoft.net/article/1609/

3.8. Distribution

Costa Rica, Guatemala, Honduras, Mexico (Carmean and Kimsey 1998).

3.9. Hosts and biology

This striking species has been reared just three times, all in 2001 and in dry forest (Sector Santa Rosa), from caterpillars of *Euscirrhopterus poeyi* Grote, 1866 (Lepidoptera: Noctuidae) feeding on *Pisonia aculeata* L. (Nyctaginaceae) and primary parasitized by *Lespesia postica* Walker, 1861 (Tachinidae) (Figures 34 and 35) [33].

Figure 34 *Euscirrhopterus poeyi* Grote, 1866 (Lepidoptera: Noctuidae)

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

Figure 35 *Lespesia postica* Walker, 1861 (Tachinidae)

Source https://v3.boldsystems.org/index.php/Taxbrowser_Taxonpage?taxid=54710

3.10. Study 5

Orthogonalys pulchella (Cresson, 1897)

3.11. Biology

The hyperparasite! These ladies lay thousands of eggs on the margin of leaves. The eggs sit there until they are eaten by a caterpillar. Then they stay dormant until that caterpillar is parasitized by something else. The larvae then hatches and parasitizes the parasite (Figures 36, 37A and 37B) [34].

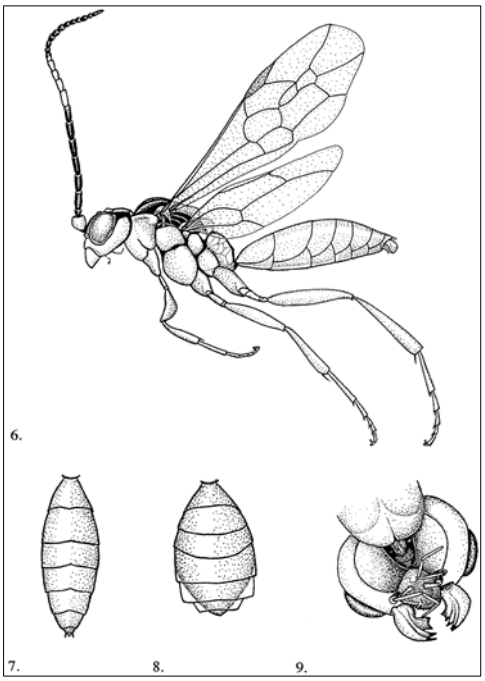

Figure 36 *Orthogonalys pulchella* (Cresson, 1897). 6, Habitus, side view. 7.8, Dorsal view of metasoma; 7, Male. 8, Female. 9, Rear view of head

Source: Shaded drawings by Micki Yuval

A **B**

Figure 37A and 37B *Orthogonalys pulchella* (Cresson, 1897)
Source: https://bugguide.net/node/view/421491

The braconid *Pneumagathis spiracularis* (Muesebeck, 1927) (Hymenoptera; Braconidae) is reported as a parasitoid of *Epargyreus clarus* (Cramer, 1775) (Lepidoptera: Hesperiidae) for the first time along with the first host plant associations for *P. spiracularis*. New host plant associations are reported for the *Casinaria lamina* (Viereck, 1921) (Hymenoptera: Ichneumonidae) parasitic on *E. clarus*. We also report the trigonalid *Orthogonalys pulchella* (Cresson, 1897) (Hymenoptera: Trigonodidae). In this paper, the *P. spiracularis* parasitoid was reported along with new host plant associations; *P. spiracularis* is the first reported host other than a Tachinidae species and the second record of a trigonalid parasite in a Braconidae species (Figures 38, 39, 40 and 41) [34].

Figure 38 Larval parasitism of the Silver-Spotted Skipper, *Epargyreus clarus* (Cramer, 1775) (Lepidoptera: Hesperiidae), in the Washington, DC Area

Source: https://bioone.org/journals/proceedings-of-the-entomological-society-of-washington/volume-123/issue-1/0013-8797.123.1.120/Larval-Parasitism-of-the-Silver-Spotted-Skipper-Epargyreus-clarus-Cramer/10.4289/0013-8797.123.1.120.short

Figure 39 *Pneumagathis spiracularis* (Muesebeck, 1927) (Hymenoptera; Braconidae)

Source: https://bioone.org/journals/proceedings-of-the-entomological-society-of-washington/volume-123/issue-1/0013-8797.123.1.120/Larval-Parasitism-of-the-Silver-Spotted-Skipper-Epargyreus-clarus-Cramer/10.4289/0013-8797.123.1.120.short

Figure 40 *Pneumagathis spiracularis* (Muesebeck, 1927) (Hymenoptera; Braconidae) is the first reported host other than a Tachinidae (Diptera) species is the first reported host other than a Tachinidae species

Source: https://www.google.com/search?q=Casinaria+lamina&source=lnms&tbm=isch&sa=X&ved=2ahUKEwi_-dO2vpP2AhVfqpUCHV56DdMQ_AUoAXoECAEQAw&biw=1366&bih=657&dpr=1#imgrc=O1rd7u4frXik0

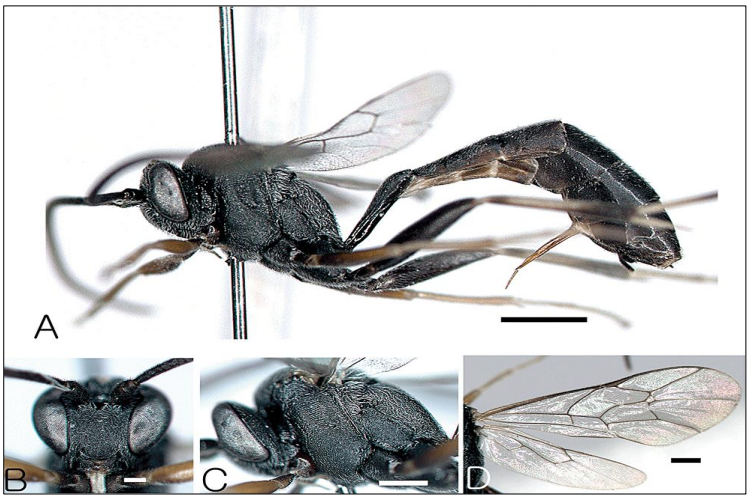

Figure 41 *Casinaria lamina* (Viereck, 1921) (Hymenoptera: Ichneumonidae)

Source: https://onlinelibrary.wiley.com/doi/10.1111/j.1748-5967.2010.00270.x

4. Conclusion

To the family Trigonalidae are hyperparasitoids of Ichneumonoidea endoparasitoids of Tachinidae (Diptera), or parasitoids of Vespidae. The female lays eggs on leaves. The eggs are ingested along with the leaf by a caterpillar larva (Lepidoptera or Symphyta). The trigonalid larva will develop only if the caterpillar is parasitized by an ichneumonid or braconid, or if it is transported by a wasp to its nest.

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