https://doi.org/10.53964/jmab.2023020

https://www.innovationforever.com

Journal of
Modern Agriculture and Biotechnology

ISSN 2788-810X (Online)

Open Access

MiniReview

New Information about Bio-ecology, Life Cycle, Habitat, Geographic Distribution and Taxonomy of the Platygastridae Family (Insecta: Hymenoptera)

Carlos Henrique Marchiori[1*]

[1]Department of Biological Science, Institution Federal Goiano, Goiânia, Goiás, Brazil

[*]**Correspondence to: Carlos Henrique Marchiori, PhD, Professor,** Department of Biological Science, Institution Federal Goiano, Rua T-65 No.1050, Goiânia 74230120, Brazil; E-mail: chmarchiori@yahoo.com.br

Received: March 23, 2023 **Revised:** May 2, 2023 **Accepted:** July 26, 2023 **Published:** August 30, 2023

Abstract

The Platygastridae are egg parasitoids of several insect orders and also of spiders. The family has hosts differentiated by subfamily: Platygastrinae. Most are parasitoids coinobionts of galls of the family Cecidomyidae (Diptera) and Sceliotrachelinae (Hymenoptera). They are egg parasitoids of the orders Coleoptera and Hemiptera. The subfamily Scelioninae behave as parasitoids of eggs of Aranae and of several orders of insects such as Orthoptera and Grylloptera. The purpose of this paper is to report new information about bio-ecology, life cycle, habitat, geographic distribution and taxonomy of the Platygastridae Family. For this review, the bibliographic search used the following databases: Scopus (https://www.scopus.com), Science Direct (https://www.sciencedirect.com), Scielo (https://scielo.org/es/), Web of Science (https://www.webofscience.com/wos/woscc/basic-search), ORCID (https://orcid.org) and Google scholar (https://scholar.google.com) between June 2022 and October 2022. The articles were published from 1972 to 2022 in indexed scientific research, book scientific chapters, theses banks, university dissertations, national and international scientific articles, scientific journals, documents and even in general journals when considered of interest. The main terms used were: Parasitic Hymenoptera, parasitoid, hosts, Platygastridae, and egg parasitoids.

Keywords: coleoptera, eggs, information, new report, lepidoptera

Citation: Marchiori CH. New Information about Bio-ecology, Life Cycle, Habitat, Geographic Distribution and Taxonomy of the Platygastridae Family (Insecta: Hymenoptera). *J Mod Agric Biotechnol*, 2023; 2(3): 20. DOI: 10.53964/jmab.2023020.

1 INTRODUCTION

Antennae inserted just above mouth; metasoma compressed laterally, usually with a lateral carina that divides the dorsal and ventral parts; internal ovipositor in a soft tissue tube; fore wing with costal vein open or without veins; female antennal club with 1 or 2 basiconic sensilla. Macropterans, brachypterans or apterans. They measure from 1.0 to 4.0mm and they are predominantly black, some yellow and a few other colors, rarely metallic (Figures 1-13) [1-3].

1.1 Biology

Platygastrids are egg parasitoids of several insect orders and also of spiders. The family has hosts differen-

Figure 1. Specimen of Platygastridae Family. Source: http://www.waspweb.org/platygastroidea/platygastridae/index.htm

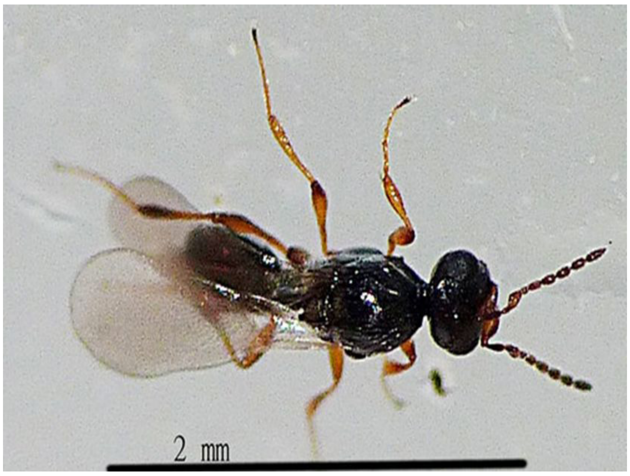

Figure 2. Specimen of Platygastridae Family. Source: https://www.flickriver.com/photos/69610519@N08/15391548737/

Figure 3. Specimen of Platygastridae Family. Source: https://www.delta-intkey.com/britin/hym/www/platygas.htm

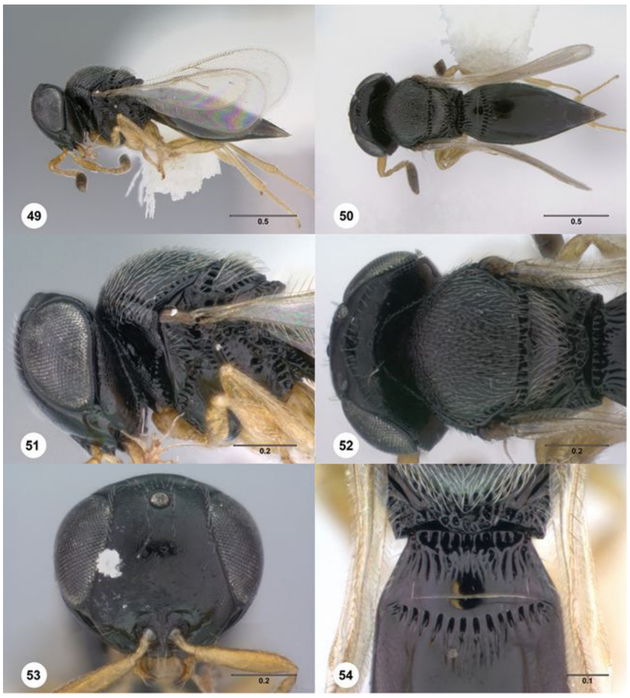

Figure 4. *Phanuromyia hjalmr* sp. nov. ♀ (49) Lateral habitus; (50) Dorsal habitus; (51) Head, mesosoma, lateral view; (52) Head, mesosoma, dorsal view; (53) Head, mouthparts, anteroventral view; (54) T1–T2, dorsal view. Source: https://www.researchgate.net/figure/Figures-49-54-Phanuromyia-hjalmr-OSUC-550078-49-Lateral-habitus-50-Dorsal-habitus_fig8_315850713

tiated by subfamily: Platygastrinae. Most are parasitoids coinobionts of galls of the family Cecidomyidae (Diptera). Sceliotrachelinae (Hymenoptera). They are parasitoids of Coleoptera and Hemiptera eggs. The subfamily Scelioninae is parasitoids of Aranae eggs and several insect orders such as Orthoptera, Grylloptera, Hemiptera, Embioptera and Dyctioptera eggs (Figures 14-16).

1.2 Biological Cycle

The wasp lays eggs in the host's egg or early larval stage, and its larva completes development when the host reaches the pupa or prepupa stage. The other subfamily is much smaller, with 20 genera. They generally have the rudiments of a vein on the fore wings. Most attack the eggs of beetles or Hemiptera. Platygastridae is the third largest family of parasitic Hymenoptera in the world. It includes important egg and larval parasitoids of insects and spiders (Figures 17-21).

The recognition and acceptance of hosts in Platygastridae appear to be influenced by morphological characteristics, such as the shape, size and coloring of the postures / eggs, in addition to kairomones found in

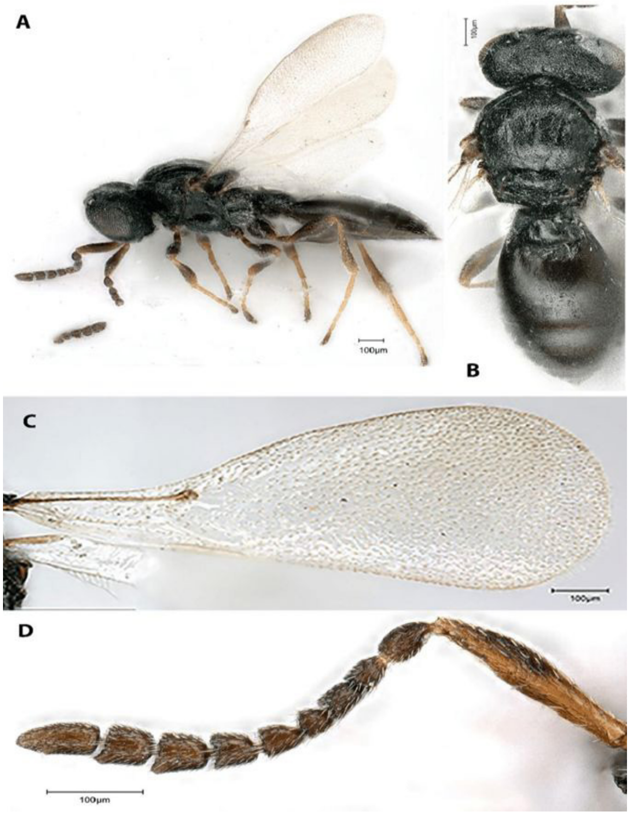

Figure 5. Female *Inostemma discessus* (Szelényi, 1939). (A) General habitus in lateral view; (B) General habitus in dorsal view; (C) Fore wing; (D) Antennae. Source: https://www.researchgate.net/figure/Female-Inostemma-discessus-A-General-habitus-in-lateral-view-B-General-habitus-in_fig2_341189485

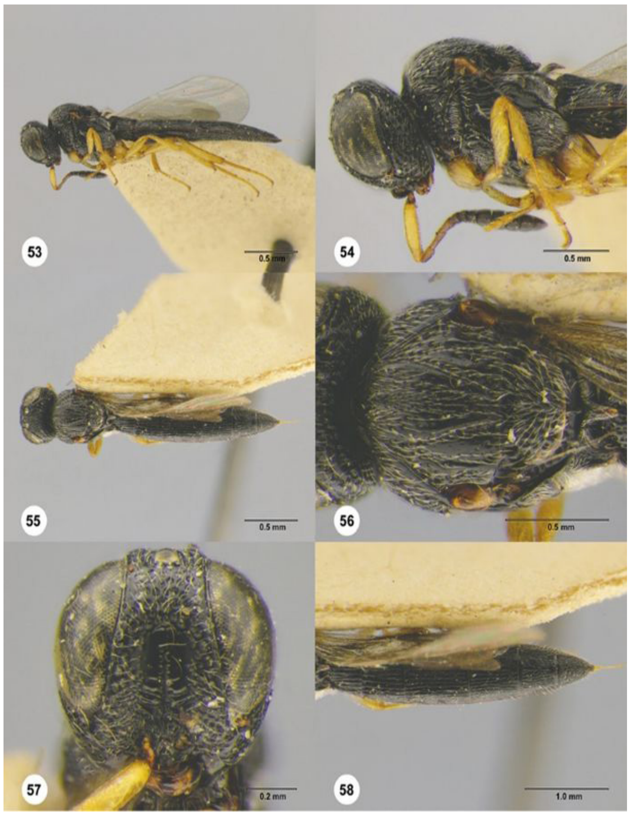

Figure 6. *Habroteleia flavipes* Kieffer, 1905, female, holotype (MCSN 0001). (53) Lateral habitus; (54) Head and mesosoma, lateral view; (55) Dorsal habitus; (56) Head and mesosoma, dorsal view; (57) Head, lateral view; (58) Metasoma and wings, dorsal view. Source: https://zookeys.pensoft.net/article/21846/element/2/110/

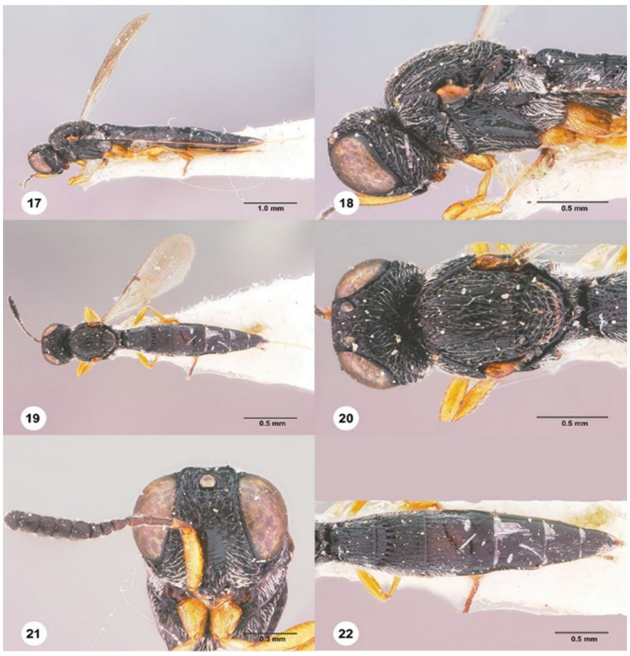

Figure 7. *Habroteleia bharatensis* Saraswat 1978, female, holotype. (17) Lateral habitus; (18) Head and mesosoma, lateral view; (19) Dorsal habitus; (20) Head and mesosoma, dorsal view; (21) Head, anterior view; (22) Metasoma, dorsal view. Source: https://jhr.pensoft.net/article/65563/

Figure 8. Morphology of the mesoscutellar spine in *Synopeas*. A. *Synopeas codex* sp. nov.; B. *Synopeas amandae* sp. nov.; C. *Synopeas* sp. nov.; D. *Synopeas occultum* sp. nov.; E. Synopeas lulis sp. nov.; F. Synopeas butterilli sp. nov.; G. *Synopeas klingunculum* sp. nov.; H. *Synopeas anunu* sp. nov.; I. *Synopeas kira* sp. nov. Source: https://jhr.pensoft.net/article/65563/

https://doi.org/10.53964/jmab.2023020

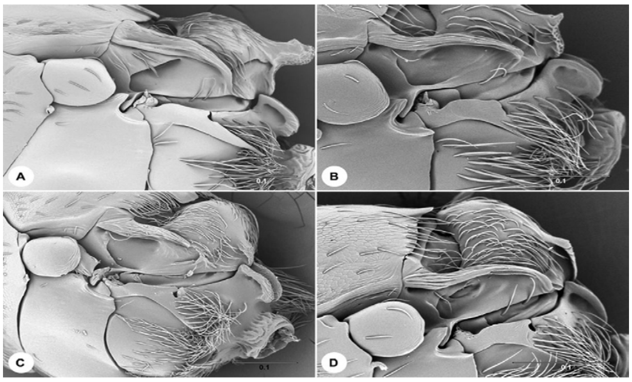

Figure 9. Margin of lateral propodeal carinae. (A) *Synopeas klingunculum* sp. nov.; (B) *Synopeas toto* sp. nov.; (C) *Synopeas codex* sp. nov.; (D) *Synopeas valavala* sp. nov. Source: https://jhr.pensoft.net/article/65563/

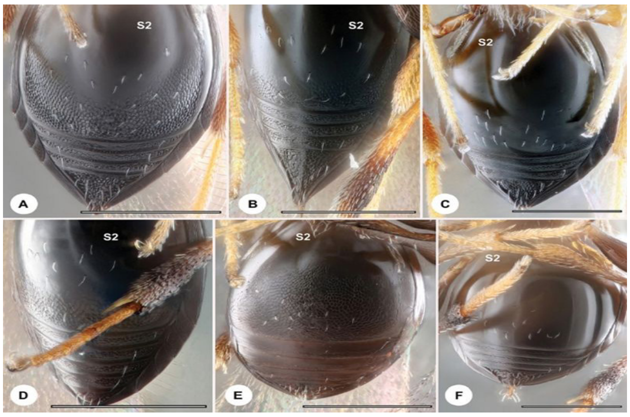

Figure 11. Sculpture of metasomal sternite 2. (A) *Synopeas sanga* sp. nov.; (B) *Synopeas occultum* sp. nov.; (C) *Synopeas roncavei* sp. nov.; (D) *Synopeas kira* sp. nov.; (E) *Synopeas codex* sp. nov.; (F) *Synopeas luli* sp. nov. Source: https://jhr.pensoft.net/article/65563/

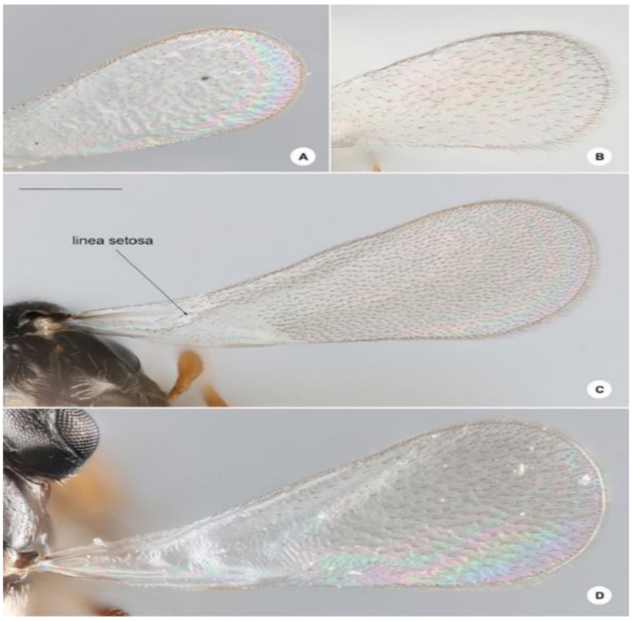

Figure 13. Forewing of *Synopeas*. (A) *Synopeas butterilli* sp. nov.; (B) *Synopeas kiki* sp. nov.; (C) *Synopeas roncavei* sp. nov.; (D) *Synopeas luli* sp. nov. Source: https://jhr.pensoft.net/article/65563/

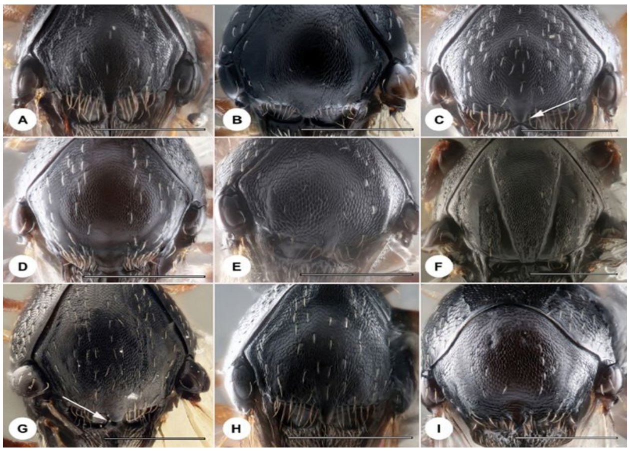

Figure 10. **Mesoscutal lamella in *Synopeas.*** (A) *Synopeas sanga*; (B) *Synopeas luli* sp. nov.; (C) *Synopeas valavala* sp. nov.; (D) *Synopeas codex* sp. nov; (E) *Synopeas zhangi* sp. nov.; (F) *Synopeas klingunculum* sp. nov.; (G) *Synopeas kalubia* sp. nov.; (H) *Synopeas kira* sp. nov.; (I) Undescribed species. Source: https://jhr.pensoft.net/article/65563/

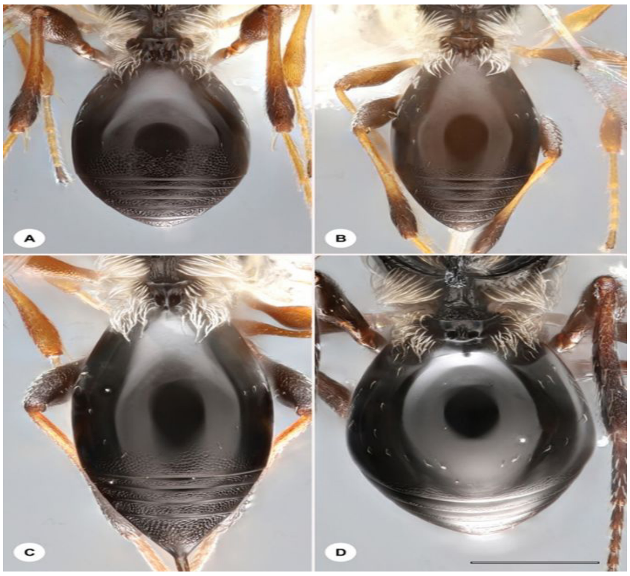

Figure 12. Sculpture of metasomal tergite. A. *Synopeas sanga* sp. nov.; B. *Synopeas occultum* sp. nov.; C. *Synopeas kira* sp. nov.; D. *Synopeas klingunculum* sp. nov. Source: https://jhr.pensoft.net/article/65563/

Figure 14. First record of egg parasitoids of *Oebalus poecilus* (Dallas, 1851) (Hemiptera: Pentatomidae) in rice in Maranhão, Brazil. Source: https://www.picuki.com/tag/Platygastridae

https://doi.org/10.53964/jmab.2023020

Figure 15. Platygastrid parasitoid likely from the genus *Idris* Förster, 1856 on the eggs of a cellar spider (Aranae). Source: https://www.picuki.com/tag/Platygastridae

Figure 17. Parasitoid Platygastridae lay their own eggs in small bed bug eggs or bed bug eggs (Hemiptera: Pentatomidae). The darkest bed bug eggs have already been parasitized and will only hatch wasps. Source: https://www.picuki.com/tag/Platygastridae

Figure 19. **The many eggs of the (Lepidoptera: Geometridae) moth have become the target of small parasitoids of the Family Platygastridae.** These wasps are laying their eggs inside the moth's eggs. Their adults hatch and grow inside the egg, emerging as adult parasitoids. Source: https://www.picuki.com/media/2276931459946372847

Figure 16. The goldenrod gall widge *Rhopalomyia solidaginis* (Loew 1862). (Diptera: Cecidomyiidae) is an ecosystem engineer whose larvae induce rosette galls by inhibiting stem growth, particularly of tall goldenrod*, Solidago altissima* L. (Asteraceae). The larvae occupy only the stem apex, leaving the leaf bunch for other inhabitants. One close associate of genus *Rhopalomyia Rübsaamen,* 1892, is a platygastrid parasitoid, and investigation often finds that the parasitoids' own larvae have devoured the gall-maker. Source: https://www.picuki.com/media/2644454358500819462

Figure 18. *Inostemma* sp., of the microscopic and strange (Hymenoptera: Platygastridae). Source: https://www.picuki.com/media/2595271593211032804

Figure 20. Eggs broken by the parasitoids Platygastridae. Source: https://www.picuki.com/media/2343907058352327273

https://doi.org/10.53964/jmab.2023020

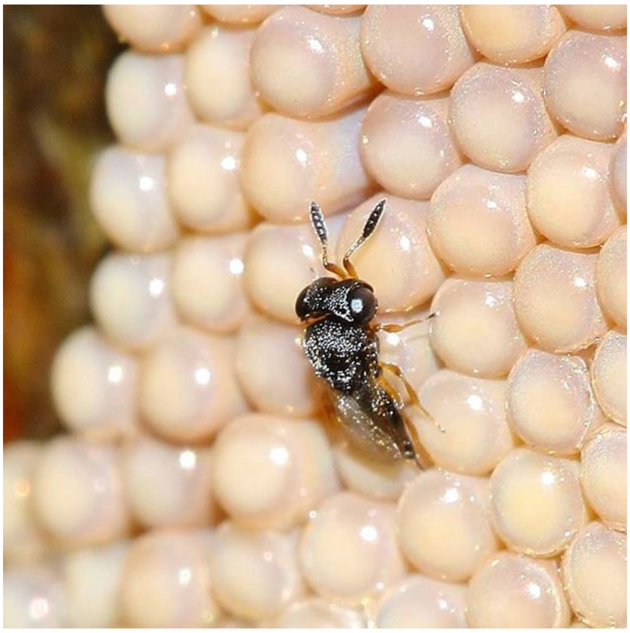

Figure 21. Egg parasitoid family Platygastridae. Parasitic wasps are particularly insidious, even trying to get past a vigilant guard to inject their own offspring into an exposed egg. The parasitoid larva will consume the contents of an egg, causing it to darken. In all ecosystems, parasitic wasps can significantly affect the viability of eggs, thus keeping host populations in check. Source: https://www.picuki.com/media/2127032229397008739

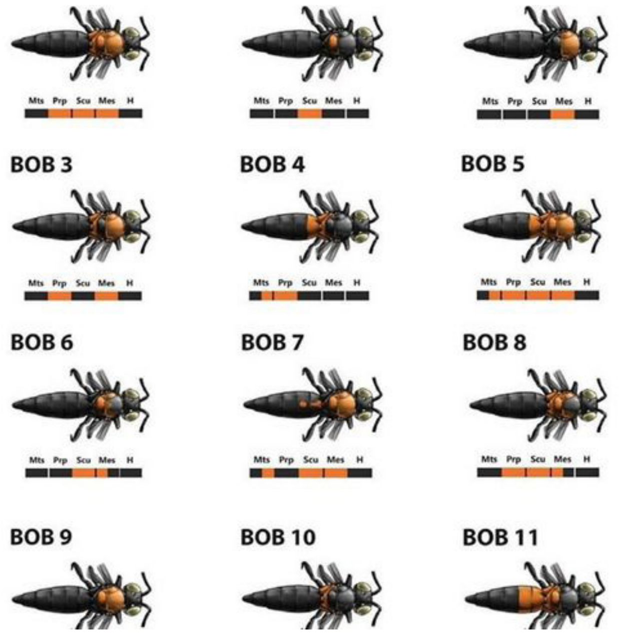

Figure 22. Certain patterns of nuclei in insects (core show) evolution, where an evolution serves an independent genetic function, the trait with respect to aposematism and mimicry. It has long been recognized as Hymenoptera, especially as a recurring pattern of black head, orange / red (B-O-B staining). The researchers included 11 variations of the typical BOB color pattern, but did not include all possible variations. The widespread occurrence of this color pattern in Hymenoptera strongly suggests convergent evolution and a potentially important function. The biology of tabulated taxa encompasses both ecto and endoparasitoids, idiobionts and koinobionts. Source: https://www.picuki.com/media/2003200222867650485

Figure 23. This is an adult wasp getting ready to lay her eggs in bed bug (Insecta: Hemiptera). Source: https://www.picuki.com/tag/Platygastridae

Figure 24. Bed bug eggs being inspected for possible by the parasitoid (Platygastridae). Source: https://www.picuki.com/media/1517896718041480123

the secretion produced by females for the purpose of uniting eggs and glue them to the substrate. *Spodoptera frugiperda* (Smith, 1797), (Lepidoptera: Noctuidae) is a cosmopolitan pest, responsible for major economic losses in different cultures (Figures 22-27)[4-8].

1.3 Ecology, Habitat and Distribution

Family of Hymenoptera in the world. Platygastridae

Figure 25. *Platygaster* Latreille, 1809, pupae inside gall. Source: https://en.wikipedia.org/wiki/Platygastridae

Figure 27. Parasitoid in the small eggs of *Miliolidiumi* nov. gen. Source: https://www.picuki.com/media/1723054063664296575

is functionally important in maintaining the stability of tropical rainforests and agroecosystems. Although the diversity of Platygastridae is relatively well known in agroecosystems, little is known about their diversity in tropical rainforests, and particularly about that of the leaf litter layer (Figure 28) (Table 1)[9,10].

1.4 Taxonomy

The family presents cosmopolitan distribution, with about 4500 described species, divided into 246 genres. In the Neotropical Region, there are more than 240 species in 135 genera. In Brazil, there are more than 110 species, in more than 30 genera.

Subfamilies: Platygastrinae: Scelioninae, Sceliotrachelinae, Teleasinae and Telenominae (Figures 29-33).

Figure 26. *Platygaster* sp. on goldenrod (Solidago). Source: https://en.wikipedia.org/wiki/Platygastridae#/media/File:Platygaster.goldenrod.jpg

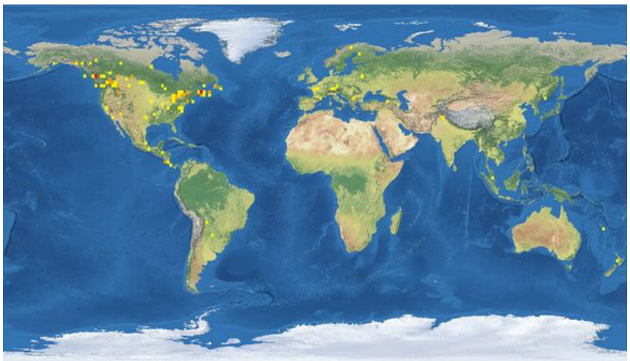

Figure 28. Collected from 17 countries. Top 20: Show All Countries. Source: https://v3.boldsystems.org/index.php/Taxbrowser_Taxonpage?taxid=516256

Genus: (Figures 34-45)[11-19].

1.5 Objective

The purpose of this paper is to report new information about bioecology, life cycle, habitat, geographic distribution and taxonomy of the Platygastridae Family.

2 METHODS

The present work uses the reference of bibliographical research, understood as the act of inquiring and seeking information on a certain subject, through a survey carried out in national and foreign databases, with the objective of detecting what there is consensus or controversy in the state of the art of literature. For this review, the bibliographic search used the following databases: Scopus (https://www.scopus.com), Science Direct (https://www.sciencedirect.com), Scielo (https://scielo.org/es/), Dimensions (https://app.dimensions.ai/discover/publication), Web of Science (https://www.webofscience.com/wos/woscc/basic-search), ORCID (https://orcid.org) and Google scholar (https://scholar.google.com) during June 2022 to October 2022. The articles were published from 1972 to

https://doi.org/10.53964/jmab.2023020

Table 1. Collected from 17 Countries (Top 20)

Canada	1029	Russia	5	France	1
United States	122	Belarus	4	Georgia	1
Costa Rica	102	Bulgaria	3	Malaysia	1
Norway	39	Finland	3	Argentina	1
Germany	12	Mexico	2		
New Zealand	5	Pakistan	1		

Figure 29. Subfamily Platygastrinae. Source: https://sciencepress.mnhn.fr/en/periodiques/european-journal-taxonomy/750/2

Figure 30. Subfamily Scelioninae. Source: https://elp.tamu.edu/ipm/bugs/family-platygastridae/hymenoptera-platygastridae-subfamily-scelioninae-male-b/

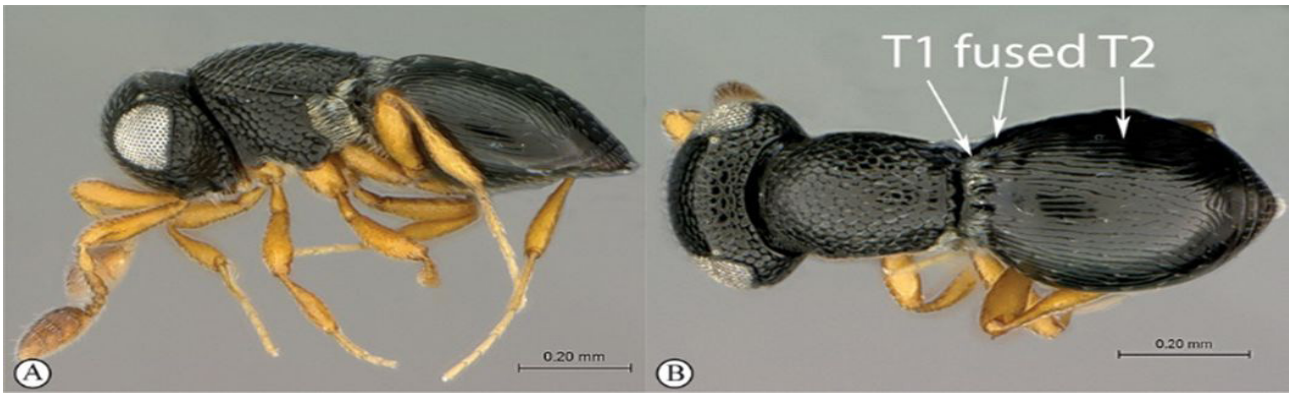

Figure 31. Subfamily Sceliotrachelinae. Wings fully developed (A) extending to at least T2 (B); T1 separated from T2 and S1 from S2 by a sulcus (B), sulcus sometimes partly obscured by dense pilosity (B); frons above torulus without transverse furrow. Source: https://jhr.pensoft.net/article/73770/

Figure 32. Subfamily Teleasinae. Source: https://v3.boldsystems.org/index.php/Taxbrowser_Taxonpage?taxid=516256

Figure 33. Subfamily Telenominae. Source: https://en.wikipedia.org/wiki/Telenominae

Figure 34. Genus *Amitus* Haldeman 1850. Source: Hymenoptera of the Afrotropical region. URL: https://www.waspweb.org

Figure 35. Genus *Euxestonotus* Fouts, 1925. Source: https://tasmaninsectfieldguide.com/hexapoda/insectsoftasmaniahymenoptera2/superfamily-platygastroidea/platygastridae/subfamily-platygastrinae/genus-euxestonotus/

Figure 36. Genus *Fidiobia* Ashmead, 1894. Source: https://v3.boldsystems.org/index.php/Taxbrowser_Taxonpage?taxid=154290

Figure 37. Genus *Inostemma* Tschirnhausi Buhl, 2014. Source: https://www.picuki.com/media/2713303594696838405

Figure 38. Genus *Iphitrachelus* Haliday, 1836. Source: https://v3.boldsystems.org/index.php/Taxbrowser_Taxonpage?taxid=154287

Figure 39. Genus *Leptacis* Förster, 1856. Source: http://www.waspweb.org/platygastroidea/platygastridae/platygastrinae/Leptacis/index.htm

Figure 40. Genus *Metaclisis* Förster, 1856. Source: https://bugtracks.wordpress.com/2015/12/17/introducing-megaselia-nantucketensis/

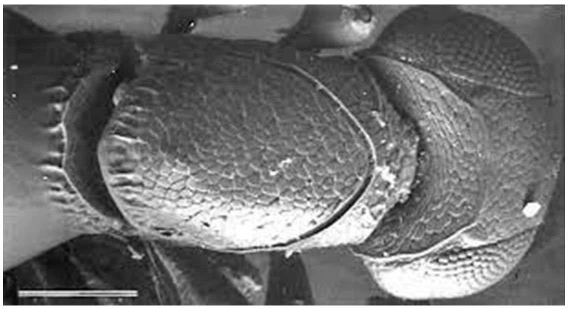

Figure 42. Genus *Parabaeus* Kieffer, 1910. *Parabaeus nasutus* van Noort, 2021. Holotype ♀ in the Iziko South African Museum, Cape Town (SAMC). Type locality: South Africa, Northern Cape, Swaarweerberg, Vredehoek Farm; 1613 m; 32°26.387'S, 20°34.501'E; 29 July - 30 September 2010; S. van Noort; Yellow pan trap; Roggeveld Shale Renosterveld; SWA09-SUC1-Y05; SAM-HYM-P040757. Source: http://www.waspweb.org/platygastroidea/Platygastridae/Sceliotrachelinae/Parabaeus/Parabaeus_nasutus.htm

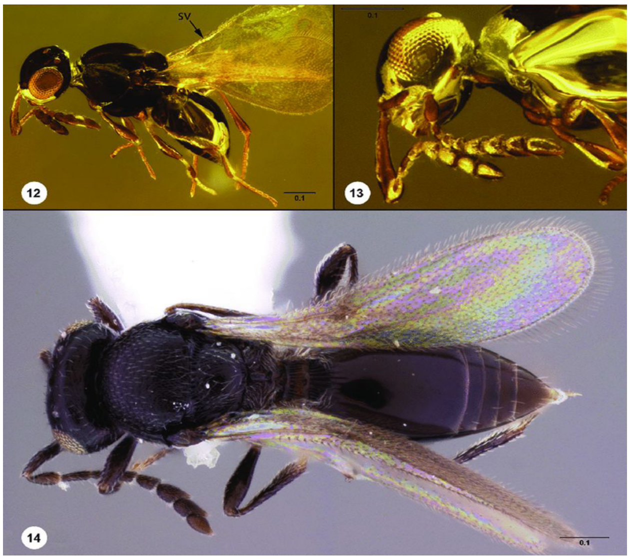

Figure 44. 12. *Platygaster,* female (USNMENT01109284), head, mesosoma, metasoma, lateral view; 13. *Platygaster,* female (USNMENT01109284), head and antennae, lateral view; 14. Allotropa, female (OSUC 404951), head, mesosoma, metasoma, dorsal view. Source: https://www.researchgate.net/figure/14-12-Platygaster-female-USNMENT01109284-head-mesosoma-metasoma-lateral-view-13_fig5_290456155

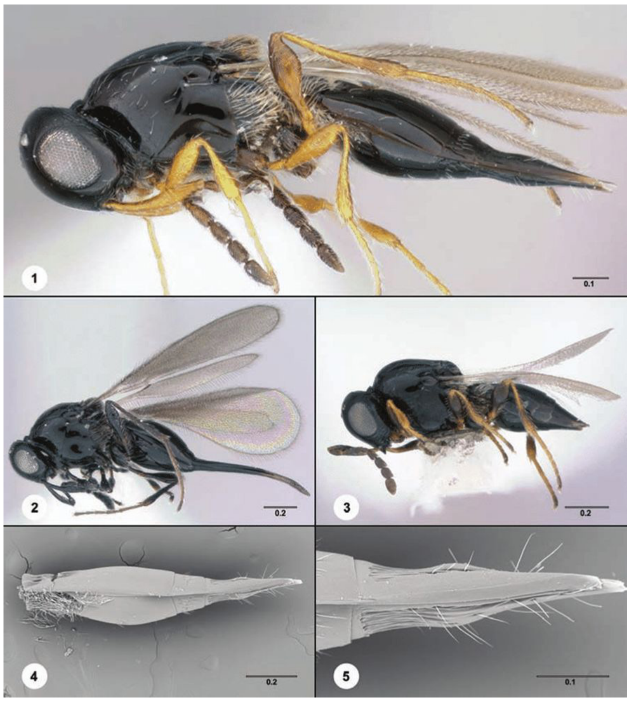

Figure 41. Genus *Metanopedias* Brues, 1910. 1. Female (OSUC 404924), habitus, lateral view; 2. Female (OSUC 265251), habitus, lateral view; 3. Female (OSUC 266113), habitus, lateral; 4. Female (USNMENT00989611_2), metasoma, lateral view; 5. Female (USNMENT00989611_2), T5, S5, lateral view. Source: https://www.researchgate.net/figure/Figures-1-5-Metanopedias-1-female-OSUC-404924-habitus-lateral-view-2-female-OSUC_fig1_317310826

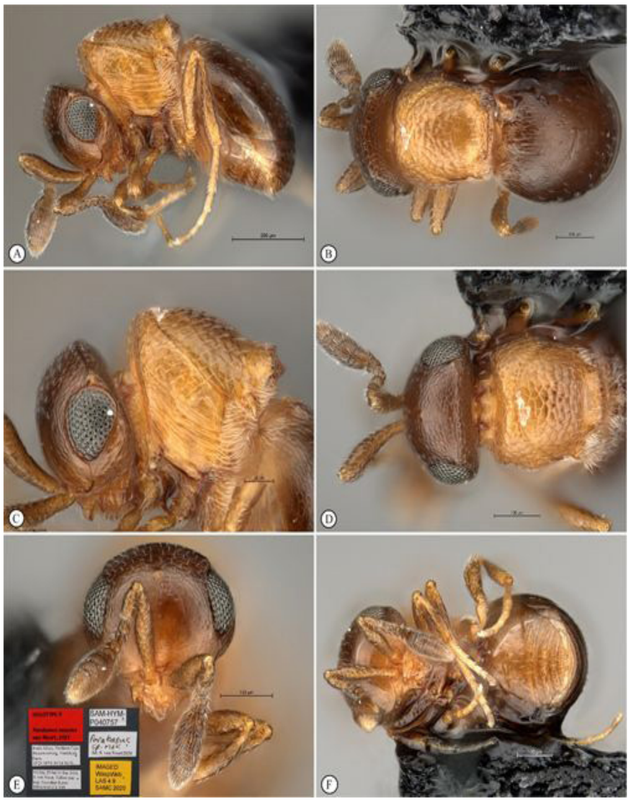

Figure 43. Genus *Piestopleura* Förster, 1856. Source: http://v3.boldsystems.org/index.php/Taxbrowser_Taxon-page?taxid=154283

Figure 45. Genus *Synopeas* Förster, 1856. Source: https://www.picuki.com/media/2278377578186364997

Figure 47. *Trissolcus basalis* (Wollaston, 1858) parasitizing bed bug eggs. Source: https://www.stopbmsb.org/biological-control/

2022 in indexed scientific research, book scientific chapters, theses banks, university dissertations, national and international scientific articles, scientific journals, documents and even in general journals when considered of interest. The main terms used were: Parasitic Hymenoptera, parasitoid, hosts, Platygastridae, egg parasitoid, Marchiori 2022[20].

3 FOLLOWING STUDY WERE SELECTED

3.1 Study 1: Bed Bug Egg Parasitoids and Their Importance in Biological Control

In soybean, the main natural enemies of phytophagous stink bugs are egg parasitoid wasps (Hymenoptera: Platygastridae: Telenominae). These can be considered efficient biological control agents due to their biological and behavioral characteristics. *Trissolcus basalis* (Wollaston, 1858) and *Telenomus podisi* (Ashmead, 1881) are the main species of Telenominae in Brazil, being potential biological control agents of Pentatomidae associated with soybean (Figures 46-47).

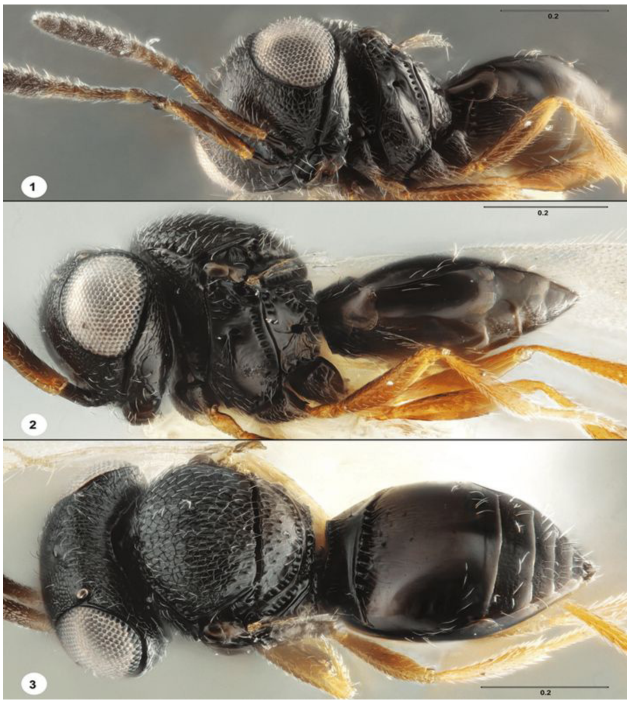

Figure 46. *Trissolcus basalis* (Wollaston, 1858). 1. Head, mesosoma, metasoma, ventrolateral view; 2. Head, mesosoma, metasoma, lateral view; 3. Head, mesosoma, metasoma, dorsolateral view. Source: https://www.researchgate.net/figure/Figures-1-3-Trissolcus-basalis-female-FSCA-00090267-1-head-mesosoma-metasoma_fig1_337366622

Like other egg parasitoids, Telenominae cause the death of the host either by the toxic effects of substances injected by the female during oviposition into the host's eggs or by the growth of the parasitoid embryo that consumes the nutrients of the host egg (Figures 48-49).

These insects have been successfully used in biological control programs in several parts of the world. Brazil showed that inoculative releases of *T. basal is* were efficient in controlling the green stink bug *Nezara viridula* (Linnaeus 1758) (Hemiptera: Pentatomidae).

However, the difficulty in production of egg parasitoids, for those who do not have an artificial diet, has prevented the extension of this program to other regions of Brazil. However, the behavioral management of these natural enemies with semiochemicals as a tool to increase conservative biological control can be a relevant action to stimulate the advancement of this and other biological control programs for bed bugs (Figure 50)[21-27].

3.2 Study 2

Bed bugs are part of the group of the main soybean

Figure 48. ***Telenomus podisi*** **(Ashmead, 1881)**. Source: http://bugguide.net/node/view/615543

Figure 49. ***Telenomus podisi*** **(Ashmead, 1881).** Source: https://vittia.com.br/produto/podisi-vit/

Figure 50. Green stink bug ***Nezara viridula*** **(Linnaeus 1758) (Hemiptera: Pentatomidae).** Source: https://naturdata.com/especie/nezara-viridula/3928/0/

Figure 51. Injuries caused by insect-pests on soybean leaves. Source: https://international-pest-control.com/wordpress/integrated-management-soybean-pests-example-brazil/

pests, being frequently found in crops of this oil seed, especially in the reproductive period of the crop where the pest has the greatest potential to cause damage. The damage resulting from the attack of stink bugs in soybean can be both quantitative and qualitative (Figure 51).

The pest can reduce soybean yield and seed quality, affecting yield components such as thousand-grain mass and seed physiological attributes such as germination and vigor. According to technical recommendations for the crop, the level of action for controlling stink bugs in soybean varies depending on the purpose of the crop, and pest control is recommended when 2 stink bugs per meter of row for crops intended for grain production, and 1 stink bug are observed per meter of row for crops intended for seed production; both are controled during the reproductive period of soybean development (Figure 52).

Among the main species that affect the culture, we can highlight the brown bug *Euschistus heros* Fabricius, 1798 (Hemiptera: Pentatomidae), the little green bug *Piezodorus guildinii* (Westwood, 1837) (Hemiptera: Pentatomidae) and

Figure 52. Southern green shield bug (nymphal stage) in group damaging soybean pods. Source: https://www.legumehub.eu/is_article/southern-green-shield-bug-in-soybean/

Figure 54. Life cycle drawing *Nezara viridula* (Linnaeus 1758) (Hemiptera: Pentatomidae). a and b: Small nymphs; c and d: Large nymphs. Source: https://www.sciencedirect.com/science/article/abs/pii/S0022191020302614

the green bug *Nezara viridula* (Linnaeus 1758) (Hemiptera: Pentatomidae). The damage may vary according to the species and population density of the pest, and may result in significant production losses (Figures 53-55).

Females of *T. podisi*, locate bed bug eggs in the field and lay them on their eggs, interrupting the development of the pest at the beginning of its cycle. The pest eggs become blackened and give rise to new *T. podisi* wasps instead of new bed bugs, which will parasitize new pest eggs (Figure 56).

Although chemical pest control prevails in most commercial crops, biological control of stink bugs in soybean is also possible. Among the main biocontrol agents of stink bugs in soybean we can highlight *T. podisi* which stands out for parasitizing stink bug eggs.

Evaluating the reproductive potential and longevity of the parasitoid *T. podisi* in eggs of different species of bugs, it was observed that among the bugs *E. heros, P. guildinii* and *N. viridula*, *T. podisi* preferentially parasitizes the eggs of the bug *E. heros*[28-30].

3.3 Study 3

The study of the performance of parasitoids at different

Figure 53. Small (a and b), large (c) and adult (d) nymphs of *Piezodorus guildinii* (Westwood, 1837) (Hemiptera: Pentatomidae). Source: https://maissoja.com.br/piezodorus-guildinii-eficiencia-nas-misturas-e-volume-de-calda/

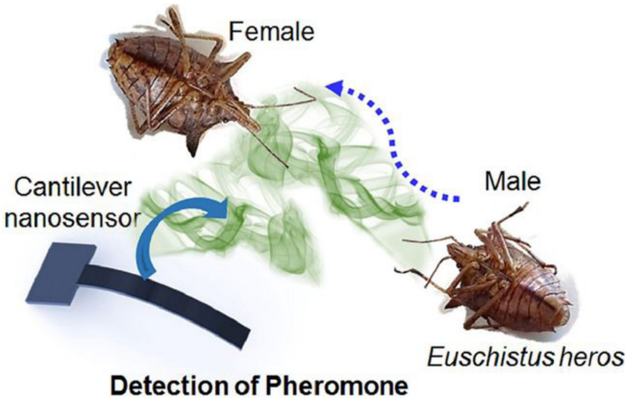

Figure 55. This revision covers the agriculture system, the losses due to insect pests, the pheromone definition and how they can be deployed. Especially, this work focuses on pheromones from stink bug *Euschistus heros* Fabricius, 1798 (Hemiptera: Pentatomidae). The use of different techniques for pest control in agriculture seeks safety and environmental preservation. The stink bug *E. heros* is one of the major pests that affects crops in Brazil. This insect releases pheromone to mate in low amounts. A promising and efficient alternative for the detection of this volatile compound is the use of nanosensors. Source: https://www.sciencedirect.com/science/article/pii/S2666053921000461

temperatures is necessary before their use in practice, as this factor can interfere with the biological characteristics of the natural enemy.

Thus, this work aimed to evaluate the effects of temperature on the biological characteristics of *Tr. basalis* reared on fresh and frozen eggs of *E. heros* and *N. viridula*. Fifty eggs of each host, per replicate, were offered to parasitism, which was allowed for 24h in a climatized

https://doi.org/10.53964/jmab.2023020

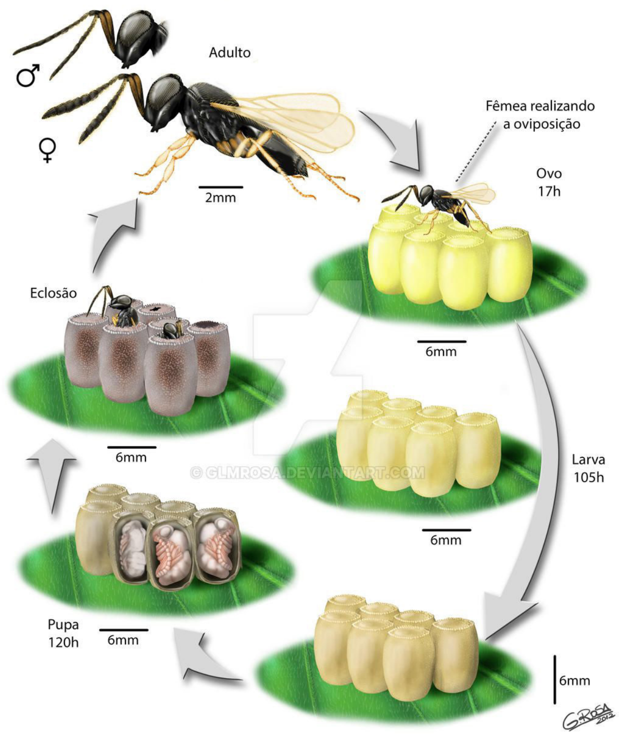

Figure 56. Life cycle of *Telenomus podisi* (Ashmead, 1881). Source: https://www.deviantart.com/glmrosa/art/Telenomus-podisi-life-cycle-809506792

Figure 58. Insect pests, which occur in soybean, the brown stink bug *Euschistus heros* (Fabricius, 1798) (Hemiptera: Pentatomidae). Source: https://revistacultivar.com.br/materias/controle-de-percevejos-em-soja

chamber (25+1ºC, 70+10% RH and 14h photophase) (Figure 57).

In both hosts there was a predominance of female emergence, with values of sex ratio in eggs fresh *E. heros* from 0.67 to 0.95 and from 0.62 to 0.98 in frozen eggs. In eggs of *N. viridula* there was variation in sex ratio from 0.72 to 0.96 in frozen eggs and from 0.51 to 0.94 in fresh eggs. The viability results were always greater than 90% in fresh *N. viridula* eggs in all tested temperatures, which shows the good adaptation of the parasitoid in the different temperatures in host (Figure 58).

However, in frozen eggs of *N. viridula* there was a variation in viability from 5.60 to 79.72% and in frozen eggs of *E. heros* from 37.14 to 66.54% and in fresh eggs from 26.43 to 66.54%, with the lowest values occurring at a temperature of 34°C and the highest values at 25°C, demonstrating the influence of temperature and type of egg offered to parasitism by *T. basalis* (Figure 59)[31].

Figure 57. *Trissolcus basalis* (Wollaston, 1858). Source: https://gebio.com.br/campo/controle-de-percevejos-com-telenomus-podisi-em-soja/

3.4 Study 4: Control of Bed Bugs with *Telenomus Podisi* (Ashmead, 1881) in Soybean

Bed bugs in soybeans can be controlled with only one parasitoid. Since the 1990s, the egg parasitoid *T. podisi* has been developed for field releases and control of bed bug eggs, especially the green bug *N. viridula*, on soybeans in the south from the country (Figure 60).

With global warming and a temperature increase of up to 1.5ºC in southern Brazil in the penultimate decade, in 2012, it was found that the change in the status of pest bugs in Brazil, with the migration of *N. viridula* to Uruguay and the dominance of *E. heros* across the country was linked to this climate change. With the predominance of the brown stink bug, *E. heros*, in soybean, the parasitoid *T. basalis* becomes obsolete, as it is more suitable for regions with milder climates (Figure 61).

Parasitoid is quite effective for most species of stink bugs that occur in soybeans, including predators of the genus *Podisus*, from which the species name comes.

For this reason, *T. podisi* became the target of current research and began to be used in experimental areas with the same release technology developed for *T. basalis*. But is this technology developed for *T. basalis* suitable

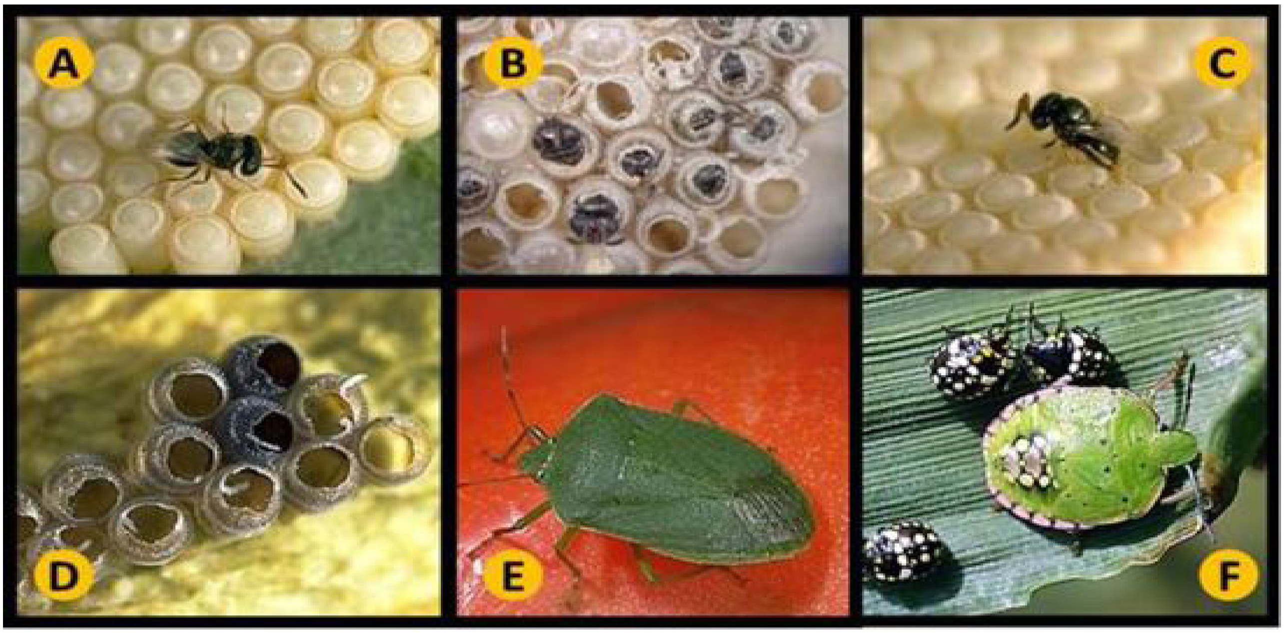

Figure 59. A. The female wasp *Trissolcus basalis* (Wollaston, 1858) parasitizes the eggs of the green ladybug *Nezara viridula* (Linnaeus 1758) (Hemiptera: Pentatomidae); B. Adult wasp *T. basalis* emerges from the eggs of the parasitized *N. viridula* green ladybug; C. Eggs of the green ladybug *N. viridula* being parasitized by the wasp *T. basalis*; D. Eggs of the green ladybug *N. viridula* parasitized (black color) by the wasp *T. basalis*; E. Green ladybug *N. viridula*; F. Green ladybug nymph *N. viridula*. Sources: https://mplk.politanikoe.ac.id/index.php/tawon-trissolcus-basalis

Figure 60. *Telenomus podisi* (Ashmead, 1881). Source: https://gebio.com.br/campo/controle-de-percevejos-com-telenomus-podisi-em-soja/

for *T. podisi*?

Recently, some research has been conducted to develop the technology for releasing *T. podisi* in the field. It was found that what was done for *T. basalis* is no different from what should be done for *T. podisi.*

3.5 A Little Bit of the Biology of the Parasitoid

The parasitoid *T. podisi* lives for about a month in the field, but parasitizes almost 80% of bed bug eggs up to two weeks after emergence. The first parasitized eggs give rise to more females and then go on to produce more males, but the sex ratio is around 0.6 (that is, it produces more females than males).

Figure 61. Release of the parasitic wasp from bed bug eggs, *Telenomus podisi* (Ashmead, 1881), (a) Sheets with bedbug eggs for infestation with the wasp; (b) Detail of the wasp parasitizing the eggs; (c) Card with parasitized eggs trapped in a plant of soybeans in the field. In surveys of stink bug egg parasitoids in natural conditions throughout Brazil, the species *T. podisi* stands out and research in recent years has indicated that this. Source https://www.embrapa.br/documents/1355163/1994197/2002_controleBiologicoInsetosPragaSojaOrganica.pdf/77dbf300-850e-4e2d-9678-2a820303a3f0

A female parasite, on average 210 eggs of *E. heros* or 76 eggs of *P. guildinii*, the little green bug. A parasitized egg takes about two weeks to develop into new adults[32].

4 CONCLUSION

Cultivars such as soybean, corn, coffee, among others, can attract many natural enemies, as well as egg parasitoids that are promising for biological control. Various genres of Platygastridae were recorded in these agroecosystems and its potential for biological control should be studied.

Acknowledgements
Not applicable.

Conflicts of Interest
The author declared no conflict of interest.

Author Contribution
Marchiori CH contributed to the manuscript and approved the final version.

References

[1] Godfray HCJ. Parasitoids, behavioural and evolutionary ecology, 1st ed. Princeton University Press: New Jersey, USA, 1994.

[2] Guevara NN. Comparative bioecology of two strains of *Telenomus remus* Nixon (Hymenoptera: Platygastridae) parasitizing eggs of *Spodoptera frugiperda* (Smith) (Lepidoptera: Noctuidae). 2013.

[3] Steidle JLM, Van Loon JJA. Chemoecology of parasitoid and predator oviposition behaviour. In: Chemoecology of insect eggs and egg deposition, 1st ed. Blackweel Publishing: New Jersey, USA, 2002; 291-317.

[4] Loiácono MS, Margaría CB. Ceraphronoidea, Platygastroidea and Proctotrupoidea from Brazil (Hymenoptera). *Neotrop Entomol*, 2002; 31: 551-560.[DOI]

[5] Buhl PN. Species of Platygastrinae and Sceliotrachelinae from rainforest canopies in Tanzania, with keys to the Afrotropical species of *Amblyaspis, Inostemma, Leptacis, Platygaster* and *Synopeas* (Hymenoptera, Platygastridae). *Tijdschr voor Entomol*, 2011; 154: 75-126.[DOI]

[6] Genus: *Aphanomerus*. Animal Diversity web. Accessed October 25 2022. Available at:[Web]

[7] Stünzner I. ABC News. Byfield National Park becomes last line of defence against threat to pandanus. Accessed October 25 2022. Available at:[Web]

[8] Queensland Times. The insects killing Fraser Island's pandanus population. Accessed October 25 2022. Available at:[Web]

[9] Manoj K, Rajesh TP, Prashanth BU et al. Diversity of Platygastridae in leaf litter and understory layers of tropical rainforests of the Western Ghats Biodiversity Hotspot, India. *Environ Entomol*, 2017; 46: 685-692.[DOI]

[10] Coghill J. ABC News. Rangers turn to tiny native wasp to save Fraser Island's iconic pandanus population. Accessed October 25 2022. Available at:[Web]

[11] Goulet H, Huber JT. Hymenoptera of the world: An identification guide to families, 1st ed. Centre for Land and Biological Resources Research: Canada Communication Group: Ottawa, CA, 1993.

[12] Murphy NP, Carey D, Castro LR et al. Phylogeny of the platygastroid wasps (Hymenoptera) based on sequences from the 18S rRNA, 28S rRNA and cytochrome oxidase I genes: implications for the evolution of the ovipositor system and host relationships. *Biol J Linn Soc*, 2007; 91: 653-669.[DOI]

[13] Buhl PN, Notton DG. A revised catalogue of the Platygastridae of the British Isles (Hymenoptera: Platygastroidea). *J Nat Hist*, 2009; 43: 1651-1703.[DOI]

[14] Sharkey MJ. Phylogeny and Classification of Hymenoptera. *Zootaxa*, 2007; 1668: 521-548.[DOI]

[15] Sharkey MJ, Carpenter JM, Vilhelmsen L et al. Phylogenetic relationships among superfamilies of Hymenoptera. *Cladistics*, 2012; 28: 80-112.[DOI]

[16] Chen H, Lahey Z, Talamas EJ et al. An integrated phylogenetic reassessment of the parasitoid superfamily Platygastroidea (Hymenoptera: Proctotrupomorpha) results in a revised familial classification. *Syst Entomol*, 2021; 46: 1088-1113.[DOI]

[17] Lahey Z, van Noort S, Polaszek A et al. Revision of the Afrotropical genus *Pulchrisolia* Szabó (Hymenoptera, Platygastridae, Sceliotrachelinae). *J Hymenopt Res*, 2019; 73: 39-71.[DOI]

[18] MacGown MW, Nebeker TE. Taxonomic review of *Amitus* (Hymenoptera: Proctotrupoidea, Platygastridae) of the western hemisphere. *Can Entomol,* 1978; 110: 275-283.[DOI]

[19] van Noort S, Lahey Z, Talamas EJ et al. Review of Afrotropical Sceliotrachelinae parasitoid wasps (Hymenoptera, Platygastridae). *J Hymenopt Res*, 2021; 87: 115-223.[DOI]

[20] Marchiori CH. Biological control performed by the Ibaliidae family (Insecta: Hymenoptera). *Open Access J Sci Technol*, 2022; 6: 75-92.[DOI]

[21] Borges M, Schmidt FGV, Sujii ER et al. Field responses of stink bugs to the natural and synthetic pheromone of the Neotropical brown stink bug, *Euschistus heros* (Heteroptera: Pentatomidae). *Physiol Entomol*, 1998; 23: 202-207.[DOI]

[22] Borges M, Colazza S, Ramirez-Lucas P et al. Kairomonal effect of walking traces from *Euschistus heros* (Heteroptera: Pentatomidae) on two strains of *Telenomus podisi* (Hymenoptera: Scelionidae). *Physiol Entomol*, 2003; 28: 349-355.[DOI]

[23] Borges M, Moraes MCB, Peixoto MF et al. Monitoring the Neotropical brown stink bug *Euschistus heros* (F.) (Hemiptera: Pentatomidae) with pheromone-baited traps in soybean fields. *J Appl Entomol*, 2011; 135: 68-80.[DOI]

[24] Corrêa-Ferreira BS, Moscardi F. Biological control of soybean stink bugs by inoculative releases of *Trissolcus basalis*. *Entomol Exp Appl*, 1996; 79: 1-7.[DOI]

[25] Colazza S, Salerno G, Wajnberg E. Volatile and contact chemicals released by *Nezara viridula* (Heteroptera: Pentatomidae) have a kairomonal effect on the egg parasitoid *Trissolcus basalis* (Hymenoptera: Scelionidae). *Biol Control*, 1999; 16: 310-317.[DOI]

[26] Laumann RA, Aquino MFS, Moraes MCB et al. Response of the egg parasitoids *Trissolcus basalis* and *Telenomus podisi* to compounds from defensive secretions of stink bugs. *J Chem Eco*, 2009; 35: 8-19.[DOI]

[27] Parra JRP. Mass creation of natural enemies. In: Biological

Control in Brazil - Parasitoids and Predators, 1st ed. Publisher Manole: São Paulo, BR, 2002. 143-161.

[28] Ferreira SAM, Dias AM, Borges M et al. Influence of visual cues on host-searching and learning behaviour of the egg parasitoids *Telenomus podisi* and *Trissolcus basalis*. *Entomol Exp Appl*, 2012; 145: 162-174.[DOI]

[29] Bin F, Vinson SB, Strand MR et al. Source of an egg kairomone for *Trissolcus basalis*, a parasitoid of *Nezara viridula*. *Physiol Entomol*, 1993; 18: 7-15.[DOI]

[30] Correa-Ferreira BS. *Trissolcus basalis* for the control of soybean stink bugs. In: Biological control in Brazil: Parasitoids and predators, 1st ed. Publisher Manole: São Paulo, BR, 2002; 1-635.

[31] Bueno RCO, Bueno AF, Xavier MFC. Biological characteristics of *Trissolcus basalis* in eggs of *Euschistus heros* and *Nezara viridula*. Accessed October 26 2020. Available at:[Web]

[32] Pinto AS. Control of bed bugs with *Telenomus podisi* in soybean. Accessed October 26 2020. Available at:[Web]