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Family Scoliidae as parasitoids of (Insecta: Hymenoptera) beetles (Insecta: Coleoptera)

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Abstract

Scoliidae waxes are solitary parasitoids from scarab beetle larvae. Female Scoliidae throws themselves into the ground in search of these larvae and then paralyze them with a string. Before laying the egg, they sometimes dig up the chamber and move the paralyzed beetle larva into it. Scoliidae wasps act as important biocontrol agents because many of the beetles they parasitize are pests, including the Japanese beetle. Male Scoliidae guards the territory, ready to mate with females emerging from the ground. Adult wasps can be flower pollinators of some plants and can find it on many flowers in late summer. The purpose of this paper is to describe the Family Scoliidae as parasitoids of (Insecta: Hymenoptera) beetles (Insecta: Coleoptera). For this, a bibliographic survey of Scoliidae was carried out oufromin the years 1971 to 2021. Only complete articles published in scientific journals and expanded abstracts presented at national and international scientific events were considered. Data were also obtained from Plataforma: Academia.edu, Frontiers, Qeios, Pubmed, Biological Abstract, Publons, Dialnet, World, Wide Science, Springer, RefSeek, Microsoft Academic, Science and ERIC.

Keywords: Biocontrol; Scarabaeidae; Larvae; Wasp; Host

1. Introduction

The females are parasitoids of the larvae of lamellicorn beetles (Scarabaeidae, Passalidae and Lucanidae) and their strong legs allow them to burrow into the ground to search for and parasitize the larvae of these beetles (Figure 1) [1,2,3].

Source: https://www.wikiwand.com/en/Scoliidae

Figure 1 Specimen of Scoliidae Family

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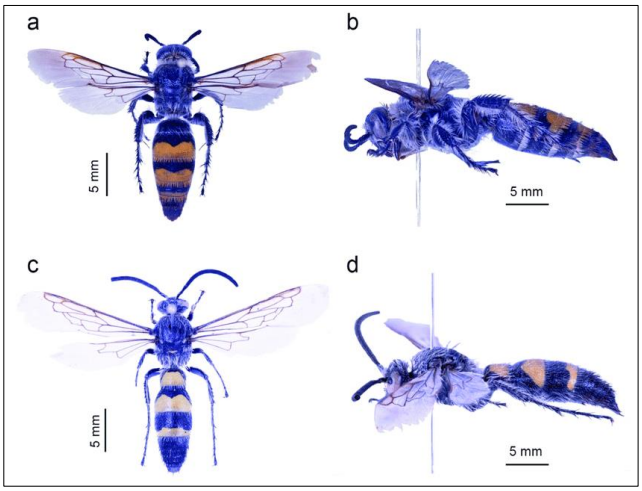
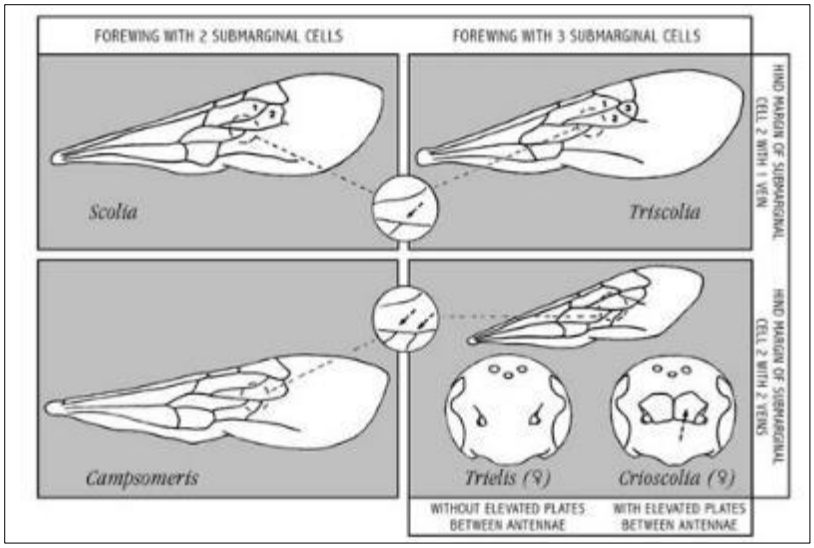
1.1. Characteristic

They are large, robust, and hairy wasps. They are generally black with brightly colored orange or yellow stripes. The wings usually have a wrinkled appearance near the tip. Males are slimmer and more elongated than females, with longer antennae, but in general sexual dimorphism is not as pronounced as in Tiphiidae or Thynnidae, two related families. The mesosternum and metasternum are separated by a straight suture (Figures 2, 3, 4, 5, 6, 7 and 8A) [3,4].



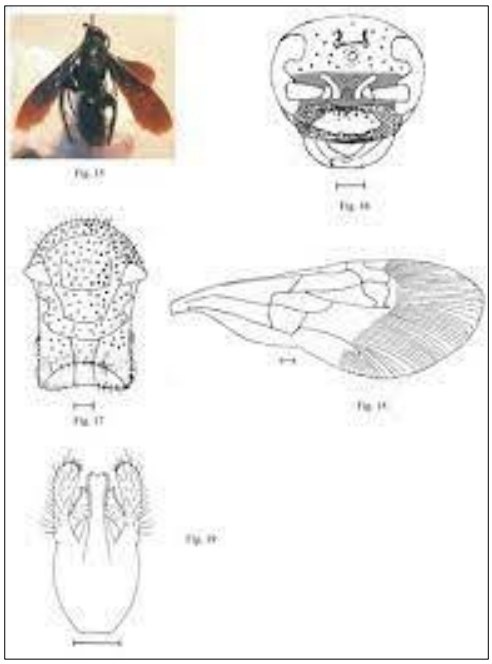
Source: https://www.researchgate.net/figure/Campsomeris-servillei-Guerin-Meneville-1831-Hymenoptera-Scoliidae-a-Habitus-dorsal_fig2_353805165

Figure 2 *Campsomeris servillei* (Guérin-Méneville, 1831) (Hymenoptera: Scoliidae) a) Habitus dorsal view of the female; b) Habitus lateral view of the female; c) Habitus dorsal view of the male; d) Habitus lateral view of the male a) Habitus dorsal view of the female; b) Habitus lateral view of the female; c) Habitus dorsal view of the male; d) Habitus lateral view of the male



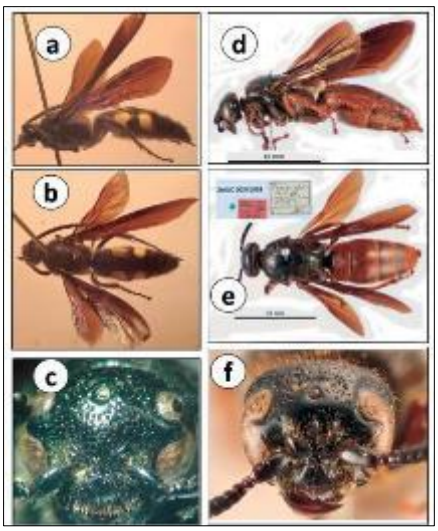
Source: https://entnemdept.ufl.edu/creatures/misc/wasps/scoliid_wasps.htm

Figure 3 Key to Nearctic Genera of Scoliidae north of Mexico (*Crioscolia* and *Trielis* males not separable) To genus. The sexes of Scolliidae are separated as follows: females, antennae 12-segmented, abdomen 6-segmented males, antennae 13-segmented, abdomen 7-segmented. In addition, males have antennae noticeably longer than females and possess a retractable, 3-pronged plate at the tip of the abdomen



Source: https://www.munisentzool.org/yayin/vol5/issue2/661-669.pdf

Figure 4 figs.1-4. *Campsomeriella collaris* (Fabricius, 1775): 1. Photographic image, 2. Face: frontal view, 3. Forewing: dorsal view, 4. Thorax: dorsal view



Source: http://www.scielo.org.co/scielo.php?script=sci_arttext&pid=S0120-548X2020000200202

Figure 5 B.C. *Scolia rufiventris* Fabricius, 1804, a, b. Habitus, male a. side view, b. Habitus, Dorsal view, c. Head, frontal view, female, d-f. *S. rufiventris*, female, d. Habitus, side view, e.g. Habitus, dorsal view and lectotype labels, f. Head, and front view

Source: Adapted from K. V. Krombein (1978)

Figure 6 Face of a scoliid wasp in coded color, illustrating the main features

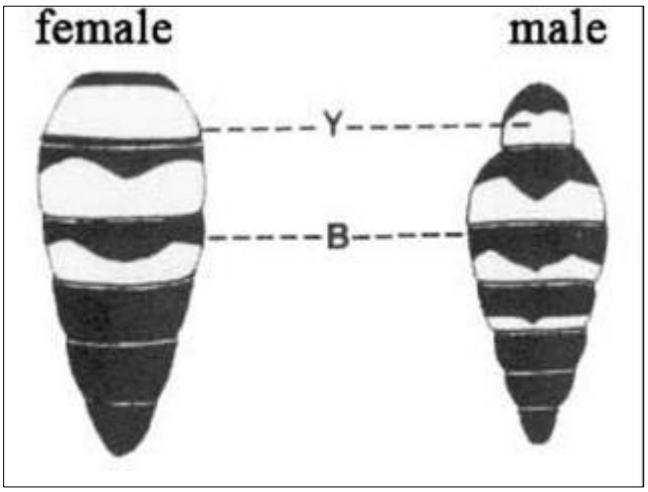
Ocellar pits.
Ocellar furrow.
Three simple eyes.
Two compound eyes.
Vertex, above curved carina frontalis
Front, below-curved carina frontalis and bisected by fissures frontalis.
Scribe.
Area frontalis.
Clypeus.
Anterior margin of clypeus.
Mandibles.
Antennal scapes.
Lamina frontalis.
Spatium frontale or frontal space.

Figure 7 Fore wing with 2 submarginal cells (aa); T1–T4 often with subposterior transverse setose bands (bb); hypostomal carina of male simple, without submandibular triangle (cc); ventral mandibular furrow of female concealed in frontal view (dd)

Source: http://idtools.org/id/hornets/factsheet.php?name=17973

Figure 8A Diagnostic characteristics

- They are black, often marked with yellow, orange, or red bands or spots.
- The wing membrane is finely longitudinally wrinkled, particularly towards the apex.
- Body length 10–50 mm.
- Mesosternum and metasternum wide and divided by a transverse suture.
- Hind coxae widely separated.
- Males are slenderer and more elongated than females, with significantly longer antennae.
- Males have 3 spines protruding from with apex of the metasoma (Figure 8B).



Source: Credit: Division of Plant Industry

Figure 8B *Campsomeris trifasciata* (Fabricius, 1775) (saussure) Variation: Body length is 10 to 15 mm. Both females and males have stable coloration and patterns

1.2. Natural History

They are solitary wasps, external parasites of beetle larvae. The females find such larvae, paralyze them with their sting poison, build a cell underground, and then lay an egg (Figures 9, 10, 11, 12, 13, 14, and 15).

Source: Atsuo Fujimaru

Figure 9 Scoliidae wasp parasitic egg on dung beetle (Scarabaeidae) larva, Japan

Source: Atsuo Fujimaru

Figure 10 Scoliid wasp (Scoliidae), parasitic larva sucking body fluid from Dung Beetle (Scarabaeidae) larva, Japan

Source: Atsuo Fujimaru

Figure 11 Scoliid wasp (Scoliidae) stinging dung beetle (Scarabaeidae) larva, Japan

Source: R. Bessin, 2000

Figure 12 Shown above is a beetle grub being fed upon by the larva of a tiphiid wasp. The tiphiid larvae are the smaller insect in the picture

Source: Photographs: J. Carrière, the capture of La Redouteplage, France, Héraut, of 21.v.1989), of SaintThibéry, France, Héraut, 24. vi.1989)

Figure 13 Encounter between a female *Scolia hirta* (Schrank, 1781) and the larva of *Oryctes nasicornis* (Linnaeus 1758). The Two-banded Scolia showed itself only very faintly sensitive to the presence of the Beetle larva and, after a ride that lasted a few seconds, it fled without initiating any attempt to attack or paralyze it. This confrontation was organized at a place called Mont Ramus, between the municipalities of Bessan and Saint-Thibéry (France, Hérault) on 14. vii.2003

Source: https://www.semanticscholar.org/paper/Contribution-%C3%A0-l'%C3%A9tude-%C3%A9thologique-de-la-grande-%C3%A0-Vereecken-Carriere/33b0f1879421a0806a6529797b2a2a759820f78e

Figure 14 Illustration of the relative size of the two protagonists. Contribution to the ethological study of the greater yellow-fronted scholia, *Megascolia maculata flavifrons* (F., 1775) (Hymenoptera, Scoliidae) in Mediterranean France

Source: Photographs: J. Carrière, capture of La Redouteplage, France, Héraut, of 21. v.1989), of SaintThibéry, France, Héraut, 24.vi.1989)

Figure 15 Illustration of the sexual dimorphism between the male (on the left and the female (on the right) of *Magascolia* Mr. *flavifrons* (F., 1775). The two photographs were taken at the same magnification ratio

Solid wasps are important biological control agents because the beetles they feed on include such pests as the Japanese beetle. Adults are secondary pollinators of wildflowers. One species, *Campsomeris bistrimacula* Lepeletier, 1845., is known to pseudocopulation with the flowers of a South American orchid, *Geoblasta pennicillata* (Rchb.) Hoehne ex M.N. Correa, 1968. These flowers have the appearance and scent of females of the wasp species, thereby tricking the males (Figures 16, 17,18 and 19) [5,6].

Source: Paul Bertner

Figure 16 Scoliid Wasp (Scoliidae), Yasuni National Park, Ecuado

Source: Jan-Luc van Eijk

Figure 17 Mammoth wasp *Megascolia maculata* (Drury 1773) female feeding on flower nectar, Virar, Croatia

Source: Photographer Jurgen Freund

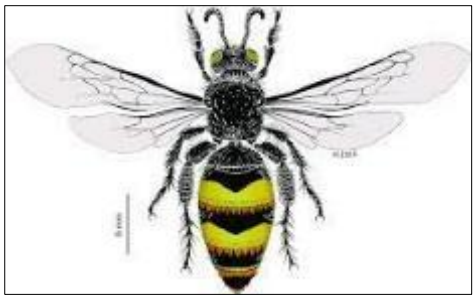
Figure 18 Mammoth wasp / Giant solitary wasp *Megascolia maculata* (Drury 1773) female sunning on a tree trunk, Lesbos/ Lesvos, Greece, May

Source: Photographer Jurgen Freund

Figure 19 Scoliid wasp (Scoliidae) by burrow, Tanjung Puting National Park, Borneo, Central Kalimantan, Indonesia

1.3. Taxonomy

Scoliidae wasps are a family of Apocrita Hymenoptera with a worldwide distribution, with a total of approximately 560 species in more than 140 genera (Figure 20) [7,8].

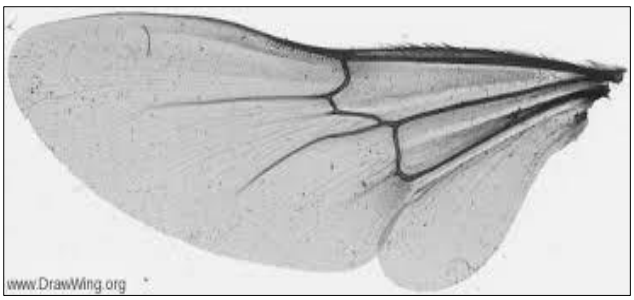


Source: https://www.canstockphoto.com/digger-wasp-scoliidae-24180735.html

Figure 20 Subfamily: Proscoliinae genus *Ampsomeris*

The taxonomy of the group is poorly studied. The only one to carry out work with neotropical fauna, studying mainly the fauna of northern South America. However, this work should be updated to a regional scale, to solve the problem of various species poorly defined. The study deals with the Subfamily: Proscoliinae. genus *Campsomeris* Lepeletier, limiting himself to pointing out that *Scolia*, the other genus present in the Neotropical Region, contains a few species [9,10].

There are no keys for the fauna of *Scolia*, nor are there currently specialists who work with this family in South America. Some species of *Scolia* are for Brazil, but not offers keys or comparative notes. The genus *Campsomeris* is much more abundant in tropical South America than the genus *Scolia* (Figure 21) [9,10].



Source: http://drawwing.org/insect/scolia-hirta-hind-wing

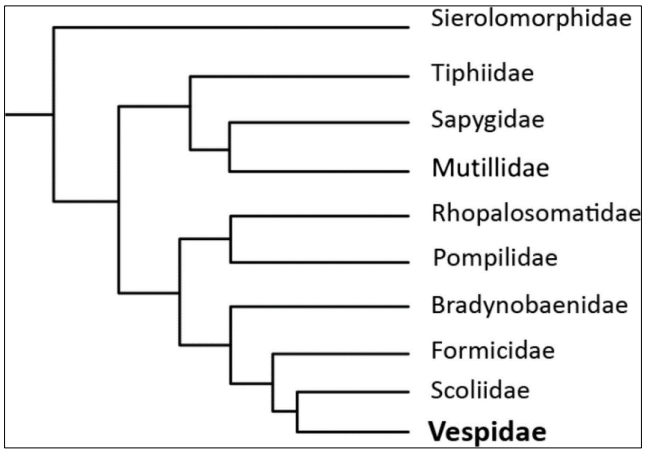
Figure 21 Subfamily Scoliinae and Genus *Scolia*

Megascolia procer (Illiger, 1802), Indonesia, *Scolia bicincta* Fabricius, 1775, female, United States *Austroscolia soror* (Smith, 1855) Australia the classification of the Scoliidae Subfamilies is as follows:

Subfamily: Proscoliinae and Scoliidae.

1.4. Phylogeny

Phylogenetically, the Solids are located in the same clade. with the solitary and social wasps, Vespidae (with which are sister groups), and with ants (Figure 22) [9,10].



Source: https://link.springer.com/chapter/10.1007/978-3-030-53510-0_15

Figure 22 The history and current state of taxonomic knowledge of this group of insects, since the pioneering works of Latreille, de Saussure, and Ducke, through Zikán and Richards, until the phylogeny-based classifications of Carpenter and other authors. In the last two decades, phylogenetic investigation in the Vespidae received the important input of DNA sequences, and analyses made with these new data matrices have produced phylogenetic hypotheses differing in several respects from those based on morphology and behavior alone

Objective

The purpose of this paper is to describe the Family Scoliidae as parasitoids of (Insecta: Hymenoptera) beetles (Insecta: Coleoptera).

2. Methods

The method used to prepare this mini-review was Marchiori 2021 methodology [11].

3. Studies conducted and selected

3.1. Study 1

Insecta Class.
Hymenoptera order.
Family Scoliidae.
Genus *Megascolia.*
Specie *Megascolia maculata* (Drury, 1773).
Common name: Mammoth wasp, giant hornet (Figure 23) [12,13].

Source: https://inpn.mnhn.fr/espece/cd_nom/231728/tab/fiche?lg=en

Figure 23 *Megascolia maculata* (Drury, 1773) back and front view and sexual dimorphism

It is one of the largest wasps in Europe (20 to 40 mm). The body is black and pubescent with two pairs of hairless yellow spots on the abdomen. It has spiny legs. Sexual dimorphism is evident: males have a black head and long antennae; females have a yellow head, and short antennae and are larger than males. Females also have large jaws designed to manipulate victims. These wasps are solitary and larval parasitoids of Scarabaeidae beetles, of the subfamily Dynastinae, with *Oryctes nasicornis* (Linnaeus 1758) (Coleoptera: Scarabaeidae) being the main host species (Figure 24) [14,15].

Source: https://www.pinterest.co.uk/pin/822540319415720789/?amp_client_id=CLIENT_ID(_)&mweb_unauth_id=&simplified=true

Figure 24 Male and female of male and male of *Megascolia maculata* (Drury, 1773) (frontal, lateral and dorsal views)

The female digs the nest in the ground, to which she transports a host larva, paralyzing it with a stinger sting. Then lay an egg on top of it. The wasp larva initially consumes the host from the outside, but then penetrates inside. Upon completion of larval development, it comes out and weaves a cocoon outside, in which it undergoes nymphal and imaginal metamorphoses, and spends the winter. The adult leaves the following spring. Adults feed on pollen and nectar without floral preference (Figures 25, 26, 27 and 28A) [14,15].

Source: https://www.museubiodiversidade.uevora.pt/elenco-de-especies/biodiversidade-actual/animais/artropodes/insectos/megascolia-maculata/

Figure 25 Larval parasitoids of Scarabaeidae beetles

Source: https://commons.wikimedia.org

Figure 26 A fertilized female *Megascolia maculata* (Fabricius, 1775) attacks a rhinoceros beetle *Oryctes nasicornis* L. 1758, larva to paralyze it and lay an egg

Source: https://entnemdept.ufl.edu/creatures/misc/wasps/scoliid_wasps.htm

Figure 27 Adults feed on pollen and nectar without floral preference

Source: https://www.museubiodiversidade.uevora.pt/elenco-de-especies/biodiversidade-actual/animais/artropodes/insectos/oryctes-nasicornis/

Figure 28A *Oryctes nasicornis* (Linnaeus, 1833) (Coleoptera: Scarabaeidae: Dynastinae). It presents sexual dimorphism: the male displays a curved horn, which serves him in the fight for access to the female. Adults do not eat. The larvae are melolontiformes and feed on dead wood. The pre-imaginal period lasts about 2 years. Adults emerge between March and May and live until October. They are nocturnal and reluctant to undertake the flight given the energy expenditure that this entails

3.2. Study 2

Scoliidae

Campsomeris is a neotropical genus of wasps in the family Scoliidae. They parasitize beetle larvae, especially those of the family Scarabaeidae (Figure 28B) [17].

Of this family, only the genus *Campsomeris* was found, with three species: *Campsomeris* sp. 1 and *Campsomeris argentea* Haliday, 1837 in Santa Catarina and *Campsomeris quadrimaculata* (Fabricius, 1775) in two states [17].

Source: https://www.discoverlife.org/mp/20q?search=Campsomeris+quadrimaculata

Figure 28B *Campsomeris quadrimaculata* (Fabricius, 1775) (Scoliidae)

To the family, Scoliidae is frequently composted by large Vespas with yellowish and yellowish tones, white or one of these cores in combination with or black. Their larvae are parasitized by the larvae of resources that they inhabit alone. Ha, you adults know we feed on flowers being able to contribute to the pollination of macieira [17].

Some species: 34some species:
Campsomeris atrata (Fabricius, 1775).
Campsomeris bistrimacula (Lepeletier, 1845).
Campsomeris dohrni (Mantero, 1903).
Campsomeris peregrina (Lepeletier, 1845).
Campsomeris vitripennis (Smith, 1855).
Campsomeris whitely Kirby, 1889.

Source: https://es.wikipedia.org/wiki/Campsomeris

Figure 29 *Campsomeris atrata* (Fabricius, 1775) (Scoliidae)

Source: https://alchetron.com/Scoliidae

Figure 30 *Campsomeris ephippium* (Say, 1837)

Source: https://br.pinterest.com/pin/207165651579095758/

Figure 31 *Campsomeris servillei* (Guén-Méneville, 1838) (Scoliidae)

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

Figure 32 *Campsomeris trifasciata* (Fabricius 1793) (Scoliidae)

3.3. Study 3

3.3.1. Biology

Scoliidae waxes are solitary parasitoids from scarab beetle larvae. Female soldiers throw themselves into the ground in search of these larvae and then paralyze them with a string. Before laying the egg, they sometimes dig up the chamber and move the paralyzed beetle larva into it. Scoliidae wasps act as important biocontrol agents because many of the beetles they parasitize are pests, including the Japanese beetle. Male School Kids guard the territory, ready to mate with women emerging from the ground. Adult wasps can be fewer pollinators of some plants and can find it on many flowers in late summer (Figures 33, 34A, and 34B) [18].

Source: https://www.canr.msu.edu/resources/japanese_beetle_tips_for_your_lawn

Figure 33 Japanese beetle life stages. L-R: Egg, 1st instar, 2nd instar, 3rd instar, pupae, adult. Photo by Dave Shetlar, OSU

Source: https://www.canr.msu.edu/resources/japanese_beetle_tips_for_your_lawn

Figure 34A Japanese beetle grubs are actively feeding on grassroots from April to the end of May and from August to November. The larvae prune off the roots, causing the turf to have difficulty maintaining water uptake. Damage becomes evident during droughty periods and is typically observed in the fall if larval numbers are high

Scoliidae also has at least one species that is known to deal with pseudo-populations of orchids. The flowers of the *Bipinnula penicillata* (Rchb.) Cisternas & Salazar (Orchidaceae} orchids in subtropical South America resemble women from *Pygodasis bistrimaculata* (Lepeletier, 1845), cheating on male wasps to try to mate and ensure pollination in the process (Figure 34B) [18].

Source: https://www.wikiwand.com/en/Scoliidae

Figure 34B *Pygodasis bistrimaculata* (Lepeletier, 1845) (Hymenoptera: Scoliidae)

Some scoliids include [which?] The largest wasps in the world, only with similarly sized tarantula wasps competing with them in size [18,19].

4. Conclusion

Scoliidae waxes are solitary parasitoids from scarab beetle larvae. Female soldiers throw themselves into the ground in search of these larvae and then paralyze them with a string. Before laying the egg, they sometimes dig up the chamber and move the paralyzed beetle larva into it. Scoliidae wasps act as important biocontrol agents because many of the beetles they parasitize are pests, including the Japanese beetle. Male Scolidae guard the territory, ready to mate with women emerging from the ground. Adult wasps can be fewer pollinators of some plants and can find it on many flowers in late summer.

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