**Biological and morphological aspects of *Plectris aliena* (Coleoptera: Melolonthidae) in sugarcane in Brazil**

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**Abstract.** *Plectris aliena* (Coleoptera, Melolonthidae) Chapin is a species already recorded causing serious damage to various cultures in North America and Australia. Although its occurrence has recently been reported in Brazil, information about its distribution, taxonomy, and biology is limited. Thus, this study aims to report this new occurrence of *P. aliena* in Deodápolis (Mato Grosso do Sul, Brazil), as well as to present biocological and morphological aspects of this species. In this way, the seasonal distribution and the life cycle was studied in the years 2017 and 2018. The larvae were sampled through trenches made in the soil and reared in the laboratory. Adults were captured using “Luiz de Queiroz” light traps. Adults have body with dense white hairs, antennae with 10 antenomeres; they measure approximately 12 mm in length, and their antennal lamellae are larger for males than females. The larvae reach 30 mm in length in the third stage and pupae show about 19 mm in length. The life cycle of this species is univoltine. Due to the great diversity of *Plectris* and the scarce information available about this species in South America, this study will facilitate its identification in the field and indicate the best time for monitoring in sugarcane crop.

**Keywords.** Macrodactylini; Seasonal distribution; Taxonomy; Biology.

**INTRODUCTION**

Brazil is the world’s largest producer of sugarcane, which has significant importance for the national economy, in production of alcohol and sugar (CONAB, 2020; Lucchesi, 1995). Ethanol production grew 24.5% in state of Mato Grosso do Sul in the 2018/2019 harvest, becoming the third largest Brazilian producer (CONAB, 2020). However, many factors reduce the productivity of this crop, with emphasis on the damage caused by soil pests (Arrigoni, 1999; Gallo et al., 2002).

Adult Melolonthidae beetles (sensu Endrödi, 1966 modified by Cherman & Morón, 2014) usually feed on plant tissues, secretions, and plant remains, or they do not feed. However, their larvae known as white grubs (“coró” in Portuguese) can be saprophagous, rhizophagous, or xylophagous (Morón, 1997, 2004). Some species are considered beneficial due to their ability to transport and process organic matter in the soil profile, opening galleries, thus contributing to nutrient cycling and water flow (Gassen, 1999; Morón, 2004; Cherman et al., 2013). Although 1,008 species of Melolonthidae are registered in Brazil, less than 1% of these cause damage to crops (Morón, 2004). Potentially harmful species belong mainly to Cyclocephalini (Dynastinae), Geniatini (Rutelinae), Melolonthini, and Macrodactylini (Melolonthinae) tribes, whose larvae feed on plant roots (Morón, 2004; Ávila & Santos, 2009; Santos & Ávila, 2009). White grubs can attack newly planted sugarcane culms, basal internodes, and the root system (Pinto et al., 2009).

In the state of Mato Grosso do Sul, the main species of white grubs that occur in the no-tillage system are *Liogenys suturalis* Blanchard, *Phyllophaga cuyabana* Moser, and *Paranomala testaceipennis* Blanchard, which also cause damage to annual crops such as corn, soybeans, wheat and oats (Ávila & Santos, 2009). *Plectris* LePeletier and Audinet-Serville species have been reported to cause damage to soybean and maize...
(Oliveira & Hoffmann-Campo, 2001). Oliveira et al. (2004) and Oliveira & Farias (2007) cited *P. pexa* Germar as a soil pest of soybean in northern Paraná state, Brazil. Morón & Salvadori (2006) reported larvae of *P. (= Demodema) brevitarsis* (Blanchard) feeding on soybean roots, in the southern region of Brazil, while Valmorbida et al. (2018) found larvae of *P. griseovestita* Moser in natural pastures and cultivated areas in the Brazilian Pampa. In addition, Coutinho et al. (2020) recorded *P. aliena* Chapin for the first time in South America, with this species having the potential to cause damage to sugarcane fields in the Midwest region of Brazil, in the municipality of Nova Andradina. *Plectris aliena* was found for the first time in lawns of Charleston, South Carolina, USA (Chapin, 1934a). Chapin (1934b) suggested that *P. aliena* is native to the northern region of South America because of the distribution of *Plectris* and other similar genera in this region. In North Carolina, producers estimated that *P. aliena* has already caused losses of more than US$ 16 million, only for industry, because larvae of this species can consume up to 100% of the sweet potato (*Ipomoea batatas* L.) roots (Brill & Abney, 2013). Brill et al. (2013) registered larvae of *P. aliena* associated with soybean (*Glycine max* L.), maize (*Zea mays* L.), cotton (*Gossypium hirsutum* L.), peanuts (*Arachis hypogaea* L.), and tobacco (*Nicotiana tabacum* L.) also in North Carolina, USA. Roberts (1968) reported larvae of this same species damaging pasture, while Samson et al. (2013) listed *P. aliena* as a pest harmful to sugarcane (*Saccharum officinarum* L.) (Poales: Poaceae), both in New South Wales, Australia.

Recently, high densities of white grubs were observed in sugarcane fields in the municipality of Deodápolis, Mato Grosso do Sul, Brazil. Due to the trend towards increased production of sugar and ethanol in the Midwest region of Brazil, *P. aliena* represents a threat to most states that produce sugarcane in the region, as mentioned by Coutinho et al. (2020).

Thus, this study aims to report the new occurrence of *P. aliena* in Deodápolis (Mato Grosso do Sul, Brazil), as well as to present biocological and morphological aspects of this species.

**MATERIAL AND METHODS**

**Collection location**

This study was conducted in areas of sugarcane crop in the state of Mato Grosso do Sul, municipality of Deodápolis (21°52′S and 54°01′W; 341 m alt.), Brazil. Sampling was carried out in three areas with 12, 25, and 29 ha, respectively, approximately 500 m apart, in soil characterized as Latossolo Vermelho (IBGE, 2019). The climate of this region corresponds to Aw, according to the Köppen classification, as hot-humid tropical environment, with rainy summer and dry winter (Alvares et al., 2013). The average annual temperature of Deodápolis is 23.1°C, with an average rainfall of 1,563 mm (IBGE, 2019).

**Seasonal distribution of *Plectris aliena* in sugarcane**

From May 2017 to April 2018, soil sampling was performed and light traps were used to obtain *P. aliena* immatures and adults, respectively. The larvae and pupae of *P. aliena* were collected through trenches made in the soil, with 100 cm length, 100 cm width, and × 30 cm depth (× ×), carried out at 15-day intervals. On each sampling date, 10 trenches were opened between the sugarcane plants, aiming to quantify the number of larvae and pupae. The larvae collected in the field were kept in 500 ml plastic containers with soil and sugarcane seedlings, which were replaced weekly. The larvae were maintained in these containers until the adult emergence. Light traps model “Luiz de Queiróz”, equipped with a 20-watt fluorescent lamp, were used from 6 pm to 6 am, to collect *P. aliena* adults. A light trap was used for each collection event being performed 24 samplings over a year. Adults were identified using the entomological key for *Plectris* species (Frey, 1967), and confirmed by comparison with the primary type housed at the entomological collection of the United States Smithsonian National Museum of Natural history, Washington D.C., United States (USNM, ex-curator Manager Floyd Skokley). Larvae were identified using the key to Melolonthidae larvae of Cherman et al. (2013) and compared with the description of Böving (1936). Voucher specimens were deposited in the Coleção Entomológica Pe. J.S. Moure, Curitiba, Brazil (DZUP, Lúcia M. de Almeida). A digital caliper (accuracy of 0.05 mm) was used to monitor larval growth and differentiation of the instars. The number of instars was determined using the Dyar rule (Parra & Haddad, 1989).

**Morphological study of *Plectris aliena* and Statistical analysis**

Examination of immature and adult stages of *P. aliena*, was performed using ZEISS® STEM SV6 microscope and ZEISS® optical microscope. The drawings were made using a coupled clear camera and a millimeter objective. Measurements of morphological characters (body length, body width, antennal club, metathoracic claws, and metatarsomers) between the sexes were subjected to the analysis of variance. When significant effect of treatment was found, the means were compared by Student’s T test for independent samples. The analyses were performed using the statistical program SAS (Statistical Analysis System, Version 9.1), and the normality of the data assessed by the Cochran test.

**RESULTS**

The presence of *P. aliena* was recorded in all samples of immatures and adults examined in the study, together with a few larvae of the following genera: *Leucothyreus* Macleay, *Cyclocephala* Dejean and *Phyllophaga* Harris. In total, 240 trenches were opened in the soil during the sampling period, being found immatures of *P. aliena*: 950
larvae (50 belonging to first instar, 190 to second instar, and 710 third instar larvae) and three pupae. In the light traps a total of 102 adult males and a single female were collected in the months of August (n = 10), September (n = 40), and October (n = 52) of 2017.

Adults were observed in the field from July to October 2017 (Fig. 1), while from September to January the first instar larvae were found in the soil profile. The second and third instar larvae began to appear in November and December 2017, respectively. The second instar larvae remained in soil until mid-June and the third instar until July of the following year, while pupae were found in the soil from June to September 2017 (Fig. 1).

The highest larval densities of *P. aliena* were observed in February (10 larvae/m²), March (5 larvae/m²) and April (16.5 larvae/m²) in 2018. Whereas between May and November 2017, larval densities were relatively low, or even null (Fig. 2).

*Plectris aliena* was identified by the following diagnostic features. Adults (N = 21) with body length: 8-12 mm; width: 4-6 mm; elongated body, uniform opaque light reddish brown color, sometimes lighter in color than pronotum. Dense and short white hairs cover the head, pronotum, and elytra, abundant on the head, more dispersed in the elytra (Fig. 3A-C). The clypeus has rounded margin, antenna with 10 antennomeres, the three distal form the club of lamellae. The average length of lamellae is $1.43 \pm 0.01$ mm (1.24-1.72 mm) in males, whereas in females are 1.0 mm. The protibiae are tridentate, with basal tooth more prominent in females; metatibiae with two spurs, apparently smaller in males (Figs. 3D, E). The tarsal claws of the anterior legs are $0.69 \pm 0.01$ mm long and are significantly smaller ($p < 0.05$) than the meso ($1.09 \pm 0.01$ mm) and metathoracic claws ($1.09 \pm 0.01$ mm); metatarsomere I is 2½-3 longer than metatarsomere Il. The aedeagus has dense, long setae on apical outer margin of the paramere.

The larvae (Fig. 4A) has cream-colored body, with yellowish orange head and legs. The third instar (N = 30) (length average 29.85 ± 1.30 mm (20-34 mm min. and max. length, respectively)) exhibit trapezoidal epipharynx; narrow and elongated jaws (Fig. 4B), labrum with two transverse carinae (Fig. 4B). Their raster has palidia, formed by two divergent rows of double pali, which are widely divergent in the posterior part (Fig. 4C).

Pupae (N = 3) with 19 ± 0.88 mm length and 9 ± 0.57 mm width; elongated and oval body shape; dark yellowish orange in color; antenna, labrum and discernible palps; and very visible compound eyes.
DISCUSSION

The occurrence of *P. aliena* in the field and the seasonal distribution of immature and adult stages in the sugarcane field evidences that the insect has a univoltine cycle. The population dynamics of *P. aliena* found in this study synchronizes its biological phases with the rainfall in the region, with a predominance of adult flights in August to October, similar to what was recorded by Coutinho et al. [2020] in the municipality of Nova Andradina, Mato Grosso do Sul state (Brazil). Oliveira & Frizzas (2017) studied the bioecological characteristics of *Phyllophaga capillata* (Blanchard) (Melolonthidae: Melolonthinae: Melolonthini), an important soil pest of the soybean crops in Central Brazil, and also verified that this species synchronizes third instar larvae and active adults with the rainy season (October-March) in that region. The same happens with *P. cuyabana*, also a soybean pest in Midwestern Brazil. Oliveira (2008) found that the beginning of the adult flights of this species occur from September to November, with peak activity in October, usually after a rain. With regard on the dynamics of *P. aliena* immatures in the field (Fig. 2), the period in which second and third instar larvae (November until July of the following year), were found in the soil profile is similar to that recorded by Coutinho et al. [2020].

The low or null population density of larvae recorded from August to October (Figs. 1, 2) matches with the appearance of pupae and adults in the soil and light traps. Coutinho et al. [2020] found that *P. aliena*, when reach-

![Image of Plectris aliena](image)

Figure 3. *Plectris aliena* Chapin, 1934 morphology in adults. Male habitus (A) and frontolateral view (B); female habitus (C), metatibial apex in male (D) and female (E); and male genitalia: dorsal (F) and lateral (G) views; data labels of the series deposited at DZUP (H). Black rows indicate pair of spurs.
ing the pre-pupa phase, build their pupal chambers for shelter and protection, and can be found up to 60 cm deep. Similar behavior and population oscillation have been observed in *P. capillata* cycle (Oliveira & Frizzas, 2017). *Plectris aliena* seems to be restricted in more sandy and humid soils (Roberts, 1968; Brill *et al.*, 2013; Brill & Abney, 2013), and there are no evidences about its occurrence in other types of soil. The sugarcane fields of Deodápolis and close to this municipality, the sandy soil (named Latossolo Vermelho Distroférico) predominates (EMBRAPA, 2013). Thus, the crops in these areas could be eventually affected by this species.

Although it was not possible to assess the damage caused by *P. aliena* in the studied areas, a considerable decrease in the growth of primary roots was observed during the opening of the trenches, which can be attributed to the larvae of this species due to their predominance in the samples.

The *P. aliena* adults collected in the Deodápolis areas suggest that at least the males of this species have positive phototropism for artificial light. Though, Coutinho *et al.* (2020) reported adults of both sexes in almost the same proportion using light traps with the same technical specifications used in this work. Our results are similar to those described by Brill & Abney (2013) in North Carolina, USA, who also found a greater number of males captured in light traps than females. Some authors suggested that it is probably related to the behavior of the males that continue flying after the first mating to look for other females for copulation (see Chapin, 1934a and

Figure 4. *Plectris aliena* Chapin, 1934 morphology in larvae. Body in lateral view (A); head in frontal view (B); raster (C). Black rows indicate the sensorial macula on distal antennomere and the carinae on labrum.
Robert, R. H. (1968). This same behavior was observed by Ferreira et al. (2016) in adults of Leucothyreus albopilosus (Melolonthidae: Rutelinae) captured in light traps in Mato Grosso do Sul, Brazil.

In this study, we verified the dimorphism of the length of the club, already pointed out by Allopp & Hutchinson (2018). They reported that the male club is 1.5 mm length, and female club is 0.8 mm length; which is similar to our results (average length of 1.43 ± 0.01 mm in males and 1.0 mm in females). Thus, the difference in the club length between P. aliena male and female is a consistent feature for sex identification. A new dimorphic character has been noted in the present study. The size of the metatibial spurs seems to be different between males and females (Figs. 3D, E), being visibly longer in males. This discovery, although preliminary, suggests that this species has more than one dimorphic characteristic. According to Frey (1967) and Brill & Abney (2013), the adults of P. aliena collected in North Carolina measure between 12-14 mm in length, which are longer than those registered in our study.

Three other species of Plectris: P. pexa (Germar), P. brevitarsis (Blanchard), and P. griseovestita (Moser) are associated with crops of economic importance in Brazil. According to Frey’s (1967) key to Plectris species, Plectris aliena differs from these in the body size (P. pexa 14-16 mm, P. griseovestita 9 mm) except P. brevitarsis (12 mm), and in the number of antennomers (P. pexa, P. brevitarsis and P. griseovestita have 8 antennomes, P. aliena has 10 antennomes). Plectris pexa is noticeably darker, and the bristles on the elytra form a defined pattern (Oliveira & Hoffmann- Campo, 2001; Oliveira et al., 2004; Oliveira & Farias 2007; Morón & Salvadori, 2006; Valmorbida et al., 2018). One of the authors of this manuscript (MACH) suggests that the identification of P. brevitarsis in southern Brazil is incorrect and needs a revision which is being carried out (Cherman, unpublished). However, what is until now known as P. brevitarsis (Morón & Salvadori, 2006) has a shiny unicolored body and elytra, dark reddish brown, thickly covered with long and abundant setae; pubescent aedeagus also in the apico-external region, but with less abundant bristles and more restricted to the distal margin of the parameres, which are longer and curved in lateral view. Plectris griseovestita is the smallest species among the four early mentioned, with elongated body, dark brown color, densely pubescent with gray hairs; and protibiae with two teeth.

CONCLUSION

A new parameter for the characterization of the secondary sexual dimorphism of P. aliena was found. The morphological data of adults and immatures presented in this study can help to perform accurate identification of this species in field conditions. Adults occurrence in light traps suggests that at least males are phototropic positive for artificial light. The seasonal distribution of P. aliena indicates that the species is univoltine, with a predominance of third instar larvae from February to April, months in which monitoring of this species, in sugarcane areas in Mato Grosso do Sul is recommended.

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AUTHORS’ CONTRIBUTION

The authors listed below participated effectively in the elaboration of the manuscript: E.S.G. and C.J.A.: Experiment setup and data collection; E.S.G., C.J.A., and M.A.C.: Tabulation, statistical analysis of data and creation of tables and figures; E.S.G. and M.A.C.: Identification of species and standardization of scientific names with their respective authors; E.S.G.: Writing the text and standardizing the rules according to the magazine; E.S.G., C.J.A., and M.A.C.: Revision of the text and addition of significant parts.

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