



General Entomology

Occurrence of Phytophagous Scarabaeidae (Coleoptera) in a pasture area at the Balsamo municipality, São Paulo, Brazil

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Abstract Pasture areas have been decreasing over the years in Brazil, largely due to the expansion of agricultural areas, mainly in the Southeast region. Natural or planted pastures are subject to attack by insects that can become pests depending on their level of infestation and among them are the Scarabaeidae beetles. The scarce information on the species of this family existing in the region of Balsamo (São Paulo) makes a study on the occurrence of these species necessary, thus generating data that can contribute to identification and information on possible existing pest species. During September 2018 to August 2019, collections of phytophagous Scarabaeidae species were done in pasture areas with a light trap. A total of 446 adults from the subfamilies Dynastinae, Melolonthinae and Rutelinae were collected. In Dynastinae the genera *Bothynus*, *Coelosis*, *Cyclocephala*, *Chalepides* and *Actinobolus* were collected, in Melolonthinae the genera *Plectris* and *Liogenys* and in Rutelinae the genera *Anomala*, *Geniates*, *Leucothyreus*, *Lobogeniates*, *Byrsopolis* and *Trizogeniates* were found. Among the species collected, some are described as pests in crops, including pastures, such as *Liogenys suturalis* Blanchard, which was the species that had the largest number of individuals during the collection period, being indicated as a species worthy of more detailed studies.

Keywords: Dynastinae; *Liogenys suturalis*; Melolonthinae; Rutelinae; Soil pests.

In Brazil, there are approximately 166 million ha covered by natural or planted pasture (ARAÚJO *et al.* 2017). These areas have been decreasing in number due to the accelerated growth of agriculture areas, urbanization and reforestation (DIAS-FILHO 2014). According to the agricultural census of 2017, the percentage of occupied natural and planted pasture areas was of 45.4%. In the state of São Paulo, out of the 16,512,145-ha available for agriculture, 29% were covered by pasture, out of which 19.4% were occupied by planted pastures. At the municipality of Balsamo, the area available for agriculture is of 12,205 ha, out of which 3,267 ha are covered by pasture (IBGE 2017).

As in any kind of plantation, pastures suffer with insect attacks which may become pests and among these there are the Scarabaeidae beetles found at soy-bean and corn plantations (PÉREZ-AGIS *et al.* 2008; OLIVEIRA *et al.* 2012), sugar cane (COUTINHO *et al.* 2011), sunflower (CAMARGO & AMABILE 2001), wheat (DA SILVA PEREIRA & SALVADORI 2011) and pasture areas (BONIVARDO *et al.* 2015; DUCHINI *et al.* 2017). The larvae are often responsible for the observed plant damage. These immatures feed on roots, affecting the water-nutrient absorption system of the plants, resulting in decreasing of the plant stand and productivity of the plantations (ÁVILA *et al.* 2014).

There are Scarabaeidae species that stand out by the wide geographic occurrence and by the damage caused to plantations (RODRIGUES *et al.* 2011). At the soy-bean culture, the damage caused by beetle larvae are known since 1980 (OLIVEIRA & GARCIA 2003). At the Rio Grande do Sul state, plantations of black oat, linen, corn and sunflower suffered damages caused by *Diloboderus abderus* Sturm, one of the main pest species (SILVA & BOSS 2002; SILVA & COSTA 2002; DAL

PRA *et al.* 2011).

Phyllophaga triticiphaga (Morón & Salvadori) have been observed causing damages to soy-bean, wheat, natural and planted pastures (DA SILVA PEREIRA & SALVADORI 2011; VALMORBIDA *et al.* 2018).

Phyllophaga cuyabana Moser, causes damage to corn and soy-bean at the states of Paraná, Rio Grande do Sul, Goiás, Mato Grosso and Mato Grosso do Sul (OLIVEIRA & GARCIA 2003; ÁVILA 2015).

Liogenys fusca (Blanchard), was observed damaging corn and soy-bean cultures at the Mato Grosso do Sul state (RODRIGUES *et al.* 2008; ÁVILA *et al.* 2014).

Cyclocephala putrida Burmeister, and *Anomala testaceipennis* Blanchard, are considered pests in pasture plantations at the San Luís province, Argentina (BONIVARDO *et al.* 2015), whilst *Cyclocephala flavipennis* Arrow, was identified as a pest in perennial pastures in the Lages region in the State of Santa Catarina (DUCHINI *et al.* 2017). At Irrigated rice plantations at the Northern and Northeastern region, larvae of *Euethleola humilis* (Burmeister), were classified as an important pest species (SANTOS & SANTIAGO 2014).

Not only larvae, but adults of phytophagous Scarabaeidae also may feed of leaves, flowers, pollen, secretions or plant remains (MAIA *et al.* 2013; CHERMAN & MORON 2014) At the Aquidauana municipality, state of Mato Grosso do Sul, NOGUEIRA *et al.* (2013) collected adults of two *Cyclocephala* species in a pasture area, namely *Cyclocephala tucumana* Brethes, and *Cyclocephala melanocephala* (Fabricius). RODRIGUES *et al.* (2019) obtained adults of *Anomala inconstans*

Burmeister, in a pasture area located at the Cassilândia municipality, state of Mato Grosso do Sul.

At the Brazilian Pampas region, VALMORBIDA *et al.* (2018) collected 25 Scarabaeidae adults in natural and planted pastures, distributed in *Cyclocephala*, *Dyscinetus*, *Diloboderus*, *Eutheola*, *Liogenys*, *Plectris* and *Leucothyreus*.

However, not all phytophagous Scarabaeidae species are considered to be pests. There are some species considered to be beneficial to the environment, such as *Bothynus medon* (Germar), *Bothynus striatellus* (Fairmaire), which builds soil galleries that facilitate water infiltrations and aid in the organic matter incorporation (SALVADORI & OLIVEIRA 2001; SILVA & SALVADORI 2004).

In the different regions of Brazil, different Scarabaeidae species are reported causing damage to cultivated plants as well as benefiting the local environment. Due to the scarce information on the entomofauna of the Balsamo municipality area, the data on the phytophagous Scarabaeidae existing in the area are limited. The data obtained in the present work is needed due to the expansions of local agriculture areas, being an important tool to predict which species might become potential pests and which can become a benefit to the local future plantations. Thus, the present work recorded the phytophagous Scarabaeidae species present in pasture areas of the Balsamo municipality.

MATERIAL AND METHODS

The experiment was conducted at the São Luis rural property (20°40'16.13" S, 49°30'51.16" W) at the municipality of Balsamo, which has 149,881 km² and is located at the Northwestern region of the state of São Paulo (Figure 1) (IBGE 2019).

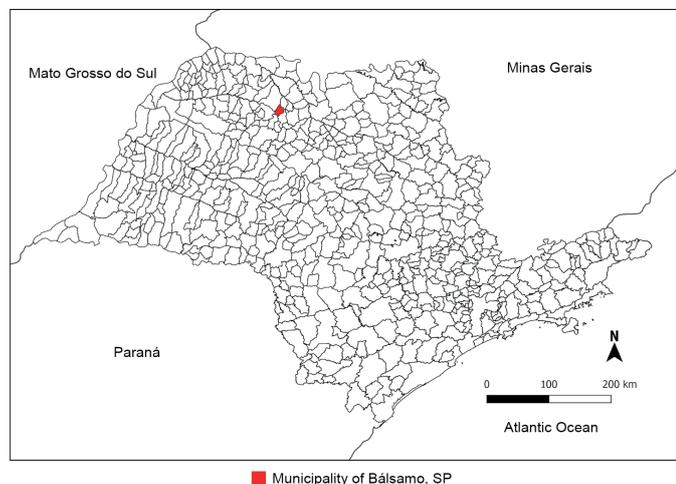


Figure 1. Map displaying Balsamo geographic location, state of São Paulo, Brazil.

The rural property has 80 ha of area, out of which 28 ha are of pasture, 39 ha of rubber tree and 11 ha of native forest, which is divided in three fragments. This Forest is found in areas of ecological tension, which is caused by the mix of two different kinds of vegetation, being classified as SN - Contact Savannah/Sazonal Forest (Figure 2) (IBGE 2019). The region has tropical climate Aw as Köppen's classification, with a rainy summer and dry winter, with mean temperature of 18° C in cooler days and 27° C in the warmer ones (ROLIM *et al.* 2007). The mean temperature throughout the 51 collect weeks was of approximately 26° C, the accumulated precipitation level was of 160 mm and the relative humidity with mean of 78% (Figure 3). All meteorologic data were obtained at the "Instituto Nacional de Meteorologia" (INMET 2019).

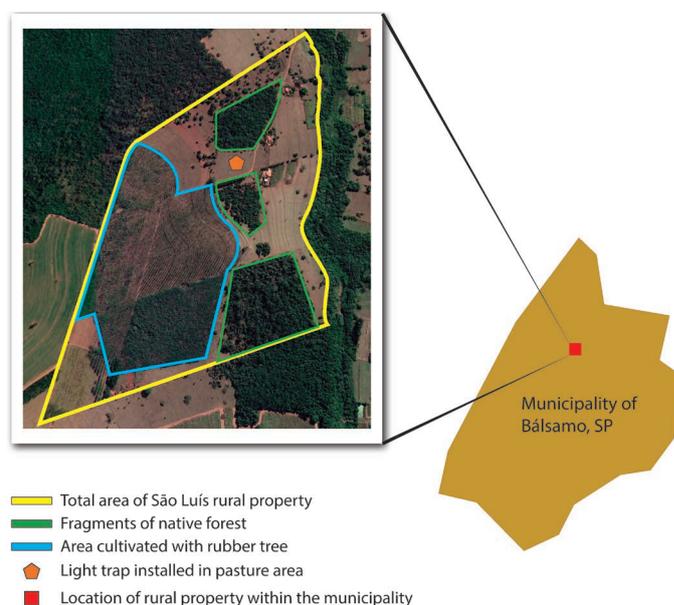


Figure 2. Research area located in the municipality of Balsamo (SP) and place where the light trap is installed in a pasture area.

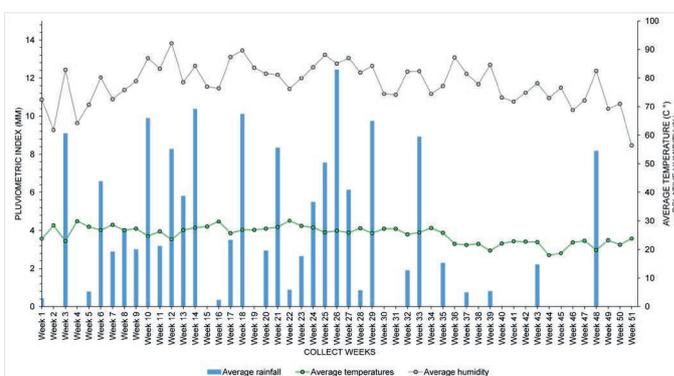


Figure 3. Meteorologic data of the Balsamo Municipality (São Paulo), from September 7th 2018 to August 30rd 2019, obtained through the conventional meteorologic station of the "Instituto Nacional de Meteorologia" located at the municipality of Votuporanga, São Paulo.

At the pasture area cultivated with palisade grass, *Urochloa brizantha* cv., a light-trap of the "Luiz de Queiroz" type, made with steel foundation and collector cup made of PVC, with a 15 watts 6500k fluorescent white lamp was installed and turned on (SILVEIRA NETO & SILVEIRA 1969). The collections were made once a week, every Friday, from 18:00 p.m. to 6:00 a.m. of the following day, from September 7th 2018 until August 30rd 2019, totaling 51 weeks.

After being collected, the Scarabaeidae adults were stored in 300 mL plastic vials in 70% glycerin alcohol, until brought to the laboratory of entomology of the "Universidade Estadual do Mato Grosso do Sul" (UEMS), campus of Cassilândia, where they were pinned, labeled sent and donate to the Dr. Juarez Fuhrmann (Zoology Museum of "Universidade de São Paulo") and Dr. Paschoal Coelho Grossi ("Universidade Federal do Pernambuco") for identification.

RESULTS AND DISCUSSION

A total of 446 Scarabaeidae adults were collected, belonging to 19 species distributed into the Dynastinae, Melolonthinae e Rutelinae (Table 1). Out of the total, 12 species might become potential pests in plantations, such as species of the *Cyclocephala*, *Liogenys*, *Anomala*, *Leucothyreus*, *Geniates*, *Plectris*, *Chalepides* and *Lobogeniates*. Benefic species of the *Bothynus* and *Coelosis* were collected as well. A percentage of 99,5% of the adults were collected during September

2018 until March 2019, coinciding with the rainy season of the Bálamo region. During May 2019 to August of the same year, the occurrence of scarabaeidae dropped significantly, fact that may be connected to the dry season, which ranges from May to August (Figure 3).

In areas of natural pasture at the Brazilian Pampas, 28 species of Scarabaeidae were collected, distributed into the Dynastinae, Melolonthidae and Rutelinae (VALMORBIDA *et al.* 2018). DUCHINI *et al.* (2017) identified four species of phytophagous Scarabaeidae in winter pastures of the Lages municipality, state of Santa Catarina. CHERMAN *et al.* (2014) observed the presence of five species in the Dynastinae, Melolonthinae and Rutelinae in pasture areas of the state of Rio Grande do Sul.

Bellow are listed the collected species and their respective subfamilies.

Dynastinae

There are approximately 800 species recorded for this subfamily (MORON *et al.* 2004).

Bothynus

A total of 18 adults of *B. medon* were collected during September until October, representing 4% of all insects collected. PEREIRA *et al.* (2013b) at the municipality of Aquidauana in the state of Mato Grosso do Sul, collected adults of *B. medon* during procreation-flight season, as the females captured had eggs ready to be laid and females ovipositing were observed in field. *B. striatellus* had a total of

28 collected adults, representing 6,2% of all insects (Table 1).

Adults of *B. medon* e *B. striatellus* were collected by RIEHS (2006) in different areas of the Paraná state, with *B. medon* being the most collected. RIEHS (*op. cit.*) reported that *B. medon* occurred from December to February, differing from the present study (Table 1). *B. striatellus* was also collected during December-February, differing from the present study, which collected the species at September, October and December (Table 1).

There are 28 species of *Bothynus* recorded for the world (DUARTE & GROSSI 2016). Adults of this genus are considered benefic to plantations, as they open galleries in the soil and facilitated water infiltrations, besides incorporating organic matter to the soil (OLIVEIRA *et al.* 2012).

Coelosis

A total of 47 adults of *Coelosis* were captured. They were identified as *Coelosis bicornis* (Leske) and *C. biloba*. *Coelosis bicornis* represented 10,5% of all insects (Table 1). *Coelosis* is compounded by seven species, all from South America with exception of *Coelosis biloba* (Linnaeus), which occur from Argentina México (ENDRÓDI 1985). Little is known about this genus, although there are records of *C. bicornis* found in degraded and flooded areas (GASCA *et al.* 2008).

An adult of *C. biloba* was collected in March (Table 1). This species usually builds its nest in ant nests, where its larvae feed from the fungi cultivated by the ants. Cannibalism of *C. biloba* adults on up to third instar larvae is also recorded (GASCA *et al.* 2008).

Table 1. Phytophagous Scarabaeidae species collected during September 7th 2018 to August 30rd 2019 with a light trap at the Bálamo municipality.

Species	Sep	Oct	Nov	Dec	Jan	Fev	Mar	Apr	Mai	Jun	Jul	Aug	Total
Dynastinae													
<i>Bothynus medon</i>	15	3	-	-	-	-	-	-	-	-	-	-	18
<i>Bothynus striatellus</i>	6	19	-	3	-	-	-	-	-	-	-	-	28
<i>Coelosis bicornis</i>	3	6	26	6	2	1	-	1	1	-	-	-	46
<i>Coelosis biloba</i>	-	-	-	-	-	-	1	-	-	-	-	-	1
<i>Cyclocephala forsteri</i>	-	-	2	-	-	-	-	-	-	-	-	-	2
<i>Cyclocephala melanocephala</i>	-	9	24	-	2	3	3	-	-	-	-	-	41
<i>Cyclocephala putrida</i>	-	-	-	-	1	2	-	-	-	-	-	-	3
<i>Cyclocephala</i> sp.	18	2	-	-	-	-	-	-	-	-	-	-	20
<i>Cyclocephala mecynotarsis</i>	-	1	-	-	-	-	-	-	-	-	-	-	1
<i>Chalepides fuliginosus</i>	-	-	-	-	-	-	1	-	-	-	-	-	1
<i>Actinobolus trilobus</i>	-	4	-	-	-	-	-	-	-	-	-	-	4
Subtotal													165
Melolonthinae													
<i>Plectris</i> sp	-	-	-	-	-	-	1	-	-	-	-	-	1
<i>Liogenys suturalis</i>	39	71	8	-	-	-	-	-	-	-	-	-	118
Subtotal													119
Rutelinae													
<i>Anomala testaceipennis</i>	-	-	-	-	-	-	1	-	-	-	-	-	1
<i>Geniates borelli</i>	-	5	4	-	-	-	-	-	-	-	-	-	9
<i>Leucothyreus alvarengai</i>	-	13	16	3	-	2	5	-	-	-	-	-	39
<i>Lobogeniates</i> sp	-	-	-	-	-	-	1	-	-	-	-	-	1
<i>Byrsopolis quadraticeps</i>	-	1	32	9	-	-	-	-	-	-	-	-	42
<i>Trizogeniates planipennis</i>	14	51	5	-	-	-	-	-	-	-	-	-	70
Subtotal													162
Total													446

Cyclocephala

Adults of *Cyclocephala* have Neotropical distribution of its 300 species (RATCLIFFE & CAVE 2002; OLIVEIRA & ALMEIDA NETO 2018). In Brazil, 82 of these species were recorded (MORÓN 2004).

A higher number of species were collected for this genus, with a total of five (Table 1). At the Brazilian Pampas, in areas of natural and cultivated pasture, solely *Cyclocephala modesta* Burmeister was collected (VALMORBIDA *et al.* 2018).

A total of 67 *Cyclocephala* were collected from September to March. Among the collected species, two adults of *Cyclocephala forsteri* Endrodi, were identified, both collected during November (Table 1). Adults of *C. forsteri* were observed feeding on flowers of the palm tree *Acronomia aculeata*, causing the falling of the floral buds (OLIVEIRA & ÁVILA 2011) and causing damage to soy-bean plantations (SANTOS & ÁVILA 2007).

A total of 41 *C. melanocephala* specimens were collected, representing 9% of all insects (Table 1). At the rubber tree plantation, it was observed an adult swarming of *C. melanocephala*, an atypical behavior as its adults usually feed on flowers and may contribute to their pollination (TAIRA *et al.* 2014; RODRIGUES *et al.* 2018). This fact may explain the relatively high number of specimens of this species, as the studied area has part of it covered by the rubber tree *Hevea brasiliensis*.

Three *C. putrida* were identified, all collected during January and February (Table 1), corroborating the results of SALDANHA *et al.* (2020), whom collected the same species with the same light trap model of the present study during the same months, what may indicate that this species has its flight season during this period. As in the present study, SALDANHA *et al.* (*op. cit.*) also collected during warmer temperatures (23° to 28°) at Cassilândia (vs. 27° at Bálamo) (Figure 2). *C. putrida* was also collected in a cultivated pasture area and in a natural vegetation area at the Rio Grande do Sul State (CHERMAN *et al.* 2014).

An adult of *Cyclocephala mecyanotarsis* Hohné, was collected during October. This species was also collected in the Amazonia, at the municipality of Itacoatiara, State of Amazonas (ANDREAZZE & FONSECA 1998). In Brazil, *C. mecyanotarsis* was described as a peach, pear and nectarine pest (BEVILAQUA *et al.* 2012).

Chalepides

A single specimen of *Chalepides fuliginosus* (Burmeister) was collected during March (Table 1). There are few studies about this genus, although *Chalepides dytiscoides* Arrow is considered to be a species with agricultural value at the regions of the dry and humid Caribbean at Colombia (PARDO-LOCARNO *et al.* 2012). *C. fuliginosus* was also collected with light trap at Campos Gerais, state of Paraná (GROSSI *et al.* 2012).

Actinobolus

During October, four adults of *Actinobolus trilobus* Lüderwaldt were collected (Table 1). Larvae of this species were observed living in termite nests of the *Nasutitermes* (LUEDERWALDT 1911). Furthermore, its larvae feed on the termite nest wall (NEITA-MORENO & RATCLIFFE 2011).

Melolonthinae

In this subfamily, there are the species which cause the most damage to plantations. Adults feed on flower and leaves, whilst the larvae feed on roots and stalks of grass, corn, pasture and wheat (RITCHER 1966). There are approximately 19, recorded species (MORÓN *et al.* 2014).

Liogenys

A total of 118 adults of *Liogenys suturalis* Blanchard were collected, representing 26,4% of all insects (Table 1). Ferreira *et al.* (2018) obtained higher numbers of this species during their collections at Aquidauana, with similar climatic conditions, at the rainy season from September to April, with similar temperatures (33° at Aquidauana and 29° at Bálamo). This may be an indicative that this species has preference for warmer temperatures.

Several species of this genus are considered to be pests in different plantations. *Liogenys suturalis* is considered to be a pest of corn, wheat and oath at the Center-West region of Brazil (SANTOS & ÁVILA 2009).

Plectris

An adult of *Plectris* were collected in March (Table 1). According to VILLEGAS *et al.* (2008), in pasture areas at Risaralda, Colombia, the period of higher abundance of species of this genus are during April and May, differing from what happened in the present study. CHERMAN *et al.* (2014) also found a morphotype of *Plectris*, but at larval stage, at the planaltina region of the Rio Grande do Sul, in plantation areas. Although 232 species of this genus are recorded to Brazil (EVANS & SMITH 2009), this genus was not expressive during collection period.

Rutelinae

This is the second largest subfamily of Melolonthidae, with 4,197 described species (MORÓN & RAMÍREZ-PONCE 2012).

Anomala

An specimen of *A. testaceipennis* was collected during March (Table 1). RODRIGUES *et al.* (2014) reported mating behavior of this species during February at Aquidauana. Both collections of the present work and at RODRIGUES *et al.* (2014) happened during rainy season. Although it had only a single specimen, *A. testaceipennis* may cause damages to several plantations, among them there are corn and pasture (ÁVILA & SANTOS 2009; RODRIGUES *et al.* 2011). This species had its mating behavior observed and it was concluded that it starts flying at six p.m. and finish the activities around six a.m. (RODRIGUES *et al.* 2014), coinciding with the time period in which the light trap was on.

Leucothyreus

A total of 39 adults of *Leucothyreus alvarengai* Frey, representing 8.7% of all insects (Table 1), were collected.

Some *Leucothyreus* species are considered pests, as described by MARTINEZ *et al.* (2013), which reported *Leucothyreus femoratus* Burmeister, attacking palm tree plantations.

According to PEREIRA *et al.* (2013a), adults of *L. alvarengai* have their flight season from September to January, partially coinciding with the collection period of the present study, as adults were collected mainly in October, despite the species kept being collected until March in lower numbers (Table 1). The collection of this species might be related to the presence of near sugar cane plantations, as COUTINHO (2015) reported the presence of *L. alvarengai* in sugar cane plantations at the region of Nova Andradina and Naviraí at Mato Grosso do Sul. However, the present recorded the presence of this species during October and November, instead of December as in COUTINHO (2015). *L. alvarengai* was also collected by DANTAS *et al.* (2018) in forest regions of Sergipe.

Geniates

A total of nine adults of *Geniates borelli* Camerano, were collected and represented 2% of all insects (Table 1).

As observed, adults were recorded during October and November, similarly to the results of RODRIGUES *et al.* (2012), at Aquidauana, MS, in which 1,918 of *G. borelli* were captured with a light trap from September to November 2006. Imatures of *G. borelli* were found in plantation succession system in which corn was cultivated during summer at February (RODRIGUES *et al.* 2011), with the presence during this time period possibility related to the flight season, which usually happens from September do December.

Lobogeniates

A specimen of *Lobogeniates* sp. was collected in March (Table 1). Adults of *Lobogeniates* are described as banana, rice and pasture pests at the Colombian Caribbean region (PARDO-LOCARNO *et al.* 2012).

Trizogeniates

A total of 70 adults of *Trizogeniates planipennis* Ohaus were collected. This species represented 15.6% of all insects (Table 1). The occurrence of *T. planipennis* was also recorded at Bahia (FERREIRA *et al.* 2018).

Byrsopolis

A total of 42 specimens of *Byrsopolis quadraticeps* Blanchard, representing 9,4% of all specimens were collected (Table 1). The high incidence of this species during collection period might be related to its wide distribution, which according to CARVALHO & GROSSI (2018) ranges the states of Goiás, Minas Gerais, São Paulo and Federal District.

The raining and dry season might influence the behavior of the Scarabaeidae, as the highest numbers resulted during the rainy season (September to April) and the lowest numbers during the dry season (From May to August).

The phytophagous Scarabaeidae species present at pasture area of the Bálamo is majoritarily compounded by species that might become pests to cultures cultivated at the region. Among the species considered with great potential of becoming a pest, *L. suturalis* was the most expressive with 118 specimens. This species is described as pest to plantations.

The presence of benefic phytophagous Scarabaeidae such as *B. medon*, *B. striatellus* and *C. bicornis* at the region is an important factor to soil nutrition and ecosystem equilibrium.

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