Diversity of Soil Beetles (Hexapoda, Coleoptera) in an Area at the Pantanal of Poconé, Mato Grosso, Brazil

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Abstract. Soil beetles (Hexapoda, Coleoptera) community, mainly Scarabaeidae, was evaluated in an area with different phytophysiognomies during the rising water period (November/2005) in the Pantanal of Poconé, Mato Grosso, Brazil. Thirty transects of 250 m, 1 km distant from each other, in an area of 5x5 km² (RAPELD) were delimitated. In each transect, which characterized a sampled area, five samples of 1 m² were collected using mini-Winkler, and five pitfall traps distributed at a distance of 50 m between one sample and another and with a distance of 1 m between the two methods. A total of 767 Coleoptera individuals belonging to 27 families and 192 species were obtained. Scarabaeidae and Staphylinidae were the most abundant families. Staphylinidae, Curculionidae and Scarabaeidae were richest in species. Scarabaeidae was represented by 236 individuals distributed in the Scarabaeinae and Aphodiinae subfamilies, 11 genera and 22 species. The multivariate analyses of variance demonstrated that the relationship between the Coleoptera community and the phytophysiognomy was significant, and the relationship between the Scarabaeidae community and the phytophysiognomy was not significant. The murundu fields, cambarazal, landi and introduced pastures were the most representative phytophysiognomies for Coleoptera richness and abundance in this region.

Keywords: Litter; Scarabaeidae; Vegetation mosaic; Wetlands.

Diversidade de Besouros de Solo (Hexapoda, Coleoptera) em uma Área no Pantanal de Poconé, Mato Grosso, Brasil

Resumo. A comunidade de besouros de solo (Hexapoda, Coleoptera), principalmente Scarabaeidae, foi avaliada em uma área com diferentes formações vegetacionais (fitofisionomias) durante o período de enchente (novembro/ 2005) no Pantanal de Poconé, Mato Grosso, Brasil. Foram delimitados 30 transectos de 250 m, distantes 1 km entre si, em uma área de 5x5 km² (RAPELD). Em cada transecto, caracterizado como uma área amostral, cinco amostras de 1 m² foram coletadas usando mini-Winkler e cinco armadilhas pitfall foram distribuídas a cada 50 m, mantendo-se uma distância de 1 m entre as duas técnicas empregadas. Foram amostrados 767 coleópteros pertencentes a 27 famílias e 192 espécies. Scarabaeidae e Staphylinidae foram as famílias mais abundantes. Staphylinidae, Curculionidae e Scarabaeidae apresentaram maior riqueza de espécies. Scarabaeidae foi representada por 236 indivíduos distribuídos entre Scarabaeinae e Aphodiinae, 11 gêneros e 22 espécies. A análise de variância multivariada evidenciou que a relação entre a comunidade de Coleoptera e as fitofisionomias foi significativa, enquanto entre Scarabaeidae e as fitofisionomias a relação não foi significativa. As áreas de campos de murundus, cambarazal, landi e pastagens introduzidas foram as fitofisionomias mais representativas para a riqueza e abundância de Coleoptera nessa região.

Palavras-Chave: Áreas úmidas; Mosaico vegetacional; Serapilheira; Scarabaeidae.

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The edaphic stratum is formed by different soil horizons, composed of live and non-live beings organized vertically in a profile of horizontal layers (Porazinska & Wall 2001), as is the litter that corresponds to the layers of organic matter on the soil that consist mainly of leaves, branches and plant remains (Brühl *et al.* 1999; Yanoviak & Kaspari 2000).

These habitats can be considered as a center of organization of the terrestrial ecosystems because they support many processes that govern their functioning (Coleman 2001). Among the live components of this biotope are microorganisms and invertebrates, especially ants, termites, annelids and beetles that play a fundamental role in the organic matter decomposition processes, influencing to different degrees the nutrient cycling, aeration and fertility of the soil (Bruyn & Conacher 1990; Lee & Foster 1991; Höfer *et al.* 2001; Lavelle 2002; Hättenschwiler & Gasser 2005).

Biological activity differentiates the soil from other geological formations (Drozdowicz 1997), accelerating the decomposition process and consequently establishing a correlation between the

fauna composition and density and speed of this process that is usually long and complex (Ribeiro *et al.* 1992). In this stratum, studies have been carried out to establish richness and abundance patterns for invertebrate communities, including the Coleoptera (Didham *et al.* 1998a, 1998b; Hanagarth & Brändle 2001; Barbosa *et al.* 2002; Marinoni & Ganho 2003).

In these environments beetles, as Scarabaeidae, act at different trophic levels, performing systemic functions such as foliage decomposition (Samways 1995), secondary seed dispersal (Stork 1987; Andersen 2002), and control populations of other invertebrates. Assemblages of coprophagous Scarabaeidae (dung beetles) are diverse throughout the tropics, and greatest diversity of these beetles is found in well-preserved environments where communities may have distinct structures, and feeding guilds (Halffter 1991), and which are sensitive to variation in soil conditions (Halffter *et al.* 1992; Almeida *et al.* 2011). Tissiani *et al.* (2015) showed that the dung beetle community in the northern region of the Brazilian Pantanal is structured as a consequence of flooding and species substitution along a gradient. Thus, species

richness and composition of any local area are not directly structured by soil texture and other environmental variables.

One of the determining factors in structuring the edaphic stratum is the plant cover. Thus the vegetation diversity and complexity is directly linked to the variety of food resources, influencing the quantity and quality of the litter available for the soil fauna, controlling the organism abundance in a determined location (Rieske & Buss 2001; Warren & Zou 2002).

The Pantanal of Mato Grosso is an extensive floodplain consisting of specific habitats, with abrupt changes in its landscape (Prance & Schaller 1982) resulting from the interaction of edaphic, hydrological and biogeographical factors and consists of mosaics of forests, savannas, natural and introduced fields in addition to monodominant vegetation stands (*e.g.* Por 1995; Silva *et al.* 2000; Battirola *et al.* 2014; Marques *et al.* 2014). Considering the complexity of vegetation formations in the Pantanal and their relations with the fauna establishment, the present study analyzed the diversity of soil beetles, mainly Scarabaeidae, in an area with different phytophysiognomies in the northern region of the Pantanal of Mato Grosso, Brazil, contributing to the knowledge of the richness of ground beetles in this region, and its relation to the heterogeneity of habitats characteristic of the Brazilian Pantanal.

MATERIAL AND METHODS

Study Area. The study was carried out in northern region of the Pantanal of Mato Grosso, specifically in the Pantanal of Poconé, in the locality of Pirizal (16°15'24"S to 17°54'32"S and 56°36'24"W to 57°56'23"W), municipality of Nossa Senhora do Livramento, Mato Grosso, Brazil. Sampling was carried out during the rising water period (November/ 2005), when was registered low rainfall in this region. In this period that follows the dry season, some areas can fly at temporarily with water from the reins, but become dry again after periods of sun. It is a period characterized by the transition between the end of the dry season and the start of the high water season (Heckman 1998).

The Pantanal of Poconé is formed by several phytophysiognomies that provide a set of varied habitats that were classified in the present study according to Veloso *et al.* (1991), Silva *et al.* (2000), Santos *et al.* (2004) and Nunes-da-Cunha & Junk (2011, 2014). Based on this classification, seven environments were presented in the sampled area, landi, vazante, murundu fields, introduced pasture, cambarazal, natural clean field and mixed field (Nunes-da-Cunha & Junk 2011).

Landi. This formation is characterized by a low and continuous canopy with its individual height varying from 3 to 7.5 m, being associated with the water courses. The arboreal stratum is dominated by *Licania parviflora* Huber (Chrysobalanaceae), *Calypthrantes eugenioides* Camb. (Myrtaceae), *Mabea* sp. (Euphorbiaceae) and *Calophyllum brasiliense* Cambess. (Clusiaceae).

Cambarazal. Dense homogeneous flooding area formation with *Vochysia divergens* Pohl. (Vochysiaceae) predominance, amazon specie with a height varying between 5-18 m, a colonizer of flooded natural fields in the Pantanal of Poconé, Mato Grosso. Its local distribution is probably due to the seeds coming from individual specimens located in nearby riparian forests.

Murundu fields. These represent about 30% of the vegetation in the Pantanal (Silva *et al.* 2000) where the murundu fields are inserted, made up of flat areas which are flooded in the rainy season and where there are countless little hills (murundu), susceptible to flooding when there is extreme flood. The flat areas and the smaller murundus are covered by rustic vegetation and the largest by woody Cerrado vegetation. Termite activities, together with the erosion processes, seem to shape them into a

rounded or elliptical form, with a maximum height of one to two meters.

Vazante. Area with periodic flow of water that distributes the water inside the aquatic to terrestrial transition zone (ATTZ). The channels are covered with herbaceous plants, and are characterized by dominance of *Reimarochloa brasiliensis* (Spreng) Hitchc. (Gramineae).

Introduced pastures. These regions are basically made up of *Brachiaria humidicola* (Rendle) Schweick (Poaceae) grass originally from Africa which adapted well in Brazil, mainly in waterlogged soils.

Natural clean fields. Characterized by the "mimoso" pasture grass *Axonopus purpusii* (Mez) Chase (Poaceae), perennial vegetation, which is resistant to temporary submersion. They are widely distributed throughout the Pantanal, they occur in Cerrado fields, the edges of bays (permanent and temporary), and mainly in areas of seasonal open fields in the sandy Pantanal areas.

Mixed fields. In these areas there are also the pasture fields which are not periodically renewed, where there is a mixture between *B. humidicola* and *A. purpusii*, known as mixed fields.

Methodology. The Coleoptera community was sampled using the mini-Winkler extractor (Bestelmeyer *et al.* 2000) and pitfall traps (Adis 2002). A total of 30 transects (250 m each one) were marked with a distance of 1 km from each other in an area of 25 km², following the RAPELD method (Rapid Assessment Protocols and Long-Term Ecological Research) (Magnusson *et al.* 2005) (Figure 1).
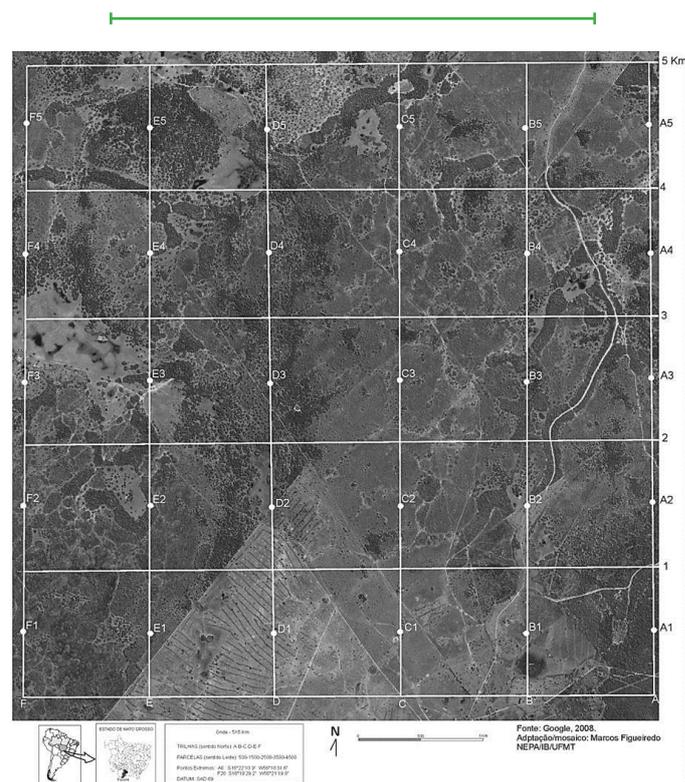

Figure 1. Sample plot of 5X5 Km, according to the RAPELD methodology (Magnusson *et al.* 2005), in the northern region of the Pantanal of Mato Grosso, Brazil. Letters (A, B, C, D, E, F) and numbers (1, 2, 3, 4, 5) represent trails in the south-north and east-west directions, respectively. Letters and numbers (*e. g.* A1, A2, A3) represent the transect location. Identification of the phytophysiognomies in each transect: "Landi" (A1, A2, B3 and D3), "vazante" (A3, D5 and F2), "murundu" field (A4, A5, B4, C3, C4, C5, E1, E2, E4, F1, F3, F4 and F5), introduced pasture (B1, B2, B5, C1 and D1), mixed field (C2 and D2), "cambarazal" (D4 and E5) and natural clean field (E3). Source: Geoprocessamento IB-UFMT.

Each transect characterized a sample point where five collections of 1 m² litter were made with the mini-Winkler extractor and then

five pitfall traps were installed. An interval of 50 m was established between each collection point to guarantee independence in the sampling. Each pitfall trap was installed for 48 hours at each sampling point and the litter samples were suspended for 72 hours in the mini-Winkler extractor in a covered environment at environmental temperature. F5 Transect could not be sampled because a sheet of water was present on the soil. The litter thickness was measured with a ruler at each sample point.

The Coleoptera were identified at the taxonomic level of family and morphospecies according to LAWRENCE *et al.* (1999), ARNETT (2000), TRIPLEHORN *et al.* (2005), and BOUCHARD *et al.* (2011). Identification was made based on the reference collection at the Laboratório de Ecologia e Taxonomia de Artrópodes (LETA) at the Instituto de Biociências, Universidade Federal de Mato Grosso, where all collected specimens were deposited. The trophic guilds were identified according to ERWIN (1983), HAMMOND *et al.* (1996) and MARINONI *et al.* (2001). Due to their dominance the Scarabaeidae were identified at specific levels and their behavior guilds (endocoprids, paracoprids and telecoprids) were determined according to WATERHOUSE (1974).

The data was analyzed by the Principal Coordinates Analysis Indirect Ranking (PCOA) with data standardized by objects (samples) to assess the existence of a pattern in the Coleoptera species distribution with a Bray-Curtis Index Association, calculated by the PATN program (BELBIN 1995). Multivariate analysis of variance (MANOVA) was applied to the Coleoptera data in general and also, specifically, to the Scarabaeidae data

to estimate whether the phytophysiognomies were predictors for the pattern extracted by the PCOA. The same was carried out for litter thickness, considering the litter quantity and volume, an indirect variable in the vegetation structure and habitat type (*e.g.* LEAL 2003). The Coleoptera community richness in this area was estimated by the Jackknife 1 calculated by the EstimateS 7.50 (COLWELL 2005), and the similarity analyzed by Bray-Curtis using the BioDiversity Pro (MCALEECE *et al.* 1997).

RESULTS

Coleoptera community. A total of 767 Coleoptera individuals were sampled distributed in 27 families and 192 species, 265 individuals (34.5%) collected with pitfall traps (11 families; 54 spp.), and 502 individuals (65.5%) with mini-Winkler extractor (25 families; 163 spp.). Scarabaeidae (30.9%; 237 individuals), and Staphylinidae (24.6%; 189 individuals) were the most abundant taxa. Many taxa occurred only in mini-Winkler samples such as Corylophidae, Silvanidae, Ptiliidae, Platypodinae (Curculionidae), and Pselaphinae (Staphylinidae), while Bolboceratinae (Geotrupidae), and Hybosoridae were collected only with pitfall traps (Table 1).

Staphylinidae (69 spp.; 35.9%, including Scydmaeninae and Pselaphinae) was the family with greatest richness, followed by Curculionidae (24 spp.; 12.5%, including Scolytinae and Platypodinae), and Scarabaeidae (22 spp.; 11.5%). The estimated total richness generated by the Jackknife 1 estimator was 314 ± 38.4 species. Thus, 61.0% of the species present in this community

Table 1. Number of individuals (N), richness (S) and trophic guilds of Coleoptera in relation to the phytophysiognomy assessed in the Pantanal of Poconé, Mato Grosso, Brazil, using mini-Winkler (mW) and pitfall traps. (P) predators, (H) herbivores, (S) saprophages, (F) fungivores, (D) decomposers (X) xylophages, ( ) = Nutritional habit considered secondary and ? - indetermined.

Taxa	Landi		Vazante		Murundu field		Introduced pasture		Natural clean field		Cambarazal		Mixed field		mW	Pitfall	Total	Richness	Trophic Guild
	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	N	N	S	
Scarabaeidae	18	5	24	10	101	16	34	11	1	1	42	8	17	4	79	158	237	22	D
Staphylinidae	30	17	13	12	55	22	33	17	1	1	52	26	5	5	173	16	189	69	P (S, F)
Scydmaeninae	(10)	(3)	(1)	(1)	(14)	(3)	(18)	(7)	-	-	(13)	(4)	(1)	(1)	(53)	(4)	(57)	(12)	P
Pselaphinae	(4)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(1)	(1)	(2)	(2)	(1)	(1)	(17)	-	(17)	(11)	(F)
Curculionidae	13	9	8	5	18	7	5	4	3	2	14	8	4	2	58	6	64	24	H (X, F)
Scolytinae	(6)	(3)	(4)	(1)	(12)	(2)	(1)	(1)	(2)	(1)	(8)	(3)	(3)	(1)	(32)	(3)	(35)	(4)	H (X, F)
Platypodinae	-	-	(1)	(1)	-	-	-	-	-	-	-	-	-	-	(1)	-	(1)	(1)	(H)
Nitidulidae	4	1	2	1	19	4	4	2	-	-	25	2	1	1	7	48	55	5	S
Tenebrionidae	34	5	-	-	2	2	5	3	-	-	9	3	-	-	49	1	50	9	S (D, F)
Corylophidae	18	3	4	3	4	3	2	2	1	1	15	2	-	-	44	-	44	6	P
Carabidae	6	3	1	1	16	6	2	2	-	1	4	3	1	1	15	18	33	5	H (X, P)
Elateridae	1	1	2	1	16	5	14	1	-	-	-	-	-	-	25	6	31	13	P
Chrysomelidae	2	2	1	1	12	6	4	3	-	-	1	1	-	-	12	8	20	10	H
Silvanidae	2	2	1	1	7	2	2	2	-	-	-	-	-	-	12	-	12	5	F
Ptiliidae	2	1	-	-	1	1	-	-	-	-	3	2	-	-	6	-	6	2	S (F)
Dytiscidae	-	-	1	1	2	2	-	-	-	-	1	1	-	-	4	-	4	3	P
Histeridae	-	-	-	-	2	2	1	1	-	-	-	-	-	-	1	2	3	2	P
Ptinidae: Anobiinae	-	-	-	-	1	1	1	1	-	-	-	-	-	-	2	-	2	2	H
Cleridae	1	1	-	-	-	-	1	1	-	-	-	-	-	-	2	-	2	2	P
Zopheridae: Colydiinae	-	-	-	-	-	-	1	1	1	1	-	-	-	-	2	-	2	1	P (F)
Hydrophilidae	-	-	1	1	1	-	-	-	-	-	-	-	-	-	2	-	2	1	D
Meloidae	-	-	1	1	-	-	1	1	-	-	-	-	-	-	2	-	2	2	H
Geotrupidae: Bolboceratinae	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	1	1	1	?
Biphyllidae	-	-	-	-	1	1	-	-	-	-	-	-	-	-	1	-	1	1	F
Byrrhidae	1	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	1	H
Eucnemidae	-	-	-	-	-	-	1	1	-	-	-	-	-	-	1	-	1	1	H
Hybosoridae	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	1	1	1	D
Limnichidae	1	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	1	?
Bostrichidae: Lyctinae	-	-	-	-	1	1	-	-	-	-	-	-	-	-	1	-	1	1	?
Phalacridae	-	-	-	-	-	-	-	-	-	-	1	1	-	-	1	-	1	1	H
Scirtidae	-	-	-	-	-	-	-	-	-	-	1	1	-	-	1	-	1	1	H
Total	133	52	59	38	260	82	112	54	7	7	168	58	28	13	502	265	767	192	

were captured during the collection events. It was observed that this community is formed by a large number of abundant species and a few dominant species. Predatory (275 ind.; 35.9%), and decomposer Coleoptera (240 ind.; 31.3%) predominated over herbivores (122 ind.; 15.9%), saprophages (111 ind.; 14.5%), and fungivorous (13 ind.; 1.8%) (Table 1).

Indirect ranking by the principal coordinates analysis (PCOA) showed that the total variation extracted on the first axis was 30% and did not show a distribution pattern for this community among the phytophysiognomies assessed (Figure 2), but multivariate regression indicated a significant effect (Pillai trace = 1.114, P = 0.042) of the phytophysiognomy on the Coleoptera community. Applying multivariate regression to the litter thickness data (6.53cm ±3.05 and 2-15 cm amplitude), no significant effect was observed of this variable on the community (Pillai Trace = 0.705, P = 0.088).
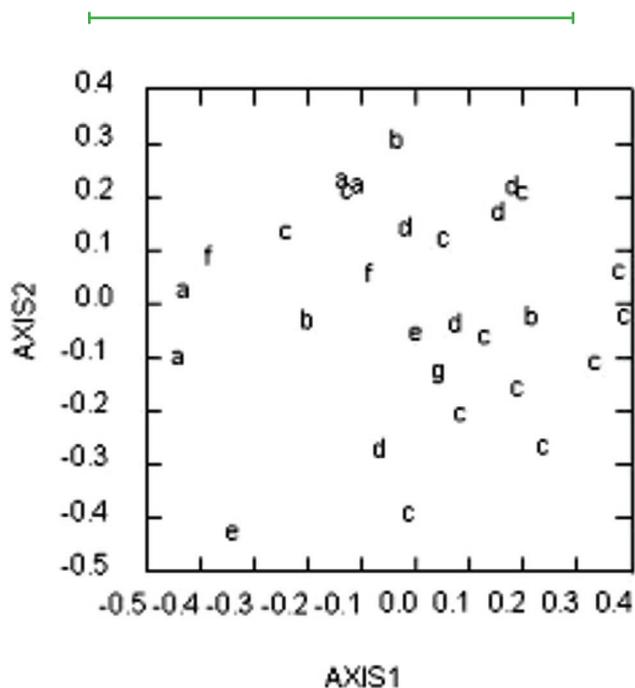
Figure 2. Main axes (axis 1 and axis 2) of the indirect ranking of the Coleoptera community sampled using the mini-Winkler extractor and pitfall trap in different phytophysiognomies in the northern region of the Pantanal of Mato Grosso, Brazil. a – "landi"; b – "vazante"; c – "murundu" field; d – introduced pasture; e – natural clean field; f – "cambarazal"; g – mixed field.

Considering the Coleoptera distribution within the phytophysiognomies, the murundu field, the most common formation in the sample area, presented the highest values for both, species abundance (260 ind.; 33.8%;), and richness (42.7%; 82 spp.), followed by the cambarazal, that in spite of occurring in only two transects presented considerable abundance (168 ind.; 21.9%) and richness (30.2%; 58 spp.), and in landi with four transects, 133 Coleoptera (52 spp.) were obtained. These three areas are more similar to each other in relation to species richness (Figure 3). Among the sampled transects, five corresponded to introduced pasture with the presence of *B. humidicola* (112 ind.; 54 spp.). Vazante (59 ind.; 38 spp.), mixed field (28 ind.; 13 spp.), and natural clean field (7 ind.; 7 spp.) corresponding to vegetation formation with less representativeness in the sampling (Table 1).

Scarabaeidae. Twenty-two Scarabaeidae species were identified, distributed in Scarabaeinae (169 individuals; 15 spp.), and Aphodiinae (68 individuals; 7 spp.). Within the Scarabaeinae, *Canthidium viride* Lucas (24.8%; 42 ind.), and *C. barbacenicum* Borre (15.4%; 26 ind.) were the most abundant species. For Aphodiinae, *Pleurophorus* sp. 1 (23.5%; 16 ind.), and

Ataenius pseudocarinatus (Balthazar) (19.1%; 13 ind.) were the most representative species (Table 2). A greater abundance of Scarabaeidae was recorded in areas of murundu field (101 ind.; 42.6%), followed by cambarazal (42 ind.; 17.7%), and introduced pasture (34 ind.; 14.3%).
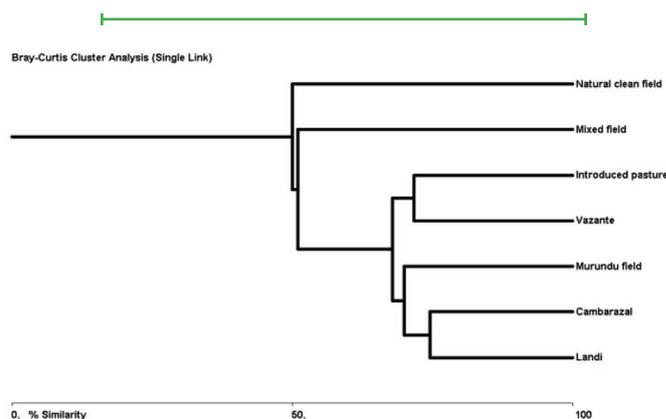

Figure 3. Bray-Curtis Index of similarity of the Coleoptera community sampled using the mini-Winkler extractor and pitfall trap in different phytophysiognomies in the northern region of the Pantanal of Mato Grosso, Brazil.

Assessment of the Scarabaeidae distribution alone showed that the PCOA on axes I and II explained only 47% of the data variation (Figure 4). Thus the Scarabaeidae community distribution pattern is not well defined. With these results multivariate analyses were carried out among the phytophysiognomies (Pillai Trace = 1.090, P = 0.130), and litter thickness (Pillai Trace = 0.096, P = 0.894), but significant values were not found for Scarabaeidae distribution.
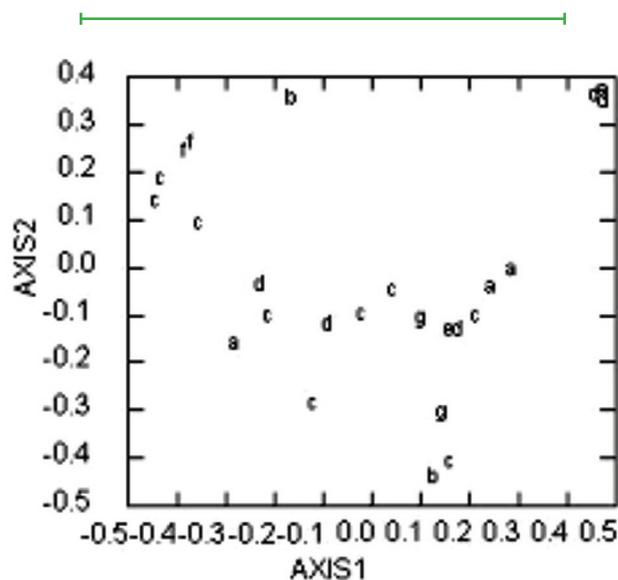

Figure 4. Main axes (axis 1 and axis 2) of the indirect ranking of the Scarabaeidae community sampled using the mini-Winkler extractor and pitfall trap in different phytophysiognomies in the northern region of the Pantanal of Mato Grosso, Brazil. a – "landi"; b – "vazante"; c – "murundu" field; d – introduced pasture; e – natural clean field; f – "cambarazal"; g – mixed field.

The Scarabaeidae are distributed in three groups according to their habit of foraging, (i) paracoprids (48.5%; 115 ind.), (ii) endocoprids (28.7%; 68 ind.) and (iii) telecoprids (8.4%; 20 ind.). Forty-six specimens (19.4% of the total), were not classified in any guild. The paracoprids included the species *Ontherus, Canthidium, Ateuchus, Dichotomius* and *Coprophaneus*, among the endocoprids, mainly, *Trichillum, Ataenius* and *Aphodius*, while *Canthon* and *Deltochilum* represent the telecoprids (Table 2).

Table 2. Scarabaeidae sampled using the mini-Winkler extractor (mW) and pitfall traps in different phytophysiognomies assessed in the Pantanal of Poconé, Mato Grosso, Brazil. *P - paracoprids, E – endocoprids, T – telecoprids; ? – Unknown.

Taxa	Methods				
	Pitfall	**mW**	**Total**	**%**	**Guild***
Scarabaeinae					
Ateuchus pygidialis (Harold)	12	-	12	5.0	P
Ateuchus sp.	2	-	2	0.8	P
Canthidium barbacenicum Borre	24	2	26	11.0	P
Canthidium sp. 2	3	-	3	1.3	P
Canthidium sp. 3	1	-	1	0.4	P
Canthidium viride Lucas	38	4	42	17.7	P
Canthon sp.	10	-	10	4.2	T
Canthon curvodilatatum Schmidt	9	-	9	3.8	T
Coprophaneus (*Coprophaneus*) *jasius* (Olivier)	3	1	4	1.7	P
Deltochilum (*Deltochilum*) *elongatum* Felsche	1	-	1	0.4	T
Dichotomius (*Luderwaldtinia*) *glaucus* Harold	1	-	1	0.4	P
Dichotomius (*Luderwaldtinia*) *nisus* (Olivier)	3	-	3	1.3	P
Ontherus (*Ontherus*) *appendiculatus* (Mannerheim)	16	5	21	8.9	P
Trichillum (*Trichillum*) *externepunctatum* Preudhomme de Borre	18	4	22	9.3	E
Trichillum (*Eutrichillum*) sp.	12	-	12	5.1	E
Aphodiinae					
Aphodius (*Labarrus*) *pseudolividus* Balthasar	-	1	1	0.4	E
Ataenius aequalis Harold	1	11	12	5.1	?
Ataenius alternatus Melsheimer	-	8	8	3.4	E
Ataenius pseudocarinatus Balthazar	3	10	13	5.5	E
Auperia denominata Chevrolat	1	5	6	2.5	?
Neorhyssemus quinquecostatus (Schmidt)	-	12	12	5.1	?
Pleurophorus sp.1	-	16	16	6.7	?
Total	**158**	**79**	**237**	**100.0**	

When the trophic groups were assessed in relation to the phytophysiognomy, it was observed that the paracoprids were dominant in five of the seven landscapes found in the sample area. The endocoprids were more represented only in the landi and pastures areas (Table 2). When the number of individuals per trophic group was compared to the methodologies used, the telecoprids and paracoprids were 78.9% of the individuals collected with pitfall traps, showing their higher activity rate, while 40.5% of the endocoprids were sampled with mini-Winkler extractor.

DISCUSSION

The spatial distribution of the Coleoptera community was significantly influenced by the vegetation formations. The taxa that compose the community corresponded to groups commonly sampled in this environment such as the Scarabaeidae, Staphylinidae, Curculionidae, Nitidulidae and Carabidae (Rodrigues, 1992; Barbosa *et al.* 2002; Marinoni & Ganho 2003).

Although it was not possible to determine specific groupings by multivariate analyses, the existence of a positive relationship between the phytophysiognomies and the Coleoptera community, observed in the present study, differs from data obtained in other regions by Franklin *et al.* (2005) and Lopes *et al.* (2005) who did not find, respectively, for the Amazon savannah and coastal wet broadleaf forest in Espírito Santo state, Brazil, any relationship between the soil invertebrate community and the vegetation structure. Types of habitat can determine the species composition in a region (Vasconcelos & Vilhena 2006). Studies have shown that litter is a predicting variable for species richness among different phytophysiognomies and different habitats (Leal 2003).

Litter thickness did not have a significant effect on the Coleoptera community, probably because a large part of the area present in these transects corresponded to open areas and natural pastures that generally do not have a great quantity of organic matter on the soil compared to forested areas. Apigian *et al.* (2006) showed that the community distribution pattern can be influenced by the type of litter, soil conditions and phytophysiognomic characteristics. The same was observed by Rieske & Buss (2001) where the relationship between the Coleoptera community and the environmental variables, including the litter, was significant.

Silva *et al.* (2013) assessed the complementariness of methods in a study on Formicidae in the same area and indicated that the association of techniques demonstrated increased efficacy in sampling in regions such as the Pantanal of Poconé, because the mini-Winkler extractor favored species collection in habitats with accumulated litter while the pitfall trap favored sampling in locations with little plant cover and thin litter. A similar situation was observed in the Coleoptera assessment, due to the small quantity of litter in a large part of these transects sampled, because they were open areas.

Nevertheless, the methodologies were shown to be efficient because they considered the sampling in only one of the seasons of the Pantanal in different plant formations, and it can be inferred that the species richness in these areas is greater than that sampled, considering the water dynamics in which the region is situated with alternating dry and high water seasons and its effect on the edaphic fauna (*e.g.* Adis *et al.* 2001; Battirola *et al.* 2009).

Phytophysiognomy and litter thickness did not have a significant effect on the Scarabaeidae distribution in our study. This result may be associated to the fact that Scarabaeidae are very mobile in the environment (Peck & Forysth 1982) and may not be influenced by certain environmental variants, such as litter thickness. Nichols *et al.* (2013) suggested that nesting activities by rollers beetles can be influenced by the physical structure of the forest floor, and can be negatively impacted by the increase in leaf litter, which would hinder their activity, affecting hence their reproductive success.

Another hypothesis suggests that as most of the Scarabaeidae collected were coprophagous and depends mainly on the presence of fecal matter (Halffter & Matthews 1966), which is not related to the environments, as all the phytophysiognomies in the area assessed are used for cattle rearing. Halffter (1991)

and Halffter *et al.* (1992) observed that for the Scarabaeidae, the plant cover affects the microclimatic conditions especially in the tropics, influencing the community distribution. Estrada & Coastes-Estrada (2002) found a positive relationship between the landscapes and the Scarabaeidae community, different from the results obtained in the present study.

The data on Scarabaeidae richness and of Scarabaeinae and Aphodiinae dominance in the samples coincide with studies carried out in Mato Grosso do Sul, Brazil, by Aidar *et al.* (2000) with 23 species in Aquidauana, Koller *et al.* (2007) with 24 species in Campo Grande and Rodrigues *et al.* (2010) who collected 21 species in Corumbá, but fewer than the 37 species found by Koller *et al.* (1999) too in Campo Grande. Tissiani *et al.* (2015) captured only 19 species in the northern region of the Brazilian Pantanal, the majority in the subfamily Scarabaeinae and Aphodiinae.

In the present study the paracoprids predominated over the endocoprids and telecoprids, different from the results by Flechtmann & Rodrigues (1995) and Koller *et al.* (1999), who reported the endocoprids as dominant, followed by paracoprids and telecoprids. These differences may be related to the methodologies used, because according to Koller *et al.* (1999), the endocoprid group was more abundant when fecal masses were collected because they remained inside them for a longer time.

The higher capture rate of paracoprids and telecoprids with pitfall traps may be related to the fact that the individuals of these groups bury their food at different distances from the location where it was obtained, and can be collected during the journey. According to Halffter & Matthews (1966), *Dichotomius nisus* (Olivier) transports fecal balls over the soil surface until it finds a safe place to deposit. From the mini-Winkler traps, 40.5% of the Scarabaeidae were endocoprids, because this methodology mainly favors the less active groups.

There is a relationship between the Coleoptera edaphic community and the phytophysiognomy, but this was not observed for litter thickness. However, for the Scarabaeidae community no relationship was found with any of the variables studied. Dung beetles assemblages can be influenced by other variables as the intensity and duration of seasonal flooding, as observed by Tissiani *et al.* (2015) that showed that the dung beetle assemblage in the northern region of the Brazilian Pantanal is structured as a consequence of flooding and species substitution along a gradient. However, our results indicated the effect of the plant structure and the mosaic of habitats on the distribution of the Coleoptera edaphic community in the Pantanal of Poconé, Mato Grosso, Brazil.

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