





## Community structure and diversity of Curculionidae (Hexapoda: Coleoptera) associated with the forest canopy in a Neotropical wetland

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**Abstract:** Curculionidae are phytophagous beetles and, in the Brazilian Pantanal, are abundant on the ground and in the tree canopy. We studied two seasonal periods (wet period in 2012 and dry period in 2013) and two distinct phytophysiognomies, one monodominant and floodable (Cambarazal) and one nonmonodominant and nonfloodable (Cerradão Cordillera), to analyze the diversity, richness, and trophic guilds associated with the canopies of these vegetation types. The samples were collected via canopy fogging. A total of 4,456 individuals were collected and grouped into 13 subfamilies, 36 tribes, 59 genera, 258 morphospecies. The community structure was influenced by the different vegetation types. The greatest richness and diversity of Curculionidae occurred in the Cerradão Cordillera vegetation during both seasonal periods. The Cambarazal richness did not differ between the dry and wet periods, but the diversity was greater in the dry period. Four guilds, i.e., phyllophagous, spermophagus, xylophagous, and xylomycetophagus, were identified in both phytophysiognomies. The results revealed that the wet and dry periods and the type of phytophysiognomy influenced the community of Curculionidae in the canopies of Cambarazal and Cerradão Cordillera of the Pantanal of Poconé, MT, Brazil.

**Keywords:** *phytophysiognomy; guilds; heterogeneous; macrohabitat; monodominant; seasonality.*

## Estrutura e diversidade da comunidade de Curculionidae (Hexapoda: Coleoptera) associados ao dossel florestal em uma área úmida Neotropical

**Resumo:** Os Curculionidae são besouros fitófagos e, no Pantanal brasileiro, são abundantes no solo e na copa das árvores. Foram estudados dois períodos sazonais (período chuvoso em 2012 e período seco em 2013) e duas fitofisionomias distintas, uma monodominante e inundável (Cambarazal), e outra não monodominante e não inundável (Cerradão sobre Cordilheira), para analisar a diversidade, riqueza e guildas tróficas dos curculionídeos associadas ao dossel destas fitofisionomias. As coletas ocorreram via nebulização das copas. O total de 4.456 indivíduos foi coletado e agrupado em 13 subfamílias, 36 tribos, 59 gêneros, 258 morfoespécies. A estrutura da comunidade foi influenciada pelos diferentes tipos de vegetação. A maior riqueza e diversidade de Curculionidae ocorreu na vegetação da Cordilheira do Cerradão durante ambos os períodos sazonais. A riqueza do Cambarazal não diferiu entre os períodos seco e chuvoso, mas a diversidade foi maior no período seco. Quatro guildas alimentares como filófago, espermófago, xilófago e xilomicetófago foram identificadas em ambas as fitofisionomias. Os resultados revelaram que os períodos de cheia e seca, e o tipo de fitofisionomia influenciaram a estrutura da comunidade, a riqueza e a diversidade de Curculionidae nas copas do Cambarazal e do Cerradão sobre Cordilheira no Pantanal de Poconé, MT, Brasil.

**Palavras-chave:** *fitofisionomia; guildas; heterogêneo; macrohabitat; monodominante; sazonalidade.*

## Introduction

Curculionidae Latreille (Curculionoidea) comprises approximately 51,000 species and is grouped into 19 subfamilies and 4,600 genera (Slipinski et al. 2011; Bouchard et al. 2024), which are popularly known as weevils, with distinct extended mouthparts on the rostrum (except the subfamilies Scolytinae, Platypodinae, and some Cossoninae (Triplehorn and Johnson 2005)).

The great diversification of weevil species occurred simultaneously with the diversification of plants, as the group is represented by phytophagous adults and larvae that feed on the living and dead parts of the plants, invading the roots, stems, fruits, flowers, and seeds. Although some larvae and adults are of great economic interest because they are crop and stored-product pests, there are beneficial species that act as pollinators or weed control (Grimaldi and Engel 2005; Triplehorn and Johnson 2005; Casari et al. 2024).

Individuals of this family can be found in all vegetation types; some species, such as Molytinae, live in the soil or litter; others, such as Conoderinae, Cossoninae, Cryptorhynchinae, and some Molytinae, live under dead wood; however, the vast majority live in shrub and canopy areas and inhabit flowers and fruits (Arnett et al. 2002; Saravy et al. 2022; Casari et al. 2024). Curculionidae are commonly found in the canopies of plants, including in wetland phytophysiognomies, indicating the strong relationship between the species and the phenology of host plants, which offer places for reproduction, development, and food for larvae and adults (Allison et al. 1997; Junk et al. 2006; Marques et al. 2007; Fernandes et al. 2010; Carneiro 2012; Grigolli et al. 2013; Meurer et al. 2013; Vanin and Bená 2015; Algarve et al. 2020; Yamazaki et al. 2021; Saravy et al. 2022).

The Pantanal is the largest floodplain in the world, and in Brazil, extends across the states of Mato Grosso and Mato Grosso do Sul. Its most striking feature is the seasonal flood pulse, which affects terrestrial and aquatic ecosystems through diverse impacts on phytophysiognomies, promoting the formation of floodable and nonfloodable areas with monodominant or heterogeneous vegetation (Gonçalves et al. 2011; Scremin Dias et al. 2011; Nunes da Cunha et al. 2023). During the aquatic phase of the Pantanal, Coleoptera and other arthropods that inhabit the soil and litter migrate in search of survival to higher areas, such as stems and canopies, or to nonflooded areas with elevated soil, where they find food resources and breeding sites to ensure their survival until the end of flooding (Adis et al. 2001; Battirola et al. 2007; Wantzen et al. 2016; Yamazaki et al. 2021).

Pantanal phytophysiognomies are directly influenced by the flood pulse, which alters the physicochemical characteristics of the region and causes the plant species to shape its phenology, such as the flowering, fruiting and leaf production periods, according to the seasonality of the biome. This dynamic affects the availability of different sites throughout the year for feeding, nesting and development of Curculionidae (Mercante et al. 2011; Pott et al. 2011; Scremin-Dias et al. 2011; Meurer et al. 2013; Wantzen et al. 2013, 2016; Tomas et al. 2019; Nunes da Cunha et al. 2023). Studies conducted in the Pantanal region of Mato Grosso confirm that the community composition changed due to the seasonality and phytophysiognomies of the biome (Santos et al. 2003; Junk et al. 2006; Battirola et al. 2007; Marques et al. 2007; Meurer et al. 2013; Yamazaki et al. 2021).

In this study, the community composition, richness, diversity, and feeding guilds of Curculionidae was sampled in the canopies of two distinct phytophysiognomies, one monodominant and seasonally flooded (Cambarazal) and one nonmonodominant and permanently dry (Cerradão). The aim was to evaluate the influence of the dry and wet periods and of the different phytophysiognomies on this canopy community in the Pantanal of Poconé, MT.

## Material and Methods

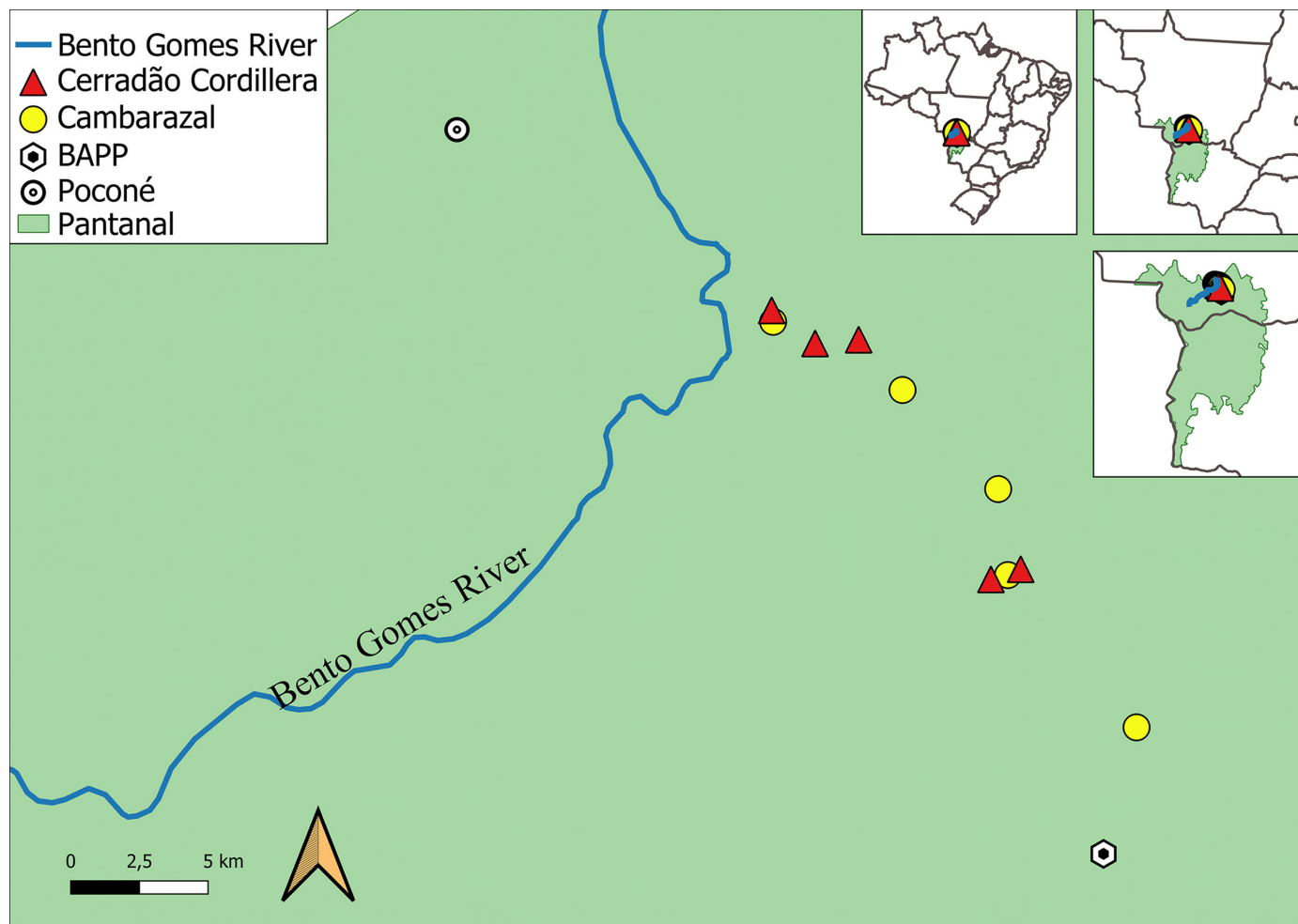
### 1. Study area

The areas selected for sampling are located in the municipality of Poconé, state of Mato Grosso, between the Bento Gomes River (16°18'S and 56°32'W) and the Advanced Research Base of the Pantanal of the Federal University of Mato Grosso (BAPP – UFMT) (16°30'S and 56°24'W) (Figure 1). Areas of Cambarazal with monodominant vegetation and Cordillera areas covered with heterogeneous Cerradão vegetation were sampled (Alho and Gonçalves 2005; Nunes da Cunha et al. 2023).

These areas are part of the Pantanal of Poconé floodplain and are located north of the Pantanal of Mato Grosso (Junk et al. 2006). The climate of the region, according to the Köppen Climate Classification, is tropical savannah, type *Aw*, characterized by dry winters and rainy summers, with temperatures oscillating between 22°C and 32°C and annual rainfall varying between 1,000 and 1,500 mm (Junk et al. 2006; Hofmann et al. 2010; Alvares et al. 2013).

In the Cambarazal, a monodominant vegetation, a single tree species, “cambará”, *Vochysia divergens* Pohl (Vochysiaceae), predominates. This species is of Amazonian origin and, owing to its strong relationship with the hydrological cycle, this species is considered invasive in the floodplains of Pantanal. It occupies areas that remain flooded throughout the aquatic phase and moulds its phenology according to the flood pulse, resulting in well-defined flowering and fruiting periods (Machado et al. 2015; Arieira et al. 2018). *Vochysia divergens* is an evergreen species that flowers during the dry period and bears fruit during the wet period. Individual trees measure up to 18 metres in height and have pedicellate and hermaphrodite flowers, forming yellow inflorescences that are approximately 25 centimetres in length. The fruits are dry, and the seeds are winged (Pott and Pott 1994; Lorenzi 2000; Carvalho 2014). Although considered monodominant, other species in addition to *V. divergens* occur in the Cambarazal, such as small and large grasses and trees, which are adapted to long periods of flooding and whose phenology is synchronous with the seasonality (Alho and Gonçalves 2005; Hofmann et al. 2010; Carvalho 2014; Uriu et al. 2017; Nunes da Cunha et al. 2023) (Appendix 1).

Cerradão, a nonmonodominant vegetation, is composed of different plant species with distinct phenological characteristics, including semideciduous species (Nunes da Cunha et al. 2023). The Cerradão sampled for this study is located in an elevated strip of land, called the Cordillera, approximately three meters above the floodplains, approximately 10 meters wide and a few kilometers long (hereafter the Cerradão Cordillera). The vegetation is dense and has a seasonal semideciduous character, with a maximum height of 20 m, and is located in regions of dry, sandy soil with good drainage. During the aquatic phase of the Pantanal, only the edges of the Cerradão Cordillera are affected by soil inundation, while their interior remains dry. The



**Figure 1.** Collection areas are located between the Bento Gomes River and the Pantanal Advanced Research Base (BAPP), in the Pantanal of Poconé, Mato Grosso, Brazil. Source: QGIS 3.30.3.

vegetation is composed of trees and shrubs, such as the “acuri” (*Attalea phalerata* Mart. ex. Spreng.), “paratudo” (*Tabebuia aurea* (Silva Manso) Benth. and Hook.f. ex S.Moore), “tarumarana” (*Buchenavia tomentosa* Eichler.), “peroba” (*Aspidosperma tomentosum* Mart.), “almecegueira” (*Protium heptaphyllum* (Aubl.) Marchand), “gonçalo” (*Astronium fraxinifolium* Shott), and “gravata” (*Bromelia balansae* Mez.), among others (Alho and Gonçalves 2005; Andrade et al. 2019; Queiroz et al. 2019; Andrade et al. 2022; Nunes da Cunha et al. 2023).

Research conducted in the Pantanal has shown that the Cerradão Cordillera is a refuge for animals during inundation since it is almost entirely above the water level, forming islands of dry forest that attract arthropods, including Coleoptera (Carneiro 2012; Aranda and Oliver 2017; Dambros et al. 2018; Andrade et al. 2022). Among the few studies that have analysed the biodiversity of Coleoptera from the Cerradão Cordillera of the Pantanal (Vieira et al. 2008; Carneiro 2012; Aranda and Oliver 2017), the present study is the first to address their biodiversity in canopies.

## 2. Sampling method

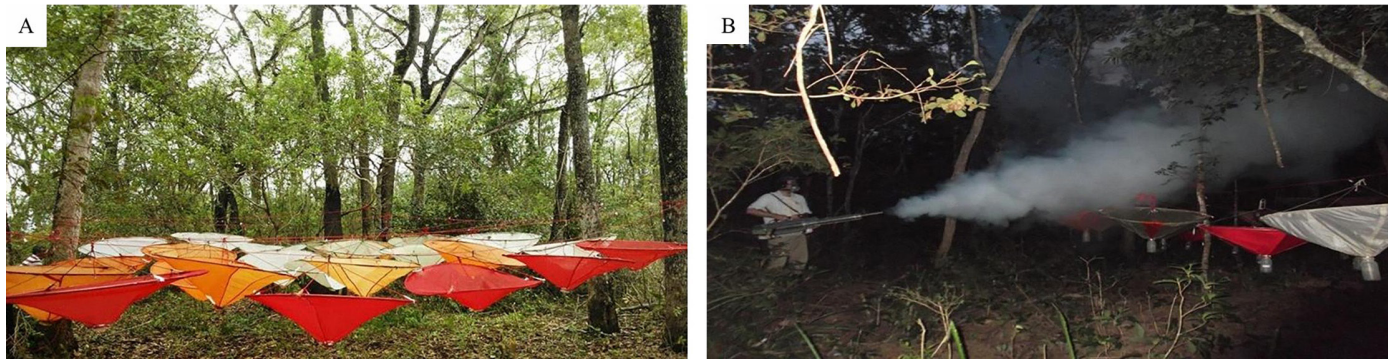
The collection method that was used was canopy fogging, which utilises a biodegradable synthetic pyrethroid insecticide (Erwin 1983;

Adis et al. 1984, 1997; Dambros et al. 2018; Yamazaki et al. 2021) in the canopy of Cambarazal and Cerradão Cordillera.

Samples were collected during two seasonal periods: dry (2012) and wet (2013). Ten areas were selected in the study region: five in the Cambarazal (Cam1, Cam2, Cam3, Cam4, Cam5) and five in the Cerradão Cordillera (Cc1, Cc2, Cc3, Cc4, Cc5). We mapped and divided quadrants of 5x5 m<sup>2</sup>, with a distance of 20 m between them; three quadrants were selected in each sampling unit, totalling 30 quadrants per seasonal period (Figure 2). A total of 25 nylon collection funnels were used per quadrant (Figure 2A), containing a collection flask with 92% alcohol at its base that was labelled and georeferenced.

Canopy fogging was performed for five minutes via a swingfog thermonebulizer, model SN50, which produces a strong jet directed from the ground to all parts of the canopy (Figure 2B). The procedures began at 6:00 am, when the wind intensity was low, preventing dispersion of the insecticide and directing it to the parts of the canopy to be studied (Adis et al. 1997). The insecticide was 0.5% lambda-cyhalothrin (Icon®), which, when diluted in diesel oil at a concentration of 1% and associated with the synergist (0.1% DDVP), increases the falling of individuals, reducing their displacement and facilitating their collection.

Each sample quadrant was sprayed with the insecticide, and after two hours, the samples were removed from the nylon funnels.



**Figure 2.** A) Distribution of nylon funnels below the canopies of Cambarazal for collecting arthropods in the Pantanal of Poconé, MT, Brazil; B) Fogging of the treetops for collecting arthropods at the study side.

To remove the collection flasks, the walls of the funnels were shaken and washed with 92% alcohol. Using canopy fogging methodology, with no selection of taxa, all arthropods present in the canopy were collected and analysed at the Laboratory of Ecology and Taxonomy of Arthropods (LETA), Federal University of Mato Grosso (UFMT), for the selection of Coleoptera and identification of Curculionidae at the genus level, when possible, and at the morphospecies level.

### 3. Vegetation sampling

Exsiccates were prepared from sterile (branches and leaves) and/or fertile (flowers and fruits) botanical material of the tree and shrub plant species present in the quadrants. The DBH (diameter at breast height) was measured with a tape measure, and the height of the species was estimated with a 3 m bar. The collected material was herborized according to the manual by Rotta et al. (2008) and incorporated into the reference collection of the Central Herbarium of the Federal University of Mato Grosso, Cuiabá Campus. The identification was performed by consulting the literature and comparing it with material already stored in the afore mentioned Herbarium, in addition to the support of its specialists. The classification system that was used was the Angiosperm Phylogeny Group: APG III (2009), and the botanical nomenclature followed that of Flora do Brasil (2020).

Information on the phenology of plant species was obtained from the following studies: Carvalho (1980), Lorenzi (2000), Pott and Pott (1994), Nunes da Cunha and Junk (2001), Reys et al. (2005), Arieira and Nunes da Cunha (2006), Santos et al. (2009), Wittmann et al. (2010), Nunes da Cunha et al. (2015), Braz et al. (2021) and Pereira (2021).

### 4. Processing of the material

The taxonomic classification used for the grouping of Curculionidae was that of Bouchard et al. (2024), and the Taxonomic Catalog of the Fauna of Brazil (Clarkson et al. 2025). For the identification of Curculionidae at the taxonomic levels of subfamily, tribe, genus, and morphospecies, the following references were used: Kuschel (1983), Wood (1961, 1993, 2007), Morimoto (1962, 1978), Clark (1978, 1990, 1993), Atkinson and Equihua (1985), Thompson (1992), Arnett et al. (2002), Marvaldi and Lanteri (2005), Prena and Whitehead (2012), Balalaikins (2013), Hernández et al. (2013), Anzaldo (2017), Legalov (2018a, 2018b, 2020a, 2020b), Lira (2018), Cortéz-Hernández and Morrone (2019) and Casari et al. (2024).

For information on the distribution, biology, life cycle, and functional guild of Curculionidae, the following references were consulted: Zimmerman (1936), Thompson (1992), Wood (1993, 2007), Clark (1978, 1990, 1993), Marinoni (2001), Marinoni et al. (2001), Arnett et al. (2002), Mecke and Galileo (2004), Korotyaev (2008), Guimarães (2009), Prena and Whitehead (2012), Balalaikins (2013), Hernández et al. (2013), Smith and Cognato (2013), Morrone (2014), Anzaldo (2017), Meira et al. (2017), Lira (2018), Sprick and Floren (2018), Clark et al. (2019), Girón (2020), Johnson et al. (2020) and Casari et al. (2024).

### 5. Data analysis

To estimate the diversity of Curculionidae, the analysis proposed by Chao et al. (2014) unifies two approaches for diversity estimation: rarefaction/extrapolation and the Hill number (Hill 1973; Chao et al. 2014, 2020; Hsieh et al. 2016). The diversity calculation with the Hill number is parameterized using the diversity order “ $q$ ”, which measures the sensitivity of the relative abundance of species. The three most commonly used measures are “ $q=0$ ” (observed richness), “ $q=1$ ” (Shannon index transformation), and “ $q=2$ ” (Simpson index transformation) (Hsieh et al. 2016).

A data matrix containing the abundance and taxonomic identification of Curculionidae sampled from the canopy of the phytophysionomies (Cambarazal and Cerradão Cordillera vegetation) during two seasonal periods (dry/2012 and wet/2013) was prepared; individuals were identified at the genus level, when possible, and the morphospecies level. The matrix was standardized via the “Hellinger” transformation method, which is considered the most suitable for community analyses with abundance matrices (Legendre and Legendre, 1998). The similarity matrix was calculated by applying the Bray-Curtis index (Bray and Curtis 1957).

To analyse the community composition, morphospecies with fewer than three occurrences were removed from the matrix because of the high abundance of rare morphospecies. To assess whether the Curculionidae community is influenced by the phytophysionomies and seasonal periods in which they were sampled, permutational multivariate analysis of variance (PERMANOVA) (Anderson 2001) was applied. The results of the PERMANOVA were represented via a PCoA, which ranks the communities according to similarity in composition. For this purpose, the Cailliez correction, which corrects the negative eigenvalues, was applied, allowing the formation of a graph (Cailliez

1983). All analyses were performed via R 4.3.2 software (R Core Team 2023) using the Vegan and iNEXT data packages (Hsieh et al. 2016; Oksanen et al. 2022).

## Results

A total of 4,456 Curculionidae individuals were sampled from the canopies of the two phytophysiognomies, of which 3,462 individuals (77.7%) occurred in the Cambarazal, and 987 individuals (22.3%) occurred in the Cerradão Cordillera. In the Cambarazal, the abundance of Curculionidae during the two seasonal periods was similar (dry: 1,626 individuals, 47%; wet: 1,836 individuals, 53%), whereas in the Cerradão Cordillera, the number of individuals doubled during the wet period compared with the dry period (dry: 364 individuals, 36.6%; wet: 630 individuals, 63.4%) (Appendix 3).

The sampled individuals were grouped into 13 subfamilies, 36 tribes, 59 genera, 258 morphospecies. A total of 192 and 129 morphospecies were identified for Cerradão Cordillera and Cambarazal, respectively (Appendix 3). In the Cambarazal, the most abundant morphospecies belonged to the genus *Sibinia* Germar, 1817 (2,041 individuals, 59%); the species *Huaca sucana* Clark, 1990 (447 individuals, 12.9%); the subtribe Cryptorhynchina (299 individuals, 8.6%) and the morphospecies *Copturus* Schoenherr, 1825 (228 individuals, 6.6%). In the Cerradão Cordillera, during the wet period, the most abundant morphospecies were *Pseudanthonomus* Dietz, 1982 (102 individuals, 16.2%, exclusive in the wet), *Tanymecus* Germar, 1817 (56 individuals, 8.9%) and the subtribe Tylodina (53 individuals, 8.5%). In the dry period, the morphospecies were *Sibinia* (43 individuals, 11.9%) and *Xyleborus affinis* Eichhoff, 1868 (21 individuals, 5.7%) (Table 1).

Diversity estimates revealed that the greatest richness and diversity of Curculionidae morphospecies occurred in the Cerradão Cordillera canopy in both periods; dry and wet periods did not affect the richness and diversity of Curculionidae in the Cerradão Cordillera, unlike in the Cambarazal, where dry was the most diverse period (Figure 3, Table 2).

According to PERMANOVA, the effects of the interaction between phytophysiognomy (Cambarazal and Cerradão Cordillera) and the periods (dry and wet) did not affect the composition of the Curculionidae community in the canopy ( $F_{1,16} = 0.952 / p = 0.461$ ). An analysis of each variable separately revealed that the composition of this community was influenced by the type of phytophysiognomy ( $F_{1,16} = 6.157 / p < 0.001$ ) but not the periods ( $F_{1,16} = 1.587 / p = 0.001$ ) (Figure 4).

PCoA revealed the occurrence of completely distinct communities between the Cambarazal and Cerradão Cordillera evaluated in this study. According to the PCoA graph, the compositions of the communities in the Cambarazal, both in the dry and wet periods, were more similar than those in the Cerradão Cordillera, where the community was more diverse between the seasonal periods (Figure 4).

According to the identification of the trophic guilds of Curculionidae, 67.3% of the individuals were spermophagus and feed on fruits and seeds; 18.3% were xylophages, which feed on wood; 12.6% were phyllophagous, which prefer leaves and flowers; and 1.8% were xyломycetophagus that pierce the wood and the fungi produced in it (Table 2, Appendix 3) (Marinoni 2001; Marinoni et al. 2001).

In the Cambarazal, there was a predominance of spermophagus (76.9%), followed by xylophages (15.5%), phyllophagous (6.7%) and xyломycetophages (0.9%). In the Cerradão Cordillera, spermophages were the most abundant (34.3%), followed by phyllophagous (33.1%), xylophages (28.1%) and xyломycetophages (4.5%) (Table 2).

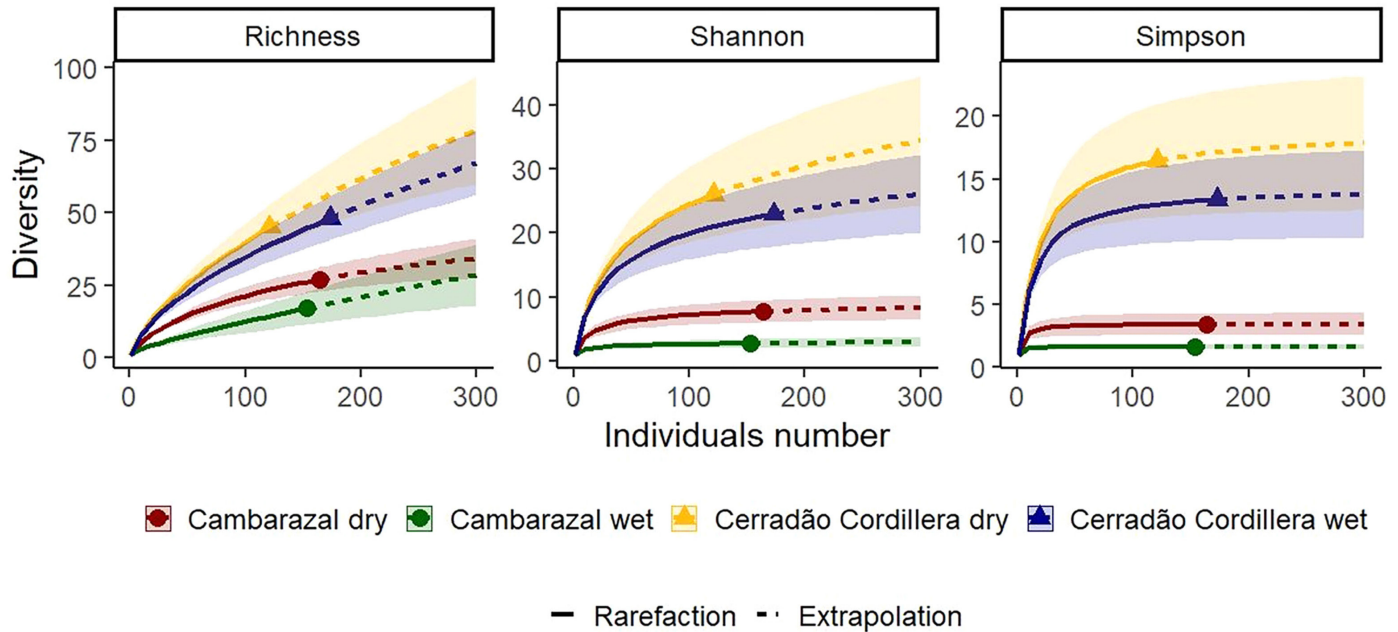
## Discussion

### 1. Occurrence of Curculionidae in the Cambarazal

The richness of Curculionidae in the canopy of Cambarazal did not differ between the dry and wet periods (Figure 3). Studies such as those by Neves (2005) and Moura (2019) have shown that low plant diversity decreases the species richness. In places with little diversity of resources, such as in monodominant phytophysiognomies, there is usually a predominance of taxa that are more specialized in exploiting

**Table 1.** Most abundance morphospecies of Curculionidae in the Cambarazal and Cerradão Cordillera during dry (2012) and wet (2013) periods in the Pantanal of Poconé, MT.

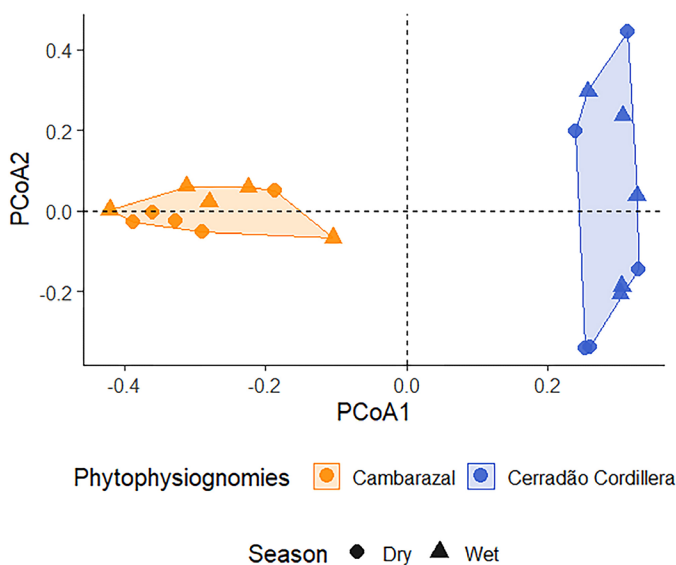
Morphospecies	Cambarazal			Cerradão Cordillera		
	Dry	Wet	Total	Dry	Wet	Total
<i>Sibinia</i> sp. 13	1126	878	2004	1	0	1
<i>Huaca sucana</i>	71	376	447	0	18	18
<i>Copturus</i> sp. 1	96	119	215	1	1	2
Cryptorhynchina sp.87	118	81	199	0	0	0
<i>Pseudanthonomus</i> sp.	0	7	7	0	102	102
<i>Tanymecus</i> sp.	2	102	104	0	56	56
Tylodina sp. 2	0	0	0	9	44	53
<i>Xyleborus affinis</i>	5	15	20	21	7	28
<i>Sibinia</i> sp. 1	0	0	0	20	4	24
<i>Sibinia</i> sp. 3	1	0	1	9	4	13
<i>Sibinia</i> sp. 5	0	1	1	2	12	14



**Figure 3.** Diversity of Curculionidae in the Cambarazal and Cerradão Cordillera during the dry and wet periods in the Pantanal of Poconé, MT (Richness, Shannon index, and Simpson index).

**Table 2.** Guild structure of Curculionidae in the Cambarazal and Cerradão Cordillera during the dry and wet periods in Pantanal of Poconé, MT.

Phytophysiognomy	Period	Trophic Guild			
		Phyllophagous	Spermophagus	Xylophagus	Xylomycetophagus
Cambarazal	dry	5.2%	78.0%	16.0%	0.8%
	wet	8.0%	75.8%	15.1%	1.1%
Cerradão Cordillera	dry	31.8%	24.4%	35.5%	8.3%
	wet	33.8%	40.0%	29.9%	2.3%



**Figure 4.** Community structure of Curculionidae in the Cambarazal and Cerradão Cordillera in the dry and wet periods in the Pantanal of Poconé, MT.

the resources of the environment, thereby decreasing their richness and diversity, according to Naveena et al. (2022), who analysed the insect community in sediment grains stored in tropical forest ecosystems. Although low plant diversity does not alter the Curculionidae richness, the monodominant phytophysiognomies have a high abundance of taxa specialized in exploiting the resources provided by vegetation, as observed in the present study with *Sibinia* spp., *H. sucanca*, *Copturus* spp. and *Cryptorhynchina* spp. (Table 1, Appendix 3).

Unlike richness, the diversity of Curculionidae in the Cambarazal changes seasonally (Figure 3). During the dry period, the highest diversity was recorded compared with that in the wet period; this highest diversity may be related to the phenology of the phytophysiognomy. Most Cambarazal plant species have a flowering period synchronized with the Pantanal dry (Appendix 1), as in the study by Costa et al. (2019). The high availability of flowers and leaves in the canopy during this period attracts these individuals, especially those that use the reproductive and vegetative structures of the host plant during their life cycle (Marques et al. 2001).

A total of 129 morphospecies were sampled in the Cambarazal areas, 79 and 77 morphospecies were sampled in dry and wet period,

respectively, among which *Sibinia* sp. 13 (2,004 individuals, 57.8%) was the most representative (Appendix 1). According to Clark (1978), who studied the natural history, taxonomy and phylogeny of the genus, individuals use flowers and fruits as sites for reproduction and development of their larvae, which are essential for their life cycle. In the Pantanal, the highest abundance of *Sibinia* occurred in the dry period, which is a period in which the Cambarazal is full of flowers; this is an important resource used as a niche site, which corroborates the proposal by Clark (1978) (Table 1, Appendix 1). *Sibinia* are also found in large numbers during wet, which may be related to their life cycle, as adults live and copulate on the host plant, and larvae develop in fruits and flowers, justifying the marked presence of the genus in the wet period, which is the period with the highest fruit abundance in the canopy (Arieira and Nunes da Cunha 2006; Machado et al. 2015).

The second most representative species in the Cambarazal was *H. sucanca*. According to Clark (1993), little is known about the association of the genus *Huaca* Clark, 1993 with plants, and there is no information on the association of this species with vegetation. The author presented a list of plant species with records of occurrence of the genus *Eugenia* L. (Myrtaceae), which is a genus that is also recorded in the Cambarazal of the Pantanal of Poconé (Appendix 1). The presence of *Eugenia florida* DC. in the Cambarazal may be one of the attractions for *H. sucanca*, which was the most abundant species in the wet period during this study (Table 1, Appendix 1).

Burke (1976) and Arnett et al. (2002) reported some data of the biology of the subfamily Curculioninae and the tribe Anthonomini, with a record of the species *H. sucanca*. These studies revealed that the individuals of this subfamily and tribe use the reproductive parts of the plant for the development of their larvae and may be specific hosts of a single species. Among the Anthonomini tribe, *Anthonomus* Germar, 1817 (Grigolli et al. 2013) is the only genus with a considerable amount of research on economic importance and was also sampled in the present study. Bélot et al. (2016) revealed that during oviposition and larval development, adults of this genus attack the flowers and fruits of cotton plantations, with a preference for flowers and, in their absence, fruits. The food preference of *H. sucanca* may be similar to that of *Anthonomus* because the two belong to the same tribe, with common life habits, as reported by Burke (1976) and Bélot et al. (2016). Thus, it is believed that the high abundance of this species in the canopy of Cambarazal during the wet period is due to the presence of fruits in the canopy used for the life cycle of the species (Appendix 1).

The third most abundant morphospecies was *Copturus* sp. 1 (Conoderinae, Lechriopini), with greater representation during wet. According to Anzaldo (2017), its individuals occur in the abaxial part of the leaves and in the trunks of living and fallen trees. Costa Lima (1956) and Anzaldo (2017) sampled adults perforating the stems of Fabaceae species, and their larvae were found inside the stem. Little is known about the biology of this group and which plant species are associated with the genus. In most cases, *Copturus* collected occurs through active search or flight interception without obtaining information about the host plant (Anzaldo 2017). In the present study, *Copturus* had similar abundances during the two seasonal periods, demonstrating a strong relationship with the monodominant phytophysiology.

## 2. Occurrence of Curculionidae in the Cerradão Cordillera

In the Cerradão Cordillera canopy vegetation, 192 morphospecies of Curculionidae were identified, of which 113 were present in the dry period and 124 were present in the wet period (Appendix 3). Although Curculionidae is less abundant in the Cerradão Cordillera, its greatest diversity and richness occurred in the canopy of this phytophysiology during both seasonal periods (Figure 4). Compared with monodominant vegetation, heterogeneous vegetation provides a greater diversity of niche resources to Curculionidae because the presence of plant species with different phenological periods makes resources available throughout the year (Hubbell 2001). As found by Aranda and Oliver (2017), who studied heterogeneous and non-flooded capões in the Pantanal, in this study the heterogeneity of vegetation and the availability of resources influenced the richness and composition of the Curculionidae communities.

Among the identified morphospecies, *Pseudanthonomus* sp. was the most abundant, although this genus occurred only during the wet period (Table 1). According to a review of its species, Clark (1990) reported that adults generally use flowers and fruits for oviposition and larval development. Little is known about the diet of adults; however, according to Lyal (2014), Anthonomini individuals may be associated with more than 40 plant families, including Malvaceae Fabaceae, Rhamnaceae and Sapindaceae both of which are found in the Cerradão Cordillera (Appendix 2). During wet, some plant species, such as Fabaceae, Malvaceae and Sapindaceae, enter the flowering period, and fruiting plants, such as Rhamnaceae, contain resources for the development of the life cycle of *Pseudanthonomus* sp. (Appendix 2). The presence of these and other plant species in the Cerradão Cordillera may have influenced the abundance of this genus, considering the biology and reproductive characteristics of the group.

The second most representative morphospecies was *Tanymecus* sp. (Table 1, Appendix 3). The genus was sampled from both phytophysiology, but with greater abundance in wet period. Georgescu (2023) studied the life cycle of a species of the genus and reported that adults feed on leaves and young stems of herbaceous plants, and the larvae feed on the roots. Species of the genus cause serious damage to plantations and are related to around 70 plant species. Among the main host plant families reported by Georgescu (2023), Fabaceae and Malvaceae occur in the Cerradão Cordillera. The high availability of leaves in the canopy of the Cerradão Cordillera, especially during the wet period, may justify the presence of the genus in the canopy. The species generally inhabit herbaceous plants, but the flood pulse may have influenced individuals to migrate to the top of the vegetation during the wet period.

In the Cerradão Cordillera, there was no predominance of certain taxa in the canopy, as in the Cambarazal, but there was a well-distributed abundance of a greater richness of individuals (Table 1, Appendix 3). Among the few morphospecies that stand out in the Cerradão Cordillera, *Tylodina* sp. 2 is exclusive to this phytophysiology, and its highest abundance occurs in wet periods. The subtribe *Tylodina* is part of Cryptorrhynchini, which, according to Lyal (2014), corresponds to a tribe of individuals who usually live in the soil or in the litter, where the larvae feed on wood, and the adults use the stems of woody plants for oviposition. These

individuals are found mostly in the leaf litter during the day and in the canopy at night. Larvae usually develop and feed on wood, which is a process that can also occur in the roots. Tylodina was more abundant in the wet, which was probably related to the flood pulse that induced the migration of individuals to the canopy (Table 1, Appendix 3). The same situation was reported for Curculionidae by Adis et al. (2001) and Yamazaki et al. (2021) in the Pantanal of Poconé, MT. Because it is a phytophysiognomy that has little waterlogging and semideciduous vegetation, the Cerradão Cordillera is considered a good habitat for soil-dwelling Tylodina. According to Heijerman (2004), some genera of the subtribe are related to semideciduous vegetation and benefit from fallen leaves and trunks as places for the nesting and development of immature plants.

The dry period presented the lowest abundance of Curculionidae in the canopy in this study (Appendix 3). The semideciduous characteristic of the Cerradão Cordillera contributed to the lower abundance of individuals in the canopy during the dry period, as it caused a decrease in niche resources provided by the phytophysiognomy compared with those in the wet period (Naveena et al. 2022). Despite being less abundant in the dry period, it is as rich and diverse as it is in the wet period (Figure 3). There was no marked predominance of any morphospecies during dry, but *X. affinis* and *Sibinia* sp. 1 were the most abundant during this period (Table 1). Although the number of leaves in the canopy during the dry period is reduced, flowers and fruits are still resources appreciated by *Sibinia* species (Clark 1978) (Appendix 2).

The species *X. affinis*, which was recorded in both phytophysiognomies and periods, was more abundant in the Cerradão Cordillera in the dry period (Table 1). According to Wood (2007), Xyleborini individuals are xylomycetophagous; adults feed on wood, opening galleries between the bark and the wood for oviposition, and the larvae expand the galleries and feed on the wood and fungi present in the tunnel walls. According to Wood (2007), *X. affinis* is found in certain plant species, including *Protium* Burm. f., *Astronium* Jack and *Ficus* L. were both sampled in the Cerradão Cordillera in the present study. *Protium heptaphyllum* (Aubl.) Marchand and *Astronium fraxinifolium* Shott. were the two most abundant plant species in this phytophysiognomy, influencing the presence of *X. affinis* in the canopy (Appendix 3). The greater abundance of *X. affinis* in the dry period may be related to freshly fallen dead or dry wood, which was more abundant during this period, both in the soil and in the canopy (Sobel et al. 2015; Costa et al. 2019).

The second most representative morphospecies in dry periods was *Sibinia* sp. 1 (Table 1, Appendix 3). Although the genus was sampled in both phytophysiognomies, *Sibinia* sp. 1 occurs exclusively in the Cerradão Cordillera, with greater abundance in dry period. Clark (1978) reported that for some species, immature development occurs in the soil, in which the female lays eggs inside flowers or fruits in the canopy and, after the eggs hatch, the larvae feed on flowers and fruits. At the end of the last larval instar, the larvae move to the soil where they are encapsulated. In addition, he reported that the pupal stage can occur in both, in the soil and in flowers, depending on the existing environmental pressures. Considering that individuals use the flowers and fruits of the canopy during the dry period to cope and oviposit, it explains the high abundance of *Sibinia* in the canopy of Cerradão Cordillera vegetation during dry period in the Pantanal.

### 3. Trophic guilds

An analysis of the feeding guilds of Curculionidae in the Cambarazal revealed the predominance of sprout-eating individuals in both the dry and wet periods (Marinoni 2001; Marinoni et al. 2001) (Table 2). These individuals were found mainly in seeds or fruit endocarps, both of which were abundant in the Cambarazal during the wet period (Appendix 1). Individuals of *Sibinia* were legume seed predators, although some species are associated with non-leguminous plants. Even with the predominance of fruits and seeds in the wet period, there was also a large representation of spermophages during dry due to the high abundance of *Sibinia* sp. 13 and *H. sucanca*, which are associated with the flowers in the canopy during this period (Tables 1 and 2). *Sibinia*, the most representative genus of this study, has a strong relationship with Cambarazal because of the presence of fruits, flowers and places for reproduction and oviposition (Clark 1978). Anthonomini, such as *H. sucanca*, feed, reproduce, and develop larvae in fruits and sometimes even in flowers when they are abundant in the canopy during dry (Dieckmann 1988; Hernández et al. 2013).

The second most abundant feeding guild in the Cambarazal was the xylophagous guild; in this study, these guilds were well represented by individuals of *Copturus* sp. and Cryptorhynchinae spp., as their adults and larvae bore holes in living or dead wood (Tables 1 and 2) (Marinoni et al. 2001; Anzaldo 2017). In the Cambarazal, the highest abundance of xylophages occurred during dry because of the presence of wood and dry branches in the canopy, which are used for food in different life cycles. The phyllophagous feeding guild, although less abundant than the spermophagous and xylophagous guilds, may be related to the phenology of Cambarazal, which produces leaves throughout the year, and the presence of flowers in the dry period (Neves 2005; Carvalho 2014) (Appendix 1).

The low abundance of xylomycetophages in this monodominant phytophysiognomy, such as *X. affinis*, which is known for boring wood, is due to the preference of these individuals for basal areas of the host plant and for the soil, where they find dead wood, recently fallen wood or stems of woody species (Marinoni et al. 2001; Wood 2007). During the wet period, there was an increase in xylomycetophages in the canopy of Cambarazal, which may be related to the flood pulse, and this increase induces the migration of terrestrial individuals to dry areas in the canopy (Marques et al. 2006). There was little variation in the trophic guilds of Cambarazal during the two sampled seasonal periods, demonstrating that the Curculionidae community was influenced little by seasonality and strongly by the type of phytophysiognomy, as shown in Figures 3 and 4. In addition, because it is a monodominant vegetation, the Cambarazal habitat maintains the food supply to Curculionidae in certain guilds (Arieira and Nunes da Cunha, 2006) (Table 3).

The Cerradão Cordillera is a heterogeneous phytophysiognomy with leaves, flowers, and fruits during all periods in the Pantanal (Aranda and Oliver 2017). Considering that its tree species are semideciduous, lose their leaves in the dry period and change the availability of food resources in the canopy (Appendix 2), the xylophagous guild is the most abundant in the dry period. Despite the loss of leaves, the phyllophagous guild is the second most abundant in guild the dry period. During the wet period, there was an increase in phyllophagous and spermophages, which was related to the abundance of leaves, fruits, and seeds in the canopy during this period (Table 2, Appendix 3).

Xylophages and xylomycetophages were more common in the Cerradão Cordillera than in the Cambarazal. Costa et al. (2019) analysed the litterfall of floodable and nonfloodable phytophysiognomies in the Pantanal and reported that litterfall was more abundant in nonfloodable areas, such as the Cerradão Cordillera. Andrade et al. (2022) studied nonfloodable plant formations in the Pantanal do Abobral and reported that during dry, the trunks and branches in the canopy were dry, with few leaves and much organic matter in the soil, including wood and fallen branches. The greater abundance of xylophages and xylomycetophages in the canopy during dry may be related to the semideciduous characteristic of the phytophysiognomy, with leafless branches exposed in the canopy attracting adults and larvae of weevils known to bear wood. The proportion of guilds occurring in the Cerradão Cordillera differed between the dry and wet periods when compared to the Cambarazal, demonstrating the heterogeneity in the supply of food resources in the two periods studied (Table 2).

## Conclusions

The Curculionidae community in the canopy of Cambarazal and Cerradão Cordillera was influenced by the type of phytophysiognomy rather than by the dry and wet periods in the Pantanal of Poconé, MT. Compared with Cambarazal, the Cerradão Cordillera had the richest and most diverse phytophysiognomy in Curculionidae, and hosted the highest abundance of individuals in the canopy. In the Cerradão Cordillera, there was no variation in the diversity and richness of Curculionidae in the canopy, unlike Cambarazal, where the greatest diversity was found in the dry period, which corresponds to the synchronized flowering of the plant species of the phytophysiognomy. Unlike diversity, Curculionidae richness in the Cambarazal did not change seasonally. In the monodominant phytophysiognomy, the dominance of the trophic guilds did not change, unlike in the heterogeneous phytophysiognomy, in which the dominance changed between periods. Considering that Curculionidae is one of the largest families of Coleoptera, new studies addressing the taxonomic aspects, life cycle, and ecological interactions of its taxa are necessary, aiming to fill several gaps in knowledge about the species, which are fundamental for studies addressing the ecology and life history of this family.

## Supplementary Material

The following online material is available for this article:

Appendix 1 - Abundance and phenology period (period of flowering, fruiting, presence or absence of leaves) of plant species sampled in the five Cambarazal (Cam), Pantanal of Poconé, MT, Brazil.

Appendix 2 - Abundance and phenology period (period of flowering, fruiting, presence or absence of leaves) of plant species sampled in the five areas of Cerradão Cordillera (Cc), Pantanal of Poconé, MT, Brazil.

Appendix 3 - Subfamily, tribe, food guild, morphospecies, number of collected individuals of Curculionidae in the Cambarazal (Cam) and Cerradão Cordillera (Cc) during the dry (2012) and wet (2013) periods in Pantanal of Poconé, MT, Brazil. (\* = morphospecies, E- spermophage; P- phyllophagous; X- xylophage; XM- xylomycetophagous).

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## Conflicts of Interest

The authors report that there are no competing interests to declare.

## Ethics

Authors are exhibit awareness and adherence to best practices in publication ethics, which include upholding authorship integrity by avoiding “ghost” or “guest” authorship, refraining from dual submission, maintaining academic integrity by avoiding plagiarism and manipulation of results, disclosing any competing interests, and complying with research ethics policies.

## Data Availability

The data from this study are available at the link <https://doi.org/10.48331/scielodata.NCYK TZ>.

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