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Original Article

Legal boundaries and conservation: The case of Seasonally Dry Forests of the Serra da Bodoquena National Park, Brazil

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ABSTRACT

The Serra da Bodoquena National Park is an important protected area that promotes the conservation of a threatened ecosystem, the Dry Forest. It comprises two major fragments of predominantly Seasonally Dry Forest vegetation. The two fragments are under different protection schemes because they are considered different biomes. The southern fragment is considered part of the Atlantic Forest biome, and is thus protected by the Atlantic Forest Law, while the northern one is considered part of the Cerrado biome and is protected by the Native Vegetation Protection Law of Brazil (2012). This difference affects management and threatens the conservation of the National Park. The Native Vegetation Protection Law is more permissive, thus increasing the conflicts between the park and surroundings in the northern fragment. We used floristic composition to provide a more accurate definition for the two fragments with regard to their phytogeographical domain. Our results identified high floristic similarity between the fragments, indicating the same vegetation type for both. Among the 202 plant species identified in this study, 76% belong to the Atlantic Forest biome. This relatively high proportion indicates that the predominant vegetation and species composition of the National Park is typical of the Atlantic Forest. The occurrence of fragments of the Atlantic Forest, with a representative number of species of its flora outside the area of application of the law of the Atlantic Forest, defined by Decree No. 6.660 / 2008, indicates the need to elaborate or adapt the law to protect these fragments.

Keywords: Atlantic Forest; environmental policy; environmental law; Neotropical forest; Protected Area; Seasonal Forest

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Introduction

Drylands are important ecosystems whose main characteristic is water deficit, caused mainly by low rainfall and high evapotranspiration rates. These environments are present on all continents, covering about 41% of the globe. Drylands have diverse ecosystems, including forests and other woody fomations, grasslands and deserts. Given their role in global carbon balance and other essential ecosystem services they provide, drylands hold significant ecological importance worldwide. Additionally, they play a crucial role in biodiversity conservation, as approximately 35% of the world's biodiversity hotspots are found within their domains (FAO 2019).

Drylands occupy over 30% of South America, with about 18% classified as forest environments (Tian *et al.* 2017; FAO 2019). Seasonally Dry Tropical Forests (SDTF) occur where the mean annual rainfall is below 1600 mm, with a 5-6 month long dry season with less than 100 mm (Gentry 1995; Pennington *et al.* 2000). Seasonally Dry Tropical Forests occur within the climatic domain of tropical savannas, generally on soils with high natural fertility and low aluminum (Al) saturation (Pennington *et al.* 2000). Based on levels of abscission in the dry season, South American SDTF can be divided into two principal types: semideciduous seasonal forests (SSF) drop 20-50% of the leaves, while deciduous seasonal forests (SDF) lose > 50% (Veloso *et al.* 1991).

Seasonally Dry Tropical Forests is one of the most threatened ecosystems in South America, fragmented due to natural and anthropogenic processes in Brazil, Argentina, Bolivia, Paraguay and Peru up to Central America (Janzen 1988; Hoekstra *et al.* 2005; Portillo-Quintero & Sánchez-Azofeifa 2010; Marcelo-Peña *et al.* 2015). One of the main factors threatening these forests throughout South America is the conversion of native vegetation to agricultural activities, causing loss of biodiversity and soil nutrients and increasing salinization (Prăvălie 2016).

In Brazil, SDTF exist in patches in the biogeographic domains of Caatinga, Cerrado and Pantanal (Ramos *et al.* 2008; Damasceno-Junior *et al.* 2009; Ribeiro *et al.* 2009; Souza *et al.* 2019). On the other hand, the Atlantic Forest domain still hosts large continuous areas of SDTF (Brasil 2006; MMA 2008). Considered a global hotspot for biodiversity and endemism, the Atlantic Forest originally spanned across 1.5 million km² encompassing 17 Brazilian states (Brasil 2006; MMA 2008; Ribeiro *et al.* 2011). However, during the past five centuries, human activity has reduced this biome to only 12% of its original extent, with only 9% of the area within conservation units (Mapbiomas 2023).

In 2006, increasing concern about deforestation have led to the creation of a new law, known of the Atlantic Forest Law (Lei Mata Atlântica No. 11.428 / 2006 ; Brasil 2006), ruled by Decree No. 6.660/2008 in 2008. The Atlantic Forest Law regulates the use, protection, and regeneration of the biome, establishing that its vegetation types, including SDTF, can only be deforested in the event of public utility and social interest (Brasil 2006; 2008). Another important aspect of this law is the delimitation of the territory where the law should be applied, based on maps prepared by the Instituto Brasileiro de Geografia e Estatística (IBGE) (Brasil 2006; 2008).

However, geographically delimiting the territory by law enforcement generates different interpretations of the policy for land use and conservation of SDTF fragments outside those limits defined by law. The possibility of different interpretations puts these environments at risk, by allowing decision makers or landholders to consider them under less restrictive laws compared with the Atlantic Forest Law. One way to resolve this issue is clearly defining the phytogeographic domain to which a particular fragment belongs, assuming criteria beyond its geographical position. Floristic inventory helps to characterize a biome as this method is accurate and can be easily translated to conservation actions (Miranda *et al.* 2018). Although we present Serra da Bodoquena as a case study, this is not an isolated dilemma caused by these differences in legislation since all SDTF fragments outside the Atlantic Forest domain face the same problem. Despite being SDTFs, doubts arise about which laws should be applied to them because of their position in other phytogeographic domains, such as Cerrado and Pantanal.

We selected Serra da Bodoquena National Park (PNSBd) as a typical area to represent this issue with legislation. The PNSBd consists of two large fragments with predominantly SSF and SDF vegetation (Damasceno-Junior *et al.* 2007; ICMBio 2013). However, according to the biome map of Brazil and the Atlantic Forest Law Enforcement Map, only the southern fragment belongs to the Atlantic Forest biome, while the northern one is considered part of the Cerrado biome (Fig. 1) (IBGE 2004; Brasil 2008). Thus, the two fragments are subject to different sets of laws. The Conservation Units legislation (SNUC-Law No. 9,985/2000) applies to both fragments; however, the southern one is under both the Atlantic Forest Law and the Native Vegetation Protection Law of Brazil, while the northern one is subjected only to the latter. This difference arises because the map delimiting the area under the Atlantic Forest Law (Law nº 11.428/2006) only considers the southern fragment to be part of the Atlantic Forest domain (Fig. 1). However, the Atlantic Forest Law Enforcement Map indicates an area next to the southern fragment outside the (PNSBd) that has already been converted by human activities, thereby characterized as of consolidated use, no longer liable to enforcement of the habitat protection law (Fig. 1).

These inconsistencies result in different interpretations with regard to what is permitted land use and which are the relevant vegetation conservation policies in these fragments and in the surrounding area. They also raise

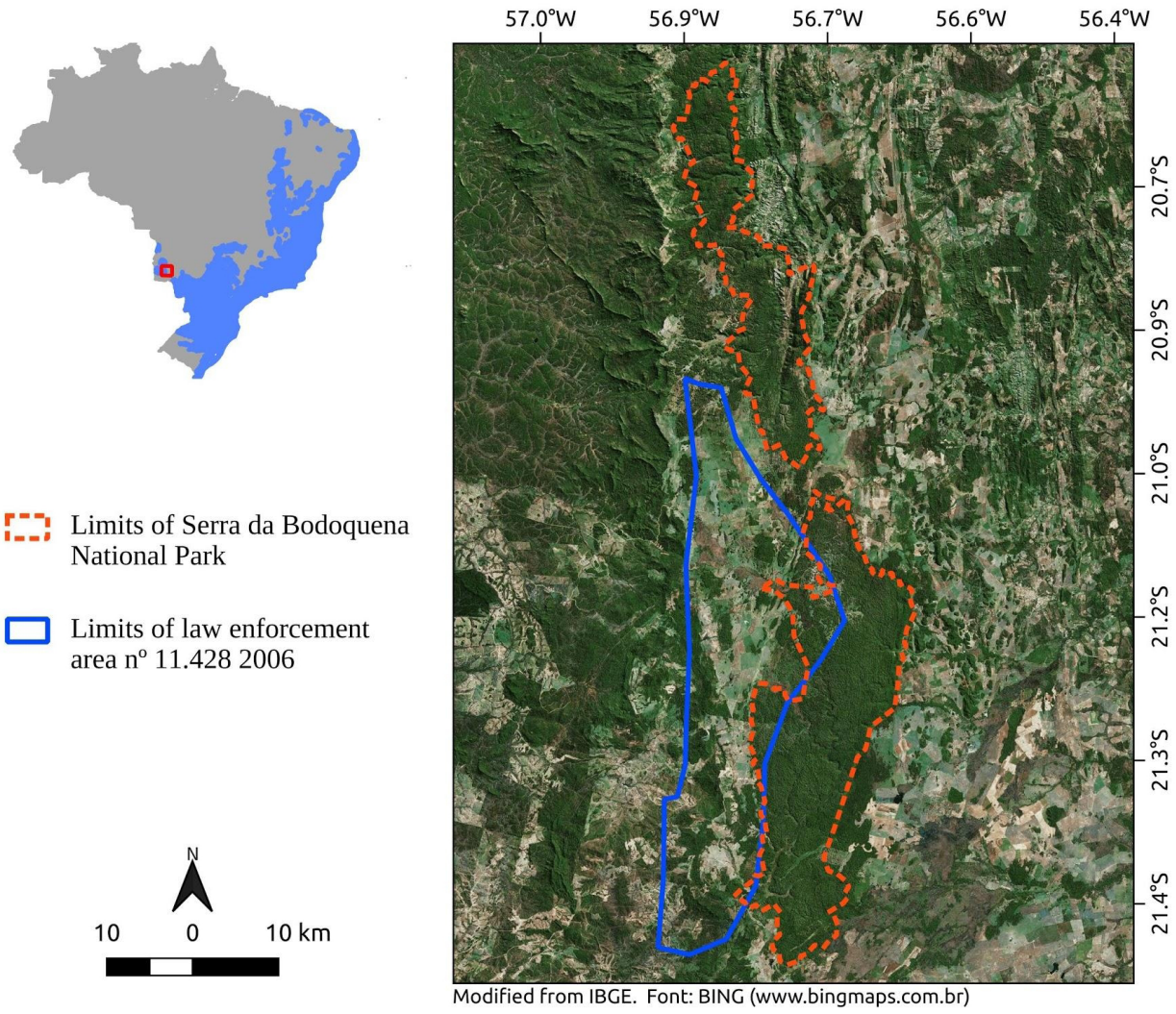

Figure 1. Delimitation of law enforcement map No. 666 2006 for the region of the Serra da Bodoquena National Park, Mato Grosso do Sul State, Brazil. The map only shows places in the southern fragment as subject to the Atlantic Forest Law, and the displacement of the map in relation to the southern fragment. The limits of application of the Law are the same as those defined as the limits of the Atlantic Forest biome.

land management problems and threaten the existence of the National Park. In 2019, landowners of neighboring lands were demanding the declassification of the National Park in front of the court (Bento Filho 2019; Terra & Souza 2019). Defining to which biome the PNSBd belongs is crucial in order to applying the appropriate laws and avoid misinterpretation.

Thus, we evaluated whether floristic information allows a clear definition of the domain biome of SDTF fragments outside the enforcement area of the Atlantic Forest Law, as a tool to avoid different interpretations with regard to law enforcement. We use Serra da Bodoquena National Park as a case study, as this National Park is composed of two fragments of SDTF, one defined under the Atlantic Forest domain and protected by the Atlantic Forest Law, while the other is considered to be part of the Cerrado domain. We carried out a floristic inventory and analyzed the similarity of the floristic composition of the two fragments as well as the floristic pattern of the surrounding biomes.

Material and methods

Study area

The Serra da Bodoquena National Park is located in Bodoquena, Bonito and Jardim municipalities of Mato Grosso do Sul State, Brazil. Created on 21 September, 2000, the park has an area of approximately 77,000 ha, divided into a northern fragment of approximately 27,800 ha and a southern of about 49.200 ha (Brasil 2000; ICMBio 2013). The Köppen classification of the climate is Aw (tropical

savannah), with rainy summers from October to April and dry winters. The mean annual rainfall is between 1,000 and 2,000 mm. While the region can experience sub-zero temperatures in the winter, monthly averages are above 18 °C. The predominant soil types are rhenzic chernosols, rigolitic neosols and red argisols. However, while the predominant vegetation is Seasonally Dry Tropical Forests, other vegetation types are also represented, including rocky outcrops with cacti, riparian forests, wetlands and dry forests (Damasceno-Junior *et al.* 2007; ICMBio 2013). In addition to the divergent biome interpretation, Serra da Bodoquena National Park has another problem. The process of consolidation of a park in Brazil generally occurs in many steps after its creation. The Brazilian government has to pay for the private land. While these compensations are not completed, the owners can continue their economic activities. Most farmers in the Bodoquena National Park are still waiting for compensation. This difference in legislation has increased problems with regard to land use and hampered the conservation of both fragments.

Collection sites

We collected and recorded plants at four sites in the southern fragment of the Serra da Bodoquena NP and five in the northern one (Fig. 2). These sites still keep the name of the cattle ranches ("fazendas" in Portuguese), because the previous owners have not yet been compensated. The sample sites in the southern fragment were: Fazenda Boqueirão (21°07'19.2"S, 56°43'12.0'W), Fazenda Santa Fé (21°15'14.4"S, 56°43'30.0"W), Reserva de Patrimônio Particular Natural Reserva do Saci (RPPN Reserva do Saci; 21°06'18.8"S, 56°37'40.8"W) and Fazenda La Harmonia (21°30'36.0"S, 56°45'07.2"W).

At Fazenda Boqueirão, we started the survey on the foothill, near the sinkhole of the Perdido River, and moved toward the top. The predominant vegetation on the foothill is Seasonal Semideciduous Forest (SSF), and along the uphill trail, the vegetation gradually becomes characteristic of Seasonal Deciduous Forest (SDF), and the terrain presents rocky outcrops.

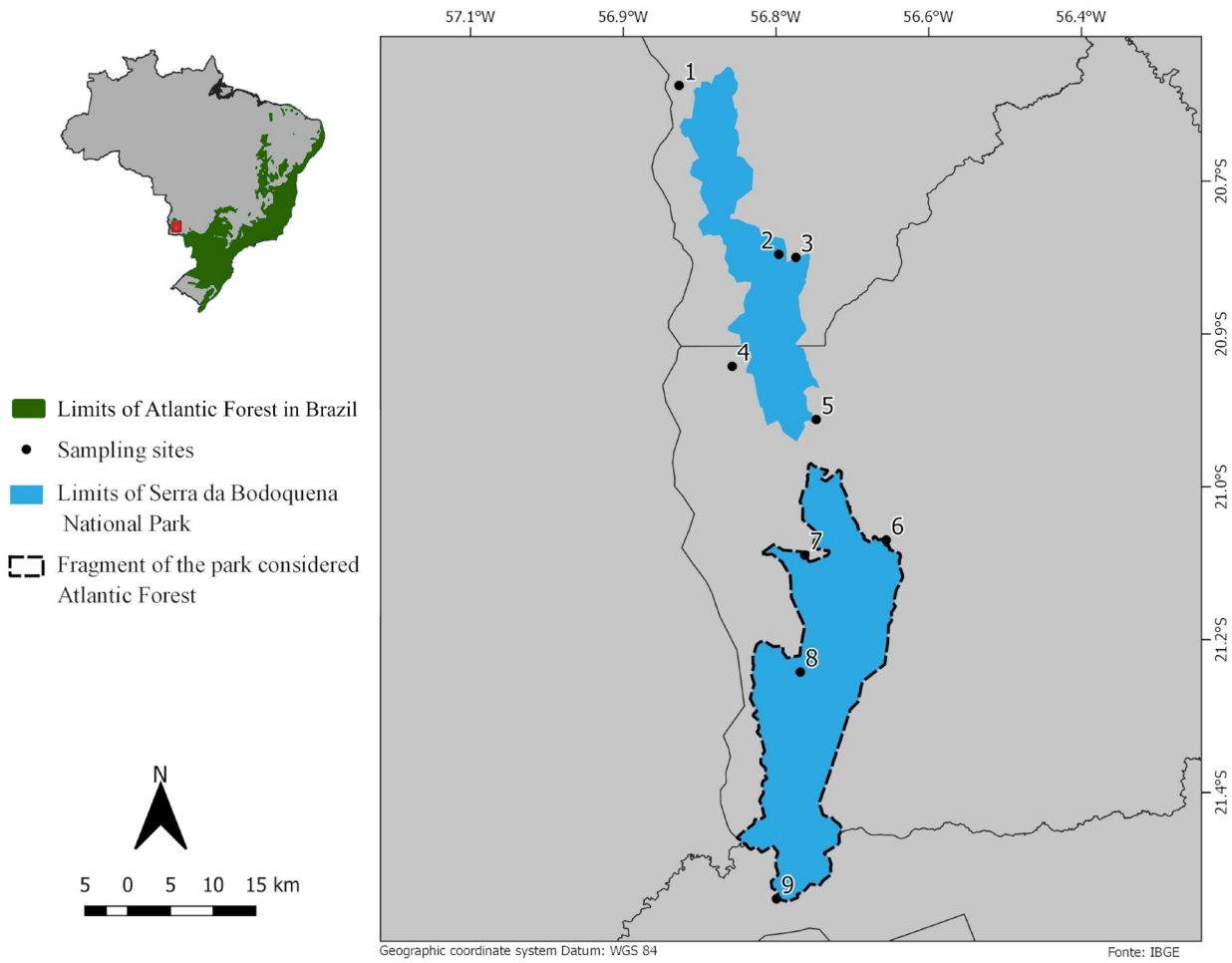

Figura 2. Sampling sites of the floristic inventory of the Serra da Bodoquena National Park: 1- Fazenda Sol de Maio; 2 – Fazenda Ouro Verde – Morro do Dente de Cão; 3 – Fazenda Ouro Verde; 4 – Fazenda Muralha; 5 – Fazenda Marambaia; 6 – RPPN Reserva do Saci; 7 – Fazenda Boqueirão; 8 – Fazenda Santa Fé; 9 – Fazenda La Harmonia.

At Fazenda Santa Fé, collection began in a small floodable area in the valley, which had small temporary ponds and up to 20-cm deep flooded patches. On the low slope, little islets of rocky outcrops occur with vegetation characteristic of dry habitats. The more elevated areas present vegetation of SSF. The RPPN Reserva do Saci and the Fazenda La Harmonia also have SSF vegetation.

In the northern fragment, the sampled sites were: Fazenda Marambaia (20°58'08.4"S, 56°42'25.2"W), Fazenda Muralha (20°54'28.8"S, 56°47'27.6"W), Fazenda Sol de Maio (20°34'47.28"S, 56°51'03.6"W), Fazenda Ouro Verde (20°47'09.6"S, 56°43'26.4"W), and Fazenda Ouro Verde-Morro Dente de Cão (20°46'51.6"S, 56°44'38.4"W). The native vegetation of Marambaia, Muralha, Sol de Maio, and Ouro Verde can be characterized as SSF, very similar to sites in the southern fragment. The Ouro Verde-Morro Dente de Cão site is located at a higher elevation with extended limestone outcrops and ruiniform relief ("Dente de Cão" means dog's tooth in Portuguese), with more open vegetation.

Data collection and analysis

The floristic assessment was carried out during 10 days in the spring, in 30 October - 10 November, 2018 to capture the abundance of flowering plants. We selected samplings as far from each other as possible to cover the fragments and to achieve homogeneous and representative sampling. We used the "wandering" technique of rapid inventory, with a minimum of five hours of survey (Filgueiras *et al.* 1994). During the survey, we recorded the species of trees and shrubs identified vegetatively and from collected fertile material, which was later deposited in the CGMS Herbarium of the Federal University of Mato Grosso do Sul. We compared vouchers of plants identified in the field with the collection of the CGMS Herbarium and consulted the literature (*e.g.*. Ramos *et al.* 2008; Souza *et al.* 2019) and virtual herbaria. When necessary, the identification of recorded species were also checked by taxonomists. We verified species distribution and new occurrence data for Mato Grosso do Sul State using the Flora do Brasil website (JBRJ 2020) and the collections of the CGMS Herbarium. We verified the threat risk of species in the IUCN red list (https://www.iucnredlist.org/).To assess the floristic similarity between the northern and the southern fragment, we generated a spreadsheet of species presence and absence at the sampling site . For this analysis, we removed unidentified species. We then calculated Jaccard index of similarity and a cluster analysis using unweighted pair group method with arithmetic mean (UPGMA; Legender & Legender 1998). We tested the differences between the groups using Permanova analysis and the *pairwise.adonis* post-hoc test. All analyses were performed using the *vegan* (Oksanen *et al.* 2019) and *pairwise.adonis* (Arbizu 2019) packages of the software R version 4.3 (R Core Team 2023).

Results

We identified 202 tree and shrub species representing 140 genera of 48 families. Eight families represented 50% of the species diversity, including trees and shrubs at PNSBd, Fabaceae (29 species), Euphorbiaceae (15), Malvaceae (13), Rubiaceae (11), Meliaceae, Rutaceae and Myrtaceae (each with nine species), and Bignoniaceae (eight; Figure S1). Fifteen families were represented by a singleton. The species-richest genera (five species each) were *Aspidosperma*, *Handroanthus*, *Inga*, *Piper* and *Trichilia*, followed by *Casearia* and *Zanthoxylum* (four species each; Figure S2). For the complete list of species, see the Supplementary Material Table 1.

Out of the 202 recorded species, 120 were characteristic of SSF, including as *Aspidosperma polyneuron* Müll. Arg. (Apocynaceae) and *Celtis iguanaea* (Jacq.) Sarg. (Cannabaceae), 19 species characteristic of SDF, including *Pseudobombax marginatum* (A.St.-Hil., Juss. & Cambess.) A.Robyns (Malvaceae) and *Brasiliopuntia brasiliensis* (Willd.) A.Berger (Cactaceae), and 62 species occured in both vegetation types, such as *Astronium fraxinifolium* Schott (Anacardiaceae) and *Adelia membranifolia* (Müll. Arg.) Chodat & Hassl. (Euphorbiaceae). Over two-thirds of the species (154) occured in the Atlantic Forest biome, with 12 restricted to the biome, for example, *Campomanesia xanthocarpa* (Mart.) O.Berg (Myrtaceae). We identified six new occurrences for Mato Grosso do Sul State, *Aralia warmingiana* (Marchal) J.Wen (Araliaceae), *Terminalia mameluco* Pickel (Combretaceae; Fig. 3), *Jatropha mollissima* (Pohl) Baill. (Euphorbiaceae), *Inga ingoides* (Rich.) Willd. (Fabaceae), *Picrasma crenata* (Vell.) Engl. (Simaroubaceae; Fig. 3) and *Zanthoxylum monogynum* A.St.-Hil. (Rutaceae) (Supplementary Material Table 1). Three species were globally Near threathend and three Vulnerable and three Endangered (Supplementary Material Table 1).

SSF vegetation generally occurred on flat areas with deeper soils, with species such as *Guarea kunthiana* A.Juss. (Meliaceae), *Jacaratia spinosa* (Aubl.) A.DC. (Caricaceae), *Attalea phalerata* Mart. ex Spreng. (Arecaceae), *Aspidosperma cylindrocarpon* Müll.Arg. (Apocynaceae) and *Nectandra hihua* (Ruiz & Pav.) Rohwer (Lauraceae) (Fig. 4 A-C). However, on hilly areas and in areas with rocky outcrops the vegetation had gradients of SDF, containing elements, such as *Cenostigma pluviosum* (DC.) Gagnon & G.P.Lewis (Fabaceae), *Senegalia polyphylla* (DC.) Britton & Rose (Fabaceae), *Averrhoidium paraguaiense* Radlk. (Sapindaceae), *Ceiba pubiflora* (A.St.-Hil.) K.Schum. (Malvaceae), *Cereus bicolor* Rizzini & A.Mattos (Cactaceae), *Eriotheca roseorum* (Cuatrec.) A.Robyns (Malvaceae), *Terminalia mameluco* and *Rhamnidium elaeocarpum* Reissek (Rhamnaceae) (Fig. 4 D-F).

The Permanova analysis identified two distinct groups ($p = 0.022$), formed by Fazenda Ouro Verde - Morro Dente

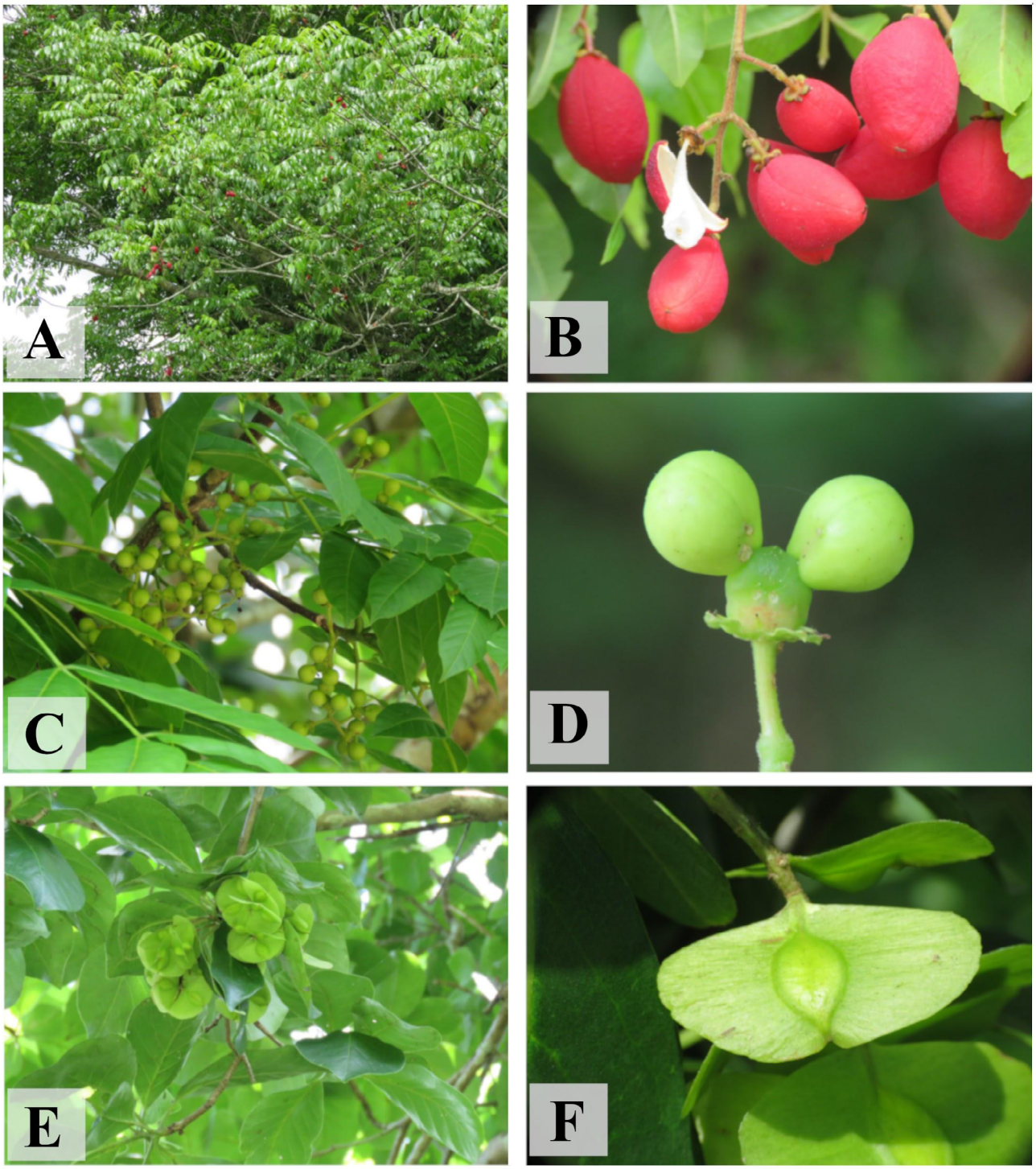

Figure 3. Typical species of Atlantic Forest of occurrence in Seasonal Forests of Southeast and Northeast of Brazil, found in almost all areas of forest in the Serra da Bodoquena National Park, Mato Grosso do Sul State, Brazil: *Averrhoideum paraguaiense* in A – general aspect of the tree and in B detail of fruits. *Picrasma crenata* in C – general aspect of a branch and in D – Detail of the apocarpic fruit. *Terminalia mameluco* in E - general aspect of a branch and F - Detail of the fruit.

do Cão and Fazenda Sol de Maio and by the other collection sites, respectively (Fig. 5). However, we did not verify any difference in distribution pattern between the northern and southern fragments of the PNSBd, suggesting that both fragments present have the same type of SDTF vegetation with a similar floristic composition (Fig. 5).

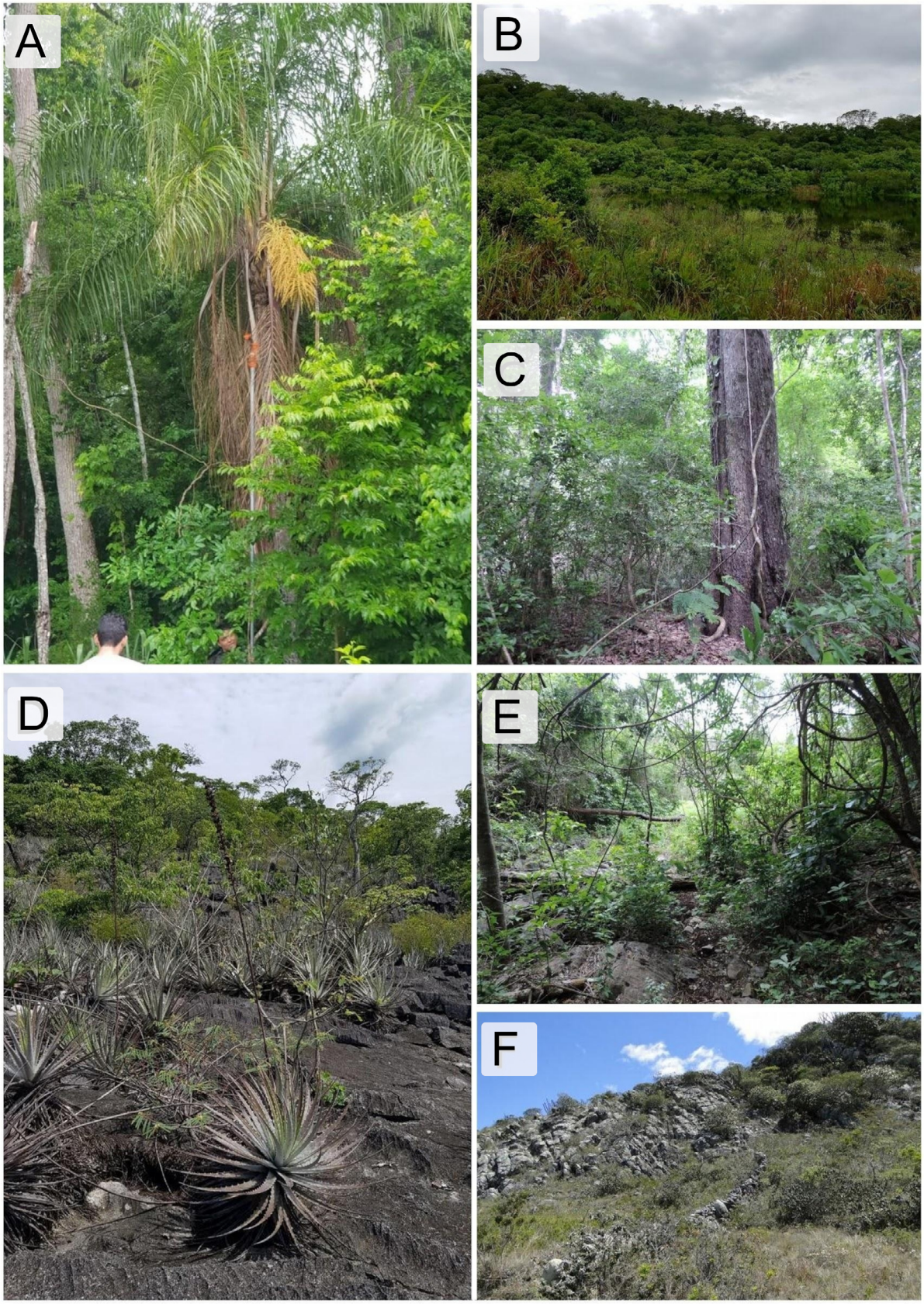

Figure 4. Aspects of the sampled vegetation types in the Serra da Bodoquena National Park, Mato Grosso do Sul State, Brazil. A - Seasonal Semideciduous Forest with *Syagrus romanzoffiana*; B, C and E - Seasonal Deciduous Forest; D and F - Areas on the hill Dente de Cão with rocky outcrops and ruiniform relief, with xerophytes (*e.g.*., *Dyckia* sp.).

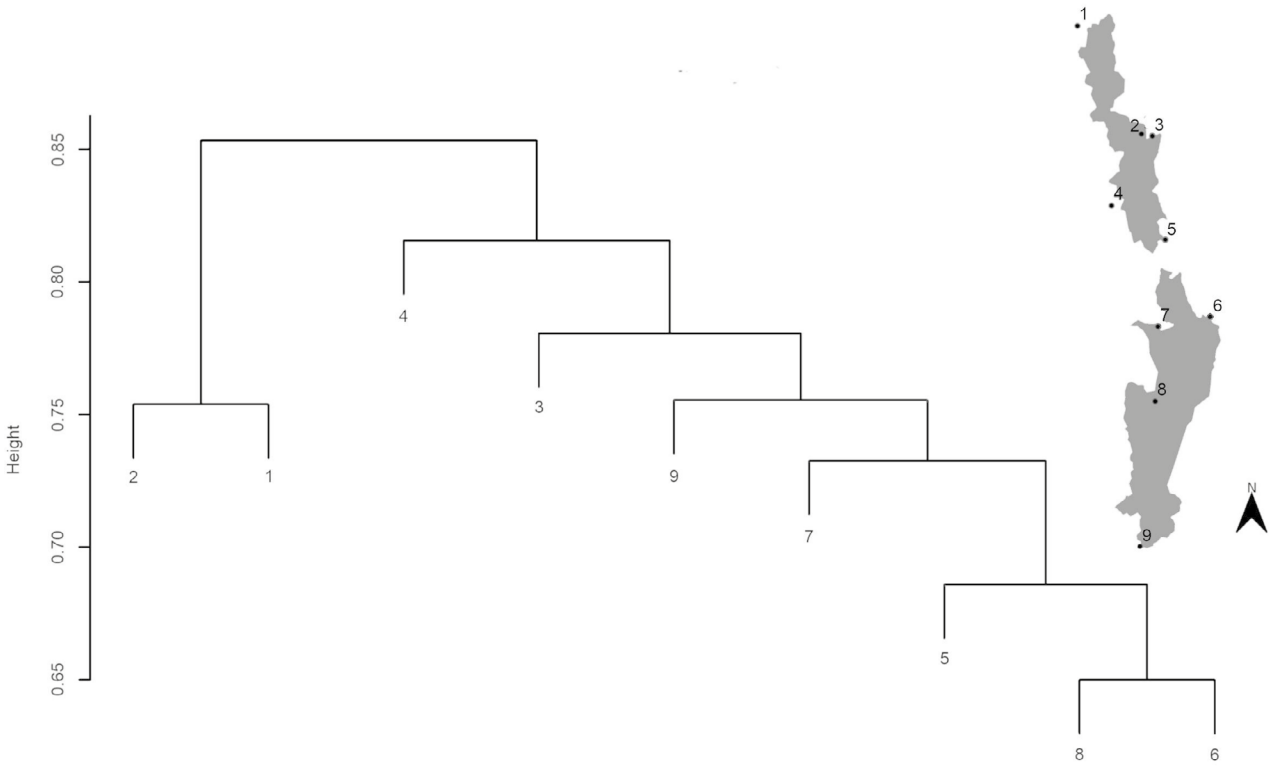

Figure 5. Dendrogram based on group mean and Mountford Similarity Index based on presence-absence matrix for 179 of tree and shrub species in the Serra da Bodoquena National Park, Mato Grosso do Sul State, Brazil. 1- Fazenda Sol de Maio; 2 – Fazenda Ouro Verde – Morro do Dente de Cão; 3 – Fazenda Ouro Verde; 4 – Fazenda Muralha; 5 – Fazenda Marambaia; 6 – RPPN Reserva do Saci; 7 – Fazenda Boqueirão; 8 – Fazenda Santa Fé; 9 – Fazenda La Harmonia.

Discussion

We found high floristic similarity between the two fragments, suggesting that both have the same type of SDTF vegetation with a similar floristic composition. Out of the 202 species of trees and shrubs recorded in the National Park, all are characteristic species of SSF, SDF or both, suggesting that the vegetation of the two fragments can be considered SDTF. Moreover, approximately 76% of these tree and shrub species can be considered typical of the Atlantic Forest (Ramos *et al.* 2008). The predominant Atlantic Forest vegetation and floristic composition and the similarity between them suggest that both fragments can be considered as Atlantic Forest vegetation, even though the northern fragment is currently mapped as part of Cerrado domain.

Fabaceae family contains the highest number of most tree species in the world (Beech *et al.* 2017). Members of this family are a common and predominant feature of the flora of Mato Grosso do Sul State, and Brazil in general (Neves *et al.* 2015; Sartori *et al.* 2018). Fabaceae species are particularly numerous in SSF (Mogni *et al.* 2015; Damasceno-Junior *et al.* 2018; Souza *et al.* 2019). The absence or low frequency of some families, such as Melastomataceae and Vochysiaceae that are characteristic of the Cerrado biome (Zappi *et al.* 2015), reinforce the connection of the National Park with the Seasonal Forest. Similar to the patterns in families, the genera with the highest species richness found in our two fragments are also characteristic of SDTF (Damasceno-Junior *et al.* 2018; Souza *et al.* 2019). Also, the typical Atlantic Forest species that occur throughout the sample sites in both fragments of the National Park can be considered another indicator that the vegetation of both fragments is composed of SDTF.

Besides the species endemic to the Atlantic Forest, we also identified some restricted-range species in the National Park, such as *Averrhoidium paraguaiense*, with records only in areas of limestone outcrop in Paraguay and the Brazilian states of Mato Grosso do Sul and Minas Gerais (JBRJ 2020), and *Basistemon silvaticus*, which has only been recorded in Bolivia and in Mato Grosso do Sul State in Brazil (JBRJ 2020). We highlight that *Terminalia mameluco* has been described from the Brazilian Southeast and Northeast (JBRJ 2020), in Mato Grosso do Sul State, it has so far only been found at Serra da Bodoquena.

Floristic survey of the region showed that the National Park also has a high species richness of other growth forms, including herbaceous and lichens. The herbaceous flora observed during our field collections, although not analysed here, was also related to the Atlantic Forest, with examples, such as Poaceae *Leersia ligularis* Trin., *Pharus lappulaceus* Aubl. and *Streptochaeta spicata* Schrad. ex Nees (unpublished data). Recently, 12 new species of lichens have been described from PNSBd (Aptroot & Spielmann 2020). The same study also reported 27 first records for lichen species for Brazil and 265 new records for Mato Grosso do Sul State, totaling 412 species, mostly shared with Atlantic Forest, Amazonia and Northeast, not the Cerrado (Aptroot & Spielmann 2020). In fact, remote and less-explored areas of Serra da Bodoquena National Park hold a great potential for discovering additional occurrences and even new species, particularly among less-known taxa, such as lichens, potentially representing significant contributions to scientific knowledge.

The flora composition was similar in all collection sites, indicating that the two fragments have the same vegetation. The separation of the two sites (Fazenda Ouro Verde - Morro Dente do Cão and Fazenda Sol de Maio) in the cladogram can be explained by their distinct environmental characteristics. At Fazenda Ouro Verde - Morro Dente do Cão, we sampled a rocky outcrops and a ruiniform relief. In fact, approximately 900 m^2 of this sampling site was on top of a hill, where the arboreal stratum is quite open and limited by the harsh conditions, only SDF species occur, which are adapted to the very shallow soil. The other outlier, Fazenda Ouro Verde was cleared and is in an advanced stage of recovery, but still contains exotic elements, such as *Psidium guajava* and *Citrus* spp.

The discrepancy between the results of our floristic inventory and the Atlantic Forest Law Enforcement Map with regard to the northern fragment may be related to the methods that were used to make the map, and its scale. The delimitation of biomes was based on remote sensing, which can fail to record certain vegetation types and also contains classification errors, as it does not differentiate between vegetation types with similar structure (Beuchle *et al.* 2015; Miranda *et al.* 2018). Furthermore, as the map was created to identify the remnants of the Atlantic Forest throughout Brazil, its scale is 1: 5,000,000 (IBGE 2004), a relatively coarse resolution that could lead to inaccurate classification at higher resolution.

Floristic inventory provided a clear definition of the biome of both fragments based on the predominant families, genera and species being characteristic of SDTF, the high proportion of Atlantic Forest species, and the high number of Atlantic Forest endemics. In addition, the floristic inventory provided new information about local and regional biodiversity. Therefore, this method can be considered an essential tool in solving problems and clarifying divergences, as we demonstrated in the cases with SDTF fragments outside the Atlantic Forest domain. However, lack of information with regard to flora can be a limiting factor in this approach. Although some the flora in some regions of Brazil have been thoroughly studied, there are still knowledge gaps regarding the botanical diversity of other regions, precluding the implementation of broad public policies, as well as the delimitation of high priority areas for conservation (Alves *et al.* 2018).

The floristic similarity between the northern and southern fragments of the National Park justifies their inclusion in the Atlantic Forest biome. This will change the relevant legislation and consequently, the management of these areas and the neighboring properties. This change in the governing legislation is fundamental for the conservation of the biodiversity values of the National Park not only to avoid misinterpretation about vegetation use and conservation legislation, but also because the Atlantic Forest Law is more restrictive than other environmental laws in Brazil with regard to the use and conservation of vegetation. Maintaining the integrity of the Serra da Bodoquena region as a National Park is of strategic importance for Brazil, since its genetic resources are still unknown and there may be yet undescribed taxa.

Given the efficiency of the floristic survey demonstrated in our study, we believe that the results of these surveys should overrule the presence or absence of particular native vegetation as conveyed by the maps in cases of doubt or divergence. Thus, floristic survey can be a relevant tool in environmental licensing decision-making in fragments outside the boundaries of the map depicted by the Atlantic Forest Law map and even the areas within its boundaries, considering that the Atlantic Forest was deforested approximately 1.5% in 2022 (Mapbiomas 2023). Fragments of STDF outside the boundaries of the Atlantic Forest are mainly in the Cerrado and the Pantanal, with the highest annual deforestation rates (Mapbiomas 2023), highlighting the threat to these fragments. Therefore, we believe that a properly carried out floristic survey, combined with environmental licensing, can reduce deforestation in these biomes. Thus, floristic survey is not only a simple and quick scientific approach, but also proved to be an adequate approach, presentinged advantages that go beyond a clear definition of the domain biome.

Conclusion and conservation implications

The presence of an Atlantic Forest patch outside the area of law enforcement, adds another important aspect to the conservation of this biome. In fact, SDTF fragments in adjacent phytogeographic domains, such as the Cerrado, may belong to the Atlantic Forest. In these cases, the conservation of these fragments is relevant for the conservation of the Atlantic Forest as a whole biome, as these disjunct fragments

may contain a representative number of plant species, including endemic and restricted-distribution species, as is the case of the Serra da Bodoquena National Park. Protection laws need to be modified to consider the existence of these and other patches that are not limited to the area provided for in the decree (No. 6.660 / 2008). The legislation should consider identifying targeted patches, not only based on their geographical location, but also considering floristic composition and the presence of indicator species.

Supplementary material

Table S1. List of trees and shrubs recorded in nine sampling sites in the Serra da Bodoquena National Park, Mato Grosso do Sul (MS), Brazil. SSF = Seasonal Semideciduous Forest, SDF = Seasonal Deciduous Forest.

Figure S1. Species richness of the main families of trees and shrubs found in the Serra da Bodoquena National Park.

Figure S2. Species richness of the main genera of trees and shrubs found in the Serra da Bodoquena National Park.

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