

SCIENTIFIC ARTICLE

Ornamental flora of the Cerrado in landscape architecture: a portrait of its practical application

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Abstract

The rich diversity of the Cerrado flora has great ornamental potential, however it is barely present in Landscape Architecture projects in Brazil and incipient in the commercial market. The study sought to systematize part of the knowledge generated by the experiences of eight professionals who work in the Landscape Architecture field and are part of a spontaneous and growing movement that seeks the development of management techniques and a language referenced by phytophysiognomies of the Cerrado, especially its savannas and grasslands. Information was gathered from semi-structured interviews with eight professionals with practical experience in introducing Cerrado flora species in Landscape Architecture projects and analyzed to identify motivations, composition and language aspects, most-used species, technical aspects of implementation and management and perceptions of market and production chain. Reiterated points were mapped and categorized. Interviews revealed efforts to develop a compositional language referenced by the Cerrado with a predominance of herbaceous species and high species diversity in keeping with the contemporary naturalistic Landscape Architecture movement. A list of 84 potentially ornamental species used by interviewees was compiled. Difficulties and market impasses were identified. Much needed strategies for increasing Cerrado flora species use in Landscape Architecture are: engagement of society via environmental education, communication and marketing; research on Cerrado soil and ecology for species selection; qualification of labor; advocacy for public policies including promotion of production chains, research and education.

Keywords: landscape architecture language, management techniques, market, systematization.

Resumo

Flora ornamental do Cerrado no paisagismo: retrato da aplicação prática

A rica diversidade da flora do Cerrado tem alto potencial ornamental, porém é pouco presente em projetos paisagísticos no Brasil e incipiente no mercado comercial. O estudo buscou sistematizar parte do conhecimento gerado pelas experiências em paisagismo de oito profissionais que fazem parte de um movimento espontâneo e crescente buscando o desenvolvimento de técnicas de manejo e de uma linguagem paisagística referenciada pelas fitofisionomias do Cerrado, especialmente suas savanas e campos. A informação foi colhida por meio de entrevistas semiestruturadas com oito profissionais com experiência prática na introdução de espécies da flora do Cerrado em projetos de paisagismo e analisada para identificar aspectos de motivação, composição e linguagem, espécies mais usadas, aspectos técnicos da implementação e manejo e as percepções de mercado e da cadeia produtiva. Pontos reiterados foram mapeados e categorizados. As entrevistas revelam os esforços envidados para desenvolver uma linguagem composicional referenciada pelo Cerrado com a predominância de espécies herbáceas e alto índice de diversidade compatíveis com o paisagismo naturalista contemporâneo. Foi compilada uma lista de 84 espécies com potencial ornamental e impasses associados ao mercado foram identificados. As estratégias necessárias para estimular o aumento no uso de espécies da flora do Cerrado no paisagismo são: o engajamento da sociedade por meio de educação ambiental, comunicação, 'marketing'; pesquisa em solos e ecologia do Cerrado para viabilizar a seleção de espécies; treinamento de mão de obra especializada; e 'advocacy' para obter políticas públicas promovendo as respectivas cadeias de produção, pesquisa e educação.

Palavras-chave: linguagem paisagística, mercado, técnicas de manejo, sistematização.

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Introduction

Cerrado is the second largest biome in South America, that covers about 22% of the land area of Brazil. Considered as one of the world's hotspots of biodiversity, the Brazilian Cerrado is the richest savanna in the world, hosting 11,627 species of native plants and a rich fauna. The biome is also the territory of native peoples, part of the Brazilian historical and cultural heritage, and who have knowledge of their biodiversity (Brasil/MMA, 2020). However, the identity of Cerrado savannas and grasslands does not appear, historically, as a striking element in Brazilian Landscape Architecture. In general, existing experiences favor the use of species from the tree strata (Siqueira et al., 2017). Trees, however, represent less than 20% of the Cerrado plant species (Durigan, 2020). Apart from tree species, the market for ornamental plants native to the Cerrado is incipient (Pastore, 2020) and (Gomes et al., 2020).

There is still much to discover about Cerrado's flora, the main threats to its conservation and economic potential (Souza et al., 2018). After the Atlantic Forest, the Cerrado is the Brazilian biome that has undergone the most changes stemming from human occupation and agriculture (Brasil/MMA, 2020). In general, biodiversity is not understood as a comparative advantage in Brazil (Coradin and Camillo, 2016), and this apparently extends to Brazilian Landscape Architecture, despite the remarkable work of using and valuing native flora done by highly renowned landscape designers and architects in our history. Glaziou (1828 - 1906), introduced species of native flora in composition with exotic ones widely used gardens and urban parks (Herbário Virtual Auguste Glaziou, 2020). The modern gardens of Mina Klabin Warchavchik (1896-1969) are considered pioneers in the use of cacti and mandacarus (*Cereus jamacaru* D.C.), (Sandeville Jr., 2003). Roberto Burle Marx (1909-1994) is known worldwide for incorporating the heterogeneity of Brazilian flora in his projects. When analyzing his participation in the landscape configuration of Brasília, Burle Marx, like Lúcio Costa, wanted to bring to the inhabitants the knowledge of Brazil's natural wealth, and at the same time, help to perpetuate endangered species. (Oliveira, 2015). Fernando Chacel (1931-2011) stood out in contemporary Landscape Architecture in Brazil by incorporating the concept of ecogenesis for restoration of degraded ecosystems using native vegetation.

As for the Cerrado's flora, its use has been quite restricted. In general, it appears sporadically and in a small number of the works of a few professionals in the region, usually incorporated into traditional compositions.

More recently, the search for a language specific to the Cerrado and the use of its flora has inspired the pioneering work of Mariana Siqueira, creator of the *Jardins de Cerrado* project, which, since 2015, has striven to create landscape expressions for the savannas and grasslands of Central Brazil through the introduction of its undergrowth in

urban gardens (Siqueira, 2016; Siqueira et al., 2017). Also, several designers have been carrying out garden projects and other experimental projects in this area, in a movement of attention to the Cerrado that is gaining unprecedented strength in the Landscape Architecture of the region, and may mean a broad renovation in its techniques and aesthetics.

This attention extends to the academic field. The aesthetic appreciation of the Cerrado and its cultural appropriation have been addressed by Professor Júlio Pastore, (Pastore, 2012; Pastore 2020). Academic works at UnB, in both Agronomy and Architecture faculties, include research on prospecting and behavior of ornamental species of Cerrado flora, developed in 2018 by M. Granzotto 'Analysis of the initial growth of herbaceous and sub-shrub species of the Cerrado for landscape purposes', Helena Bokos, "Jardins de Cerrado: Ideas for creating a landscape identity using native flora" in 2017, and the research by Pedro Dias Boa Sorte, "Thermal simulation of green walls composed of native vegetation from the Cerrado", in 2016. At the School of Agronomy of the Federal University of Goiás, Professor Larissa Leandro Pires has coordinating research on the feasibility of cultivating Cerrado species for ornamental purposes, as the results seen in Zucchi et al. (2019). At the same field, Embrapa Cerrados has published 'Ornamental Climbers of the Cerrado' (Ramalho and Proença, 2004). It is also worth mentioning the great influence of research and initiatives in the area of restoration of the Cerrado, such as those developed by Ib/UnB, Embrapa, the *Rede de Sementes do Cerrado* (Cerrado Seeds Network), among others.

The objective of this work is to systematize part of the accumulation of knowledge generated with the practical application of the introduction of ornamental species of the Cerrado in Landscape Architecture, in order to contribute to the structuring of a new approach centered on the flora of the Cerrado and, ultimately, collaborate for the valorizing and protection of this biome. It is not intended to make an exhaustive study on the theme, but rather to present a picture of the current situation from the point of view of eight landscape designers who have, in different measures and in various ways, sought to refer to the Cerrado in their work, their motivations and dynamics and the incremental knowledge they have generated.

Material and Methods

The information on which this work is based was collected through individual semi-structured interviews with eight professionals carried out in the period from October 10, 2019 to January 1, 2020. The criterion for the selection of the interviewees was their practical experience with the introduction of the flora of the Cerrado in Landscape Architecture projects (public and private)¹, especially in the Federal District of Brazil.

¹ The distinction between garden types was not the object of this work. It is recommended that subsequent research raise the differences in the use of Cerrado flora species between public and private gardens.

The questionnaire, with open-ended questions, sought to comprehensively capture the motivations and composition and language aspects addressed by the interviewees; the species most used by professionals in their projects and technical aspects of implementation and management; and their perceptions of the market and the production chain. We opted to apply a semi-structured questionnaire to allow the interviewees to bring up the points they deemed most relevant in their answers. It was considered an indicative of relevance the number of times the points made were reiterated by the interviewees, through content analysis. The aim was capturing the prominent points in the set.

To organize the results, the responses of the interviewees were gathered and categorized according to the similarity of their central ideas. Thus, the aspects mentioned more than once in the set of interviews were mapped. The central ideas that emerged in the responses were systematized into three main topics and their subtopics:

1) Practice panorama (including: 1.1. Reasons for using native Cerrado species in Landscape Architecture; 1.2. Landscape Architecture features; 1.3. Deployment and management; 1.4. Market perception).

2) Challenges and strategies for the insertion of native Cerrado species in Landscape Architecture projects.

3) Listing of cited Cerrado native species.

Below we present the topics listed above, bringing together the convergent citations on each point, as well as an exemplary quote to illustrate the subject in question, when pertinent.

Interviewed professionals

Interviewed 1: a consultant in ecological restoration and commercialization of native seeds, biologist, MSc in Biological Sciences. Interviewed 2: Agronomist, MSc in Landscape Architecture and PhD in Architecture. Interviewed 3: postgraduate student of Ecology, owner of a landscape contracting and design company, produces seedlings of native ornamental species from the Cerrado. Interviewed 4: architect and urban planner, MSc in Architecture and Urbanism and PhD in Sustainable Development. Interviewed 5: architect and urban planner and environmental educator, owner of a Landscape Design office. Interviewed 6: forestry agronomist, MSc in Forest Sciences and specialist in Ornamental Plants and Landscape Architecture. Interviewed 7: agronomist, owner of a landscape contracting and design company, produces seedlings of native ornamental species from the Cerrado. Interviewed 8: landscape architect, MSc in Landscape Architecture, business owner of a landscape contracting and design company.

Results

Landscape Architecture practices panorama

In this topic we present the relevant points regarding the interviewees' experiences, their motivations and perceptions.

Reasons for the use of native Cerrado species in landscape architecture

The main reasons cited involve objective aspects referring to environmental sustainability: the need to conserve biodiversity (5 citations), support for fauna and decrease in water use (3 citations) and the adaptation of species to local climate and soil conditions (2 citations). Among the subjective factors, aspects related to the aesthetic quality of the Cerrado flora emerge (3 citations), the promotion of the appropriation of the Cerrado as a landscape and the identity relationship with the biome (2 citations each).

As an illustration of these points, we highlight the speech of interviewee 5 who defends the representation of the biome in constructed landscapes as a way of bringing people closer to the original flora and landscapes, contributing to the dissemination of aspects of the Cerrado ecology and aesthetics and the conservation of biodiversity: "The garden has become for me much more a means to promote education than an end in itself". Interviewee 2 states that Cerrado species help with the identity issue and can contribute to better continuity solutions between the scales of the gardens and the landscape:

"The very marked separation between the aesthetic references of the gardens and the natural areas, as in the case of the Cerrado, can contribute to their urban remnants being considered 'wastelands'. In this sense, [the ornamental species of the Cerrado] have social, cultural, economic and ecological importance".

Landscape Architecture features

The inclusion of one or more native species from the Cerrado in at least 70% of the designs carried out in 2019 was recurrent for 75% of respondents. The association between native and exotic species in Landscape Architecture is perceived positively by most professionals (87.5%). Interviewee 7, for example, does not make exclusive use of native species from the Cerrado and defends a gradual strategy of inserting native flora in Landscape Architecture projects, until reaching the point of creating a garden exclusively with these species: "We are in a scenario of people's lack of knowledge about native plants, of prejudice against what is native. So, I think radicalism is not the best way. The Cerrado can be integrated by various garden concepts.". Interviewee 8 defends an ideal proportion of 80% native and 20% exotic plants, since, in his view, the exclusive use of native species "is not realistic; it is not economically feasible".

From the statements extracted from half of the interviewees (4 citations), it can be seen that in part of their projects there is a tendency to develop a landscape language that seeks the Cerrado's own identity, with a predominance of the herbaceous layer and high species diversity, aligned with the naturalist aspect. This point is exemplary in the speech of Interviewee 3, who associates the language of naturalist gardens with the diversity of the Cerrado's flora, mainly herbaceous species and grasses: "Only two or three

species could not fit in the garden with native species. Biodiversity must be worked on. [...] Nature is always the inspiration”.

Deployment and management

The techniques most used by the interviewees for the implementation of projects and garden management are: (i) Garden planting: by planting seedlings produced in a nursery (7 citations each); by direct sowing (planting from seeds) (7 citations); (ii) Weed control; by hoeing/pulling by hand, especially in cases of direct sowing (6 citations); by repeated soil harrowing before sowing (2 citations) and by spreading inert material to cover the soil (4 citations), (iii) Fertilization and soil management: low use of fertilizers (4 citations); use of mulching to enrich its microbiota (2 citations); (iv) Irrigation: watering during the dry season, especially during the establishment of the garden to guarantee the demand for water in the initial stage of species development (4 citations) and (v) Vegetation management: pruning close to the soil is applied for several species, mainly herbaceous, during the dry season, usually in naturalist compositions (3 citations); sporadic pruning can be indicated depending on each case (3 citations).

Market perception

For the interviewees, based on the implemented projects, clients who feel greater identification with the Cerrado respond well to the garden project with native flora (5 citations) and to the resulting garden (8 citations). Interviewee 1 points out that the client's positive attitude remains when they feel identified with the proposal. “[...] The client who has a little to look at, at first [on presentation of the project] eventually recognizes himself and sees himself as part”.

There is a market demand for native species from the Cerrado in Landscape Architecture projects (6 citations). The acquisition of seedlings and seeds is usually done in nurseries/commercial suppliers (6 citations) and from their own production (5 citations). Interviewee 6 estimates that requests for native seedlings from the Cerrado are not enough to maintain production costs in a nursery at present, but she believes that will change over the years. “The more we start using it, the more demand will increase”.

Challenges and potential strategies for the insertion of native Cerrado species in Landscape Architecture

In this topic, we bring together the main challenges and strategies for phasing the inclusion of native species from the Cerrado in Landscape Architecture, according to the systematization of the opinions and experiences reported by the interviewees.

The structuring of production and commercialization chains would be a key point for including native plant

species in Landscape Architecture, according to the responses of all interviewees (8 citations). For Interviewee 4, the experimental character of the initiative makes it difficult to obtain seedlings from a variety of plants: “I think it will take some time before it becomes commercial”.

Altered edaphic conditions is the main factor that impacts the results of gardens with native species, according to all respondents (8 citations). In particular, the use of limestone, making it hypertrophic and more alkaline, can prevent the development of native Cerrado species adapted to more acidic and nutrient-poor soils (3 citations).

Greater knowledge on the part of professionals about the native flora and Cerrado landscapes (4 citations) and its climatic conditions, especially in relation to the dry season (3 citations), were also mentioned as important in enabling a broader selection and management of species.

The need for more investment in research and systematization of knowledge, which is still scarce in the area, is pointed out as one of the fundamental factors to enable the dissemination of the incorporation of species of Cerrado flora in Landscape Architecture (6 citations).

The engagement of society through environmental education (3 citations) and communication and marketing strategies (3 citations) and, in particular, the dissemination of the Cerrado concept as a reference for Landscape Architecture (2 citations) could increase demand/acceptance of the Cerrado flora.

The investment in the qualification of teams for the implantation and maintenance of gardens (4 citations) are stated as fundamental aspects for their success. In that sense, the points that influence management are the workers' ability to identify the Cerrado flora (relevant mainly in the manual weeding of the gardens planted in direct sowing) (4 citations), and the technical knowledge for carrying out specific cultural treatments (2 citations).

Among the potential strategies to promote the expansion of the ornamental flora of the Cerrado in the market, issues related to the landscape language (5 citations) were mentioned, among which the establishment of a specific language, alignment with the naturalist aspect, ecological bias and greater species diversity.

Native Cerrado species listed

The potentially ornamental species of Cerrado flora indicated by the eight people interviewed resulted in a unique and unprecedented list. The 84 species listed belong to 21 families according to Brasil (2020), (Table 1).

There was a low repetition of species among respondents. Of the total species listed, only 23% were mentioned by two or more people. Among these, the *Schizachyrium sanguineum* (Retz.) Alston stands out, cited by half of the interviewed group. Among the 21 families, there was a preponderance of *Poaceae* (18%) and *Fabaceae* (14%).

Table 1. List of ornamental species of Cerrado flora indicated by respondents, organized by plant habits, according Brasil (2020).

Plant habits	Family		Scientific name	Endemic species	Red list (IUCN, 2020)
HERB	Asteraceae	**	<i>Achyrocline satureioides</i> (Lam.) DC.		
		*	<i>Aldama filifolia</i> (Sch.Bip. ex Baker) E.E.Schill. & Panero	x	
	Cyperaceae		<i>Rhynchospora elatior</i> Kunth		
		*	<i>Rhynchospora globosa</i> (Kunth) Roem. & Schult.		
			<i>Rhynchospora speciosa</i> (Kunth) Boeckeler.	x	
	Eriocaulaceae		<i>Actinocephalus bongardii</i> (A.St.-Hil.) Sano.	x	
	Poaceae		<i>Andropogon fastigiatus</i> Sw.		
		**	<i>Andropogon leucostachyus</i> Kunth		
			<i>Aristida gibbosa</i> (Nees) Kunth		
			<i>Aristida riparia</i> Trin.		
			<i>Aristida setifolia</i> Kunth		
		*	<i>Axonopus aureus</i> P. Beauv.		
			<i>Axonopus pellitus</i> (Nees ex Trin.) Hitchc. & Chase		
			<i>Axonopus siccus</i> (Nees) Kuhlmann.		
		**	<i>Loudetiopsis chrysothrix</i> (Nees) Conert		
			<i>Paspalum carinatum</i> Humb. and Bonpl. ex Flügge		
			<i>Paspalum bicilium</i> Mez		
			<i>Paspalum eucomum</i> Nees ex Trin.	x	
		**	<i>Paspalum stellatum</i> Humb. & Bonpl. ex Flügge		
		***	<i>Schizachyrium sanguineum</i> (Retz.) Alston		
*		<i>Trachypogon spicatus</i> (L.f.) Kuntze			
HERB/ SUB-SHRUB	Asteraceae	¹	<i>Aldama bracteata</i> (Gardner) E.E.Schill. & Panero	x	
			<i>Aldama robusta</i> (Gardner) E.E.Schill. & Panero	x	
	Lamiaceae		<i>Hypenia brachystachys</i> (Pohl ex Benth.) Harley	x	
			<i>Hypenia macrantha</i> (A.St.-Hil. ex Benth.) Harley	x	
Menispermaceae		<i>Cissampelos ovalifolia</i> DC.			
SUB-SHRUB	Apocynaceae		<i>Mandevilla longiflora</i> (Desf.) Pichon		
	Asteraceae		<i>Chresta exsucca</i> DC.		
			<i>Chrysolaena obovata</i> (Less.) Dematt.		

SUB-SHRUB/ BUSH	Bixaceae		<i>Cochlospermum regium</i> (Mart. ex Schrank) Pilg.		
	Calophyllaceae		<i>Kielmeyera regalis</i> Saddi	x	
	Fabaceae		<i>Calliandra dysantha</i> Benth.		
		*	<i>Mimosa claussenii</i> Benth.	x	x
		*	<i>Periandra mediterranea</i> (Vell.) Taub		
			<i>Senna rugosa</i> (G.Don) H.S.Irwin & Barneby		
	Melastomataceae		<i>Lavoisiera bergii</i> Cogn.	x	
	Myrtaceae		<i>Eugenia puniceifolia</i> (Kunth) DC.	x	x
Velloziaceae		<i>Vellozia compacta</i> Mart. ex Schult. & Schult.f.	x		
BUSH	Anacardiaceae	**	<i>Anacardium humile</i> A.St.-Hil.		
	Apocynaceae		<i>Allamanda laevis</i> Markgr.	x	
	Asteraceae		<i>Chresta sphaerocephala</i> DC.	x	
			<i>Lepidaploa aurea</i> (Mart. ex DC.) H.Rob.	x	
	Bignoniaceae		<i>Jacaranda ulei</i> Bureau & K.Schum.	x	
	Fabaceae		<i>Calliandra brevipes</i> Benth.		
		*	<i>Mimosa densa</i> Benth.		
		*	<i>Mimosa manidea</i> Barneby	x	
	Malpighiaceae		<i>Heteropterys pteropetala</i> A. Juss.	x	
	Melastomataceae		<i>Lavoisiera grandiflora</i> A.St.-Hil. ex Naudin	x	
			<i>Pleroma heteromallum</i> D.Don	x	
	Myrtaceae	*	<i>Campomanesia pubescens</i> (Mart. ex DC.) O.Berg	x	
		<i>Eugenia uniflora</i> L.			
Polygonaceae		<i>Coccoloba cereifera</i> Schwacke	x		
BUSH/ TREE	Anacardiaceae		<i>Schinus terebinthifolia</i> Raddi		
	Calophyllaceae	²	<i>Kielmeyera coriacea</i> Mart. & Zucc.		
	Fabaceae	²	<i>Senna silvestris</i> (Vell.) H.S.Irwin & Barneby		
	Lythraceae	²	<i>Diplusodon virgatus</i> Pohl		
	Malpighiaceae		<i>Byrsonima umbellata</i> Mart. ex A.Juss	x	x
			<i>Byrsonima verbascifolia</i> (L.) DC.		
			<i>Heteropterys byrsonimifolia</i> A.Juss.	x	
	Melastomataceae	**	<i>Pleroma candolleianum</i> (Mart. ex DC.) Triana	x	
Solanaceae		<i>Solanum lycocarpum</i> A.St.-Hil.			

TREE	Anacardiaceae		<i>Tapirira guianensis</i> Aubl.		
	Bignoniaceae		<i>Handroanthus chrysotrichus</i> (Mart. ex DC.) Mattos		
		*	<i>Jacaranda caroba</i> (Vell.) DC.	x	x
			<i>Jacaranda macrantha</i> Cham	x	
			<i>Tabebuia aurea</i> (Silva Manso) Benth. & Hook.f. ex S.Moore		
	Caryocaraceae		<i>Caryocar brasiliense</i> Cambess.		
	Fabaceae		<i>Copaifera langsdorffii</i> Desf.		
			<i>Hymenaea courbaril</i> L.		
			<i>Inga laurina</i> (Sw.) Willd.		
			<i>Inga marginata</i> Willd.		
Lythraceae		<i>Lafoensia pacari</i> A.St.-Hil.			
Melastomataceae		<i>Pleroma stenocarpum</i> (Schrank et Mart. ex DC.) Triana			
LIANA/ VINE/ CREEPER	Bignoniaceae	¹	<i>Fridericia platyphylla</i> (Cham.) L.G.Lohmann		
	Malpighiaceae		<i>Banisteriopsis gardneriana</i> (A.Juss.) W.R.Anderson & B.Gates	x	
PALM TREE	Arecaceae		<i>Acrocomia aculeata</i> (Jacq.) Lodd. ex Mart.		
			<i>Attalea geraensis</i> Barb.Rodr.		
			<i>Butia archeri</i> (Glassman) Glassman	x	
			<i>Euterpe edulis</i> Mart.		
			<i>Syagrus comosa</i> (Mart.) Mart.		
			<i>Syagrus flexuosa</i> (Mart.) Becc.	x	
			<i>Syagrus glaucescens</i> Glaz. ex Becc.	x	x
		*	<i>Syagrus oleracea</i> (Mart.) Becc.	x	
		*	<i>Syagrus romanzoffiana</i> (Cham.) Glassman		

* species cited by 2 interviewees; ** species cited by 3 interviewees; *** species cited by 4 interviewees

¹can be bush; ²can be sub-shrub

Regarding the plant habits, according to the data available in Brasil (2020), it can be affirmed that there is a balance between the strata, but with predominance of the lowest, verified by the greater presence of shrubs (40%), sub-shrubs (24%) and herbaceous plants (31%). (Table 2).

Table 2. Distribution of species by habit

Habit	Number of species *	Proportion in relation to the total species (N = 84)
Bush	34	40%
Herb	26	31%
Tree	21	25%
Sub-shrub	20	24%
Palm tree	9	11%
Liana /vine/creeper	2	2%

* a species can have more than one habit

According to data of Brasil (2020), most of the species listed are not endemic to Brazil (61%). All species occur in the Cerrado and 71% of them are present in at least more than one phytogeographic domain, especially in the Atlantic Forest (60%), followed by the Caatinga (43%) and the Amazon (39%).

Regarding the total number of species, again, according to the data available at Brasil (2020), the predominant vegetation types are Cerrado (*lato sensu*) (80%) and Campo Rupestre (rupestrian grassland) (52%) (Table 3). It is worth mentioning that during the elaboration of table 3 we noticed that most of the species listed (87%) are found in two or more types of vegetation among the 22 categories identified.

Table 3. The five types of Brazilian vegetation with the highest proportion of species mentioned in relation to the total number

Types of vegetation	Number of species *	Proportion in relation to the total species (N = 84)
Cerrado (<i>lato sensu</i>)	67	80%
Rupestrian grassland	44	52%
Campo Limpo (Cerrado grassland)	28	33%
Anthropic area	27	32%
Gallery Forest	22	26%

* a species can occur in more than one type of vegetation

The cited species are not commonly recognized as ornamental. For comparative purposes, when cross-referencing the list of 65 species of herbaceous plants, shrubs, sub-shrubs and vines listed by the professionals interviewed with the more than one thousand from the book *Plantas para Jardim no Brasil* (Plants for Gardens in Brazil) (Lorenzi, 2013), which is a reference for landscape architects and designers, only 7 species from the selected list (8%) appeared in that publication: *Allamanda laevis* Markgr; *Attalea gerensis* Barb.Rodr; *Calliandra brevipes* Benth; *Fridericia platyphylla* (Cham.) L.G.Lohmann; *Pleroma heteromallum* (D. Don) D. Don; *Pleroma stenocarpum* (Schrank et Mart. ex DC.) Triana; *Syagrus flexuosa* (Mart.) Becc. Among the endemic species, 5 were included in The IUCN Red List of Threatened Species (IUCN, 2020): *Byrsonima umbellata* Mart. ex A.Juss, *Eugenia puniceifolia* (Kunth), *Jacaranda caroba* (Vell.) DC, *Mimosa clausenii* Benth (Least Concern); *Syagrus glaucescens* Glaz. ex Becc (Vulnerable category).

Discussion

The results referring to the Landscape Architecture practice panorama reveal that the use of native species of the Cerrado is mainly motivated by aspects alluding to environmental sustainability, in line with the environmental advantages of the use of native species in Landscape Architecture (Heiden et al., 2006; Junqueira and Peetz, 2018), and with valorizing the relationship between society and nature present in the environmental approaches of Landscape Architecture (Cesar and Cidade, 2003). Despite the great current concern with climate change, the theme was not specifically mentioned in the interviewees' statements. In addition to the objective factors cited, there are also subjective aspects associated to self-identification

with the Cerrado that motivate to use native flora in most of the cases, generally associated with exotic species.

The Cerrado identity also seems to be, according to the interviews, a fundamental factor in the adhesion and commitment of clients. Imparting knowledge of the importance of the biome through environmental education (Iared and Oliveira, 2013), communication and marketing can contribute in that sense, but it would be important to deepen studies on composition elements that represents people's bond with the Cerrado.

The interviewees also identify the need for more knowledge and understanding of this Brazilian Phytogeographic Domain on the part of the technical and academic areas. The experiments, empirical experiences and the network of professionals and researchers involved in the interface between Landscape Architecture and the Cerrado, cited on Introduction, seem to be a sign of progress in overcoming the current incipient situation of research and poor accumulation of knowledge in this field.

The understanding of the original and altered soil conditions of the Cerrado appears as a key to the success of the garden. Fertilizing for species of local flora is a topic to be explored, considering nutritional specificities, which prevent the use of the conventional protocols (Haridasan, 2008). Covering the soil with organic matter seems to be an efficient strategy to improve its conditions, especially as a habitat for microorganisms (Gilmer et al., 2020). It is worth noting that the current and future effects of climate change on the edaphoclimatic and floristic conditions of the Cerrado were not mentioned by any of the interviewees and could be analyzed in more depth in future research.

The most used techniques for implantation and management of green areas with Cerrado flora species are aligned, in general, with sustainable practices, as one of advantages of the use native species in landscaping (Junqueira and Peetz, 2018). It can be assumed that

drastic pruning – at few centimeters above the ground - is recommended in gardens with a more naturalistic language (Kingsbury, 2004). Although the low demand for irrigation of native species in landscaping (Junqueira and Peetz, 2018), the importance of irrigation during the establishment of the garden with Cerrado flora species was commented on. A relevant aspect for management success, according to the interviewees, is the qualification of the workers; they need to know the species of the local flora and their specific cultivation treatments.

The search for the creation of a Landscape Architecture language with a Cerrado identity, as part of the dynamics of landscape appropriation of the territory emerges as a demand identified by the interviewed. This new language would follow the paths of sustainable and naturalistic approaches, with high diversity and an ecological focus, also defended by Siqueira (2016) and Siqueira et al. (2017).

Diversity is present in the list of 84 species of Cerrado flora indicated by the interviewees. It is a unique and unprecedented list, given that the species are not commonly identified as ornamental, including some that are threatened. The higher relative number of species of the *Poaceae* family and the predominance of species with lower strata habits corroborate the tendency of a more naturalistic bias, with predominance of herbaceous and arbustive plants (Kingsbury, 2004), which expresses the savanna formations described in item 1.2. The species mentioned in this work are mostly generalist and flexible because they are found in more than two types of vegetation and occur widely in Brazil (Brasil, 2020), that is, potentially appropriate for varied environments. Those characteristics may represent an advantage for their application in Landscape Architecture.

Despite the existence of market demand, the low availability of species, the lack of skilled labor (Junqueira and Peetz, 2018), and alteration of original environmental conditions are among the main factors restricting the expansion of the use of the native flora of the Cerrado in most projects and the consolidation of these species in the ornamental plant market. There is an evident impasse between the incipient productive chain of the ornamental flora of the Cerrado, which does not develop due to consumer demand, which, in turn, albeit growing, is restricted due to the absence of products on the market.

Conclusions

The testimonies and opinions that emerged from the interviewees' statements reveal an effort to develop a compositional language referenced by the Cerrado, influenced by currents of contemporary naturalistic landscape architecture, with a predominance of the herbaceous stratum and high species diversity. Their techniques of implantation and management of green areas are generally aligned with sustainable practices. In these gardens, native species are generally used together with exotic species. Most of 84 Cerrado plants listed by the interviewed professionals are unprecedented use

in Landscape Architecture. Much needed strategies for increasing Cerrado flora species use in Landscape Architecture are: engagement of society via environmental education, communication and marketing; research on Cerrado soil and ecology for species selection; qualification of labor; advocacy for public policies including promotion of production chains, research and education.

Author Contribution

SSM: contributed to the study's design; gathered, analyzed, and interpreted the data; drafted the article and revised the manuscript; **JBP:** contributed to the study's design, helped to interpret the data and revised the manuscript.

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