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Article

Contribution of the Brazilian National Forest Inventory to the knowledge of Cerrado woody flora

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***Abstract*:** The National Forest Inventory (Inventário Florestal Nacional-IFN) is a large initiative that uses standardised methods to survey Brazilian forestry resources. One target of the IFN is the Cerrado, which contains one of the richest floras in the world. The aim of this study was to assess the contribution of the IFN to the knowledge of Cerrado woody flora. We analysed data from field-collected vouchers sampled by the IFN Cerrado. We restricted our analyses to IFN collections of native trees and shrubs, including palms, which were identified at the species level. Habitat of each collection was obtained by overlaying specimens' geographic coordinates with land cover maps available in the Mapbiomas platform. Our final dataset comprised 28,602 specimens distributed in 2,779 sites (conglomerates) in Bahia, Distrito Federal, Goiás, Maranhão, Mato Grosso, Mato Grosso do Sul, Minas Gerais, Piauí, São Paulo and Tocantins. Collections were located in the following habitats: savannas (40.5%), forests (30.2%), anthropic areas (25.6%), grasslands (3.5%), and water (0.2%). We recorded 1,822 species belonging to 543 genera and 105 families, representing 34% of Cerrado woody species recorded on Flora do Brasil 2020. Fabaceae had the largest number of species, while *Tapirira guianensis* and *Matayba guianensis* were the most collected species. We highlight 60 potentially new records of occurrence for several states and 64 new records for the Cerrado, primarily in riparian forests where species from other biomes occur. In addition, 232 recorded species are Cerrado endemics, while 36 are cited in the CNCFlora's red list as endangered. The systematic sampling carried out by the IFN enabled vegetation sampling in remote and poorly known areas, which expanded the geographic range of many woody species and contributed to the knowledge of plant diversity in the Cerrado.
***Keywords*:** *conservation; endemism; plant diversity; sampling effort; survey; vegetation types.*

A contribuição do Inventário Florestal Nacional para o conhecimento da flora lenhosa do Cerrado

Resumo: O Inventário Florestal Nacional (IFN) é uma ampla iniciativa que emprega métodos padronizados para inventariar recursos florestais brasileiros. Um dos alvos do IFN é o Cerrado, o qual possui uma das floras mais ricas do mundo. O objetivo deste estudo foi avaliar a contribuição do IFN para o conhecimento da flora lenhosa do Cerrado. Nós analisamos dados de vouchers coletados em campo pelo IFN Cerrado. Nós restringimos nossas análises a coletas do IFN pertencentes a árvores e arbustos, incluindo palmeiras, identificadas ao nível de espécie. O habitat de cada coleta foi obtido pela intersecção entre as coordenadas geográficas dos espécimes com mapas de cobertura disponíveis na plataforma Mapbiomas. O conjunto final de dados foi composto por 28.602 coletas distribuídas em 2.779 sítios (conglomerados) localizados na Bahia, Distrito Federal, Goiás, Maranhão, Mato Grosso, Mato Grosso do Sul, Minas Gerais, Piauí, São Paulo e Tocantins. As coletas foram realizadas nos seguintes habitats: savanas (40,5%), florestas (30,2%), áreas antrópicas (25,6%), campos (3,5%) e água (0,2%). Ao todo foram registradas 1.822 espécies pertencentes a 543 gêneros e 105 famílias, representando 34% das espécies lenhosas do Cerrado registradas na Flora do Brasil 2020. Fabaceae apresentou o maior número de espécies, enquanto que *Tapirira guianensis* e *Matayba guianensis* foram as espécies mais coletadas. Destacam-se possíveis novos registros de ocorrência de 60 espécies para diversos estados e de 64 espécies para o Cerrado, predominantemente nas florestas ripárias onde geralmente ocorrem espécies de outros biomas. Além disso, foram registradas 232 espécies endêmicas do Cerrado, bem como 36 espécies citadas na lista vermelha do CNCFlora como ameaçadas. A amostragem sistemática realizada pelo IFN permitiu o inventário da vegetação em áreas remotas e pouco coletadas, permitindo a expansão da distribuição geográfica de diversas espécies lenhosas, e contribuindo para o conhecimento da diversidade vegetal no Cerrado.

Palavras-chave: *conservação; endemismo; diversidade vegetal; esforço amostral; inventário; tipos de vegetação.*

Introduction

Brazil harbours one of the richest floras in the world, and it is home to a large number of endemics (BFG 2021). Recent advances took place after the compilation of an updated national checklist containing information on species descriptions and geographic distributions (Flora do Brasil 2020; http://floradobrasil.jbrj.gov.br). However, large gaps still exist in the documentation of plant diversity in Brazil. Such knowledge gaps are related to incomplete taxonomic knowledge ("Linnean shortfall"; Whittaker et al. 2005), as represented by a high number of new species being described every year in the country (BFG 2021). These gaps are also a product of unsatisfactory understanding of the geographic distribution of species ("Wallacean shortfall"), particularly in poorly sampled regions of the country (e.g., Sousa-Baena et al. 2014, Oliveira et al. 2016).

Since 2007, the Brazilian Forest Service (Serviço Florestal Brasileiro-SFB) has been coordinating a survey of Brazilian forest resources through the National Forest Inventory (Inventário Florestal Nacional-IFN). The IFN aims to provide data about forest structure, composition, vitality, biomass, wood and carbon stock (SFB 2020). This initiative seeks to support development policies and assist in the identification of strategies and opportunities for sustainable use, restoration and conservation of forest resources (SFB 2019, 2020). The IFN adopts a standardised sampling method applied to each Brazilian biome (Amazon, Atlantic Forest, Caatinga, Cerrado, Pantanal and Pampa; SFB 2017a). IFN systematic sampling generates a vast amount of scientific data, including thousands of plant occurrence records widely distributed across the country, mostly trees and shrubs. The compilation and analysis of such dataset would be a useful source of biodiversity information on Brazilian biomes that would help to increase floristic knowledge and support conservation planning. Although summary reports for some states have been published (https://www.florestal.gov.br/resultados), comprehensive analyses, including the large volume of plant diversity data sampled by the IFN surveys, are still missing for most states (but see Versieux et al. 2017 and Vibrans et al. 2020 for analyses of Rio Grande do Norte and Santa Catarina, respectively).

The Cerrado, which originally occupied around 23% of the Brazilian territory, is located in Central Brazil between two areas of wet forests, the Amazon and Atlantic Forest, and forms a dry corridor, together with the Caatinga, in the northeast and the Chaco in the southwest (Oliveira-Filho & Ratter 2002, Werneck et al. 2012). The Cerrado presents notable physiographic variation (e.g., Sano et al. 2019) and an associated number of vegetation types. These include grasslands, wetlands, savannas, and seasonally dry and wet forests (Ribeiro & Walter 2008), the occurrence of which depends on ecological factors at the local scale, such as soil fertility, water availability and fire regime (Bueno et al. 2018). Because of this complex mosaic of vegetation types, the Cerrado is a savanna-dominated biome with the richest flora in the world (Klink & Machado 2005). It has around 12,000 angiosperm species, including 40% endemics (Flora do Brasil 2020). However, the Cerrado has been highly threatened by deforestation, which has resulted in the loss of around 50% of its native vegetation (Alencar et al. 2020). Because of its species richness, high levels of endemism and anthropic pressure, the Cerrado is considered one of the 35 global biodiversity hotspots for conservation (Mittermeier et al. 2011). Its plant species extinctions are projected to increase as a consequence of habitat loss (Strassburg et al. 2017).

Considering the elevated rates of habitat loss and outstanding species richness, it is essential to increase knowledge about the Cerrado's rich and endangered flora through large-scale inventories. Such inventories are certain to result in new collections of herbarium specimens and occurrence data. This would, in turn, tackle both Linnean and Wallacean shortfalls (Whittaker et al. 2005) on plant diversity by increasing the number of specimens available for taxonomic work. It would also expand the geographic ranges of known species, particularly in poorly collected areas. Information provided by new inventories can help in the development of conservation strategies, identify priority areas for threatened species, and foster the discovery of new species.

Here, we carried out a data compilation of species occurrence records generated by the IFN Cerrado, seeking to assess the project's contribution to knowledge of the Cerrado's woody flora. It is expected that the systematic data survey and wide geographic breadth of the IFN will provide useful information on species geographical distribution in the Cerrado. Questions we intended to resolve herein are as follows: (1) How many species were recorded by the IFN? (2) What is the proportion of woody species surveyed by IFN compared to information available in the literature? (3) Were any species found and recorded for the first time for the Cerrado flora or for individual states? (4) How many endemic or endangered species were recorded?

Material and Methods

The Serviço Florestal Brasileiro provided the data collected by the IFN Cerrado, which followed a standardised methodology (SFB 2017b). Data were surveyed across most of the extension of the Cerrado biome (sensu Instituto Brasileiro de Geografia e Estatísticas; https://www.ibge.gov.br) in different habitats, except in indigenous lands, where plant collecting would demand special permissions. Surveys were carried out in sampling sites called conglomerates (0.4 ha) that were systematically distributed on a 20 km x 20 km grid that sampled different habitats, including various types of natural vegetation and also anthropic areas (e.g. pastures, agriculture). Each conglomerate was composed of four crosswise subunits formed by rectangles of 20 m x 50 m located 30 m from the conglomerate's centre. Sampling included all individuals with diameter at breast height (DBH) $\geq$ 10 cm, or diameter at 30 cm height from the soil (DSH) $\geq$ 10 cm in cases of adult individuals with height > 1.5 m, but DBH absent. Individuals with DBH $\geq$ 5 cm were measured in two smaller subplots (10 m x 10 m each). Individuals taller than 1.3 m, but with DBH/DSH < 5 cm, were sampled in two subplots (5 m x 5 m each). This sampling strategy was particularly designed for the IFN Cerrado in order to maximise sampling of savanna trees, which are normally stunted with twisted trunks. Individuals were assigned to morphotypes in the field and later received more accurate taxonomic identification. Detailed information on IFN Cerrado sampling methodology is provided in SFB (2017b).

The analyses presented here were based on the herbarium vouchers collected during field surveys carried out during the IFN Cerrado. Voucher specimens (sterile or fertile) representing species measured within conglomerates were collected in the field for identification in herbaria. Field teams were required to make a collection of any given species at least once every 15 conglomerates, including species readily identified in the field, as well as individuals with uncertain identification. Thus, specimens collected correspond to a subset of all individuals

measured in IFN surveys, and are expected to comprise a representative sample of species surveyed. Conglomerates placed in areas harboring a richer flora (e.g., preserved forest) are expected to be more intensively collected than anthropic areas with fewer species (e.g., pastures). Extra collections not corresponding to sampled individuals within plots were also made. Appropriate information regarding collections, such as sampling unit, location, geographic coordinates, field name, habit and other observations, was annotated in a standardised form and later entered into a database. A total of 52,778 specimens collected were sent to the CEN, IBGE and UB herbaria for identification by generalist botanists and also by specialists in several families (Table S1, supplementary material). Specimens were databased, imaged, and finally incorporated into these collections. Duplicates were sent to other herbaria.

Our analysis included specimens collected in 2,779 conglomerates surveyed in ten states (Bahia, Distrito Federal, Goiás, Maranhão, Mato Grosso, Mato Grosso do Sul, Minas Gerais, Piauí, São Paulo and Tocantins) from 2011 to 2020. Field surveys and botanical identifications for Minas Gerais and São Paulo were not completed by the finalization of our analyses, and data for these states are partial. We restricted our analyses to only herbarium specimens (sterile and fertile) since these records are more reliable than unvouchered occurrence data that were also available from the IFN Cerrado dataset. We included only woody species, the main focus of the IFN, by retaining records belonging to species with life form reported as "shrub" or "tree", according to the Flora do Brasil 2020, including shrubby and arborescent palms. From the initial dataset of 52,778 specimens, we excluded 3071 records corresponding to herbs, subshrubs, lianas and bamboos. We also excluded 20,710 records identified only at family, genus or not determined, as well as those records identified at the species level, but with an ambiguous identification (indicated by "cf." or "aff."). Also, 323 records corresponding to exotic or introduced species, according to the Flora do Brasil 2020, were excluded. Infraspecific categories were treated at the species level. After this filtering process, the final dataset totalled 28,602 records of native woody plants identified at the species level (Table S2, supplementary material).

Species names were checked in the RStudio program, version 3.6.3 (RStudio Team 2020), by using the flora package (Carvalho 2017), the underlying database of which is the Flora do Brasil 2020. By the end of name checking, species names identified as synonyms were replaced by their respective accepted names. The geographic distribution of each species was verified based on information provided by Flora do Brasil 2020 (accessed through flora package) in order to identify possible new occurrence records for the Cerrado or for individual states. Species that only occur within the Cerrado in Flora do Brasil 2020 were listed here as Cerrado endemics. To identify endangered species collected by the IFN Cerrado, we consulted the CNCFlora Red list (National Centre for Plant Conservation; CNCFlora 2021).

To characterise the environmental variation of IFN Cerrado sampling sites, we analysed the different habitats in which each specimen was collected. The habitat of each collection was obtained by overlaying specimens' geographic coordinates with land cover maps available in the Mapbiomas platform (collection 6.0; Souza et al. 2020), which have a spatial resolution of 30 x 30 m that is compatible with the size of our sampling units (conglomerates). Original land use classes from Mapbiomes (see terms listed in parentheses) were merged into five major categories: grasslands ("formação campestre"), savannas ("formação savânica"), forests ("formação florestal"), anthropic areas ("pastagem", "agricultura", "mosaico de agricultura e pastagem", "silvicultura"), and water ("água"). A land use map for 2017 was downloaded from Mapbiomes as a shapefile, and habitat classes for each of the 28,602 occurrence records were retrieved using ArcGIS 10.3 (Environmental Systems Resource Institute).

We assessed the completeness of species richness recorded in the IFN Cerrado based on the sampling effort (Martins & Santos 1999). We verified sampling efficiency by using the rarefaction/extrapolation curve based on sample size (number of specimens) according to the Hill number (q=0) using the iNext package (Chao et al. 2014) in the RStudio program. We also compared the number of species in our dataset with the data available in Flora do Brasil 2020 to assess the representativeness of the woody flora sampled by the IFN Cerrado.

Results

Our clean dataset, composed of 28,602 specimens distributed in IFN's 2,779 conglomerates, covered most of the Cerrado (Figure 1). The number of specimens collected varied from one to 127 per conglomerate (average 10.3) with 68% of conglomerates presenting less than ten collections (Figure 2). The number of specimens was not equally distributed among states, with a higher incidence of collections in the central region of the Cerrado, especially in Goiás, and also in northern Maranhão (Figure 1). Collections were recorded in the following land use classes: savannas (40.5%), forests (30.2%), anthropic areas (25.6%), grasslands (3.5%), and water (0.2%).

We recorded a total of 1,822 woody species sampled by the IFN Cerrado. However, the rarefaction curve did not reach stability (Figure 3), suggesting that increasing sampling would result in recording additional species. Species numbers varied among states (Table 1) with the highest numbers in Goiás (735), followed by Mato Grosso (683), Maranhão (647), Tocantins (563), Bahia (513), Mato Grosso do Sul (382), São Paulo (314), Piauí (291), Distrito Federal (190), and Minas Gerais (132). Most species were found in savannas (1,204 species) and forests (1,200), followed by anthropic areas (891), grasslands (373), and water (130).

Species recorded belong to 543 genera and 105 families, including two *Podocarpus* gymnosperm species (see Table S3 for full species list, authorship, habit, number of collections and distribution). Among families collected, the top ten presenting the highest number of species were Fabaceae (336 species), Rubiaceae (85), Myrtaceae (78), Malvaceae (72), Melastomataceae (65), Euphorbiaceae (63), Asteraceae (60), Sapotaceae (49), Malpighiaceae (47) and Annonaceae (46). These families represented 47.2% of specimens and contributed to 49.6% of species.

The number of specimens collected per species varied widely with 29% of species (528) represented by a single collection (Figure 4). The most collected species were *Tapirira guianensis* (374 specimens), *Matayba guianensis* (305), *Vatairea macrocarpa* (290), *Myrcia splendens* (269), *Diospyros lasiocalyx* (249), *Machaerium acutifolium* (220), *Qualea parviflora* (215), *Terminalia argentea* (207), *Pouteria ramiflora* (206) and *Callisthene fasciculata* (204). All these species are typically found in savannas and forests within the Cerrado, including the widespread riparian forest species *Tapirira guianensis*. The IFN Cerrado contributed

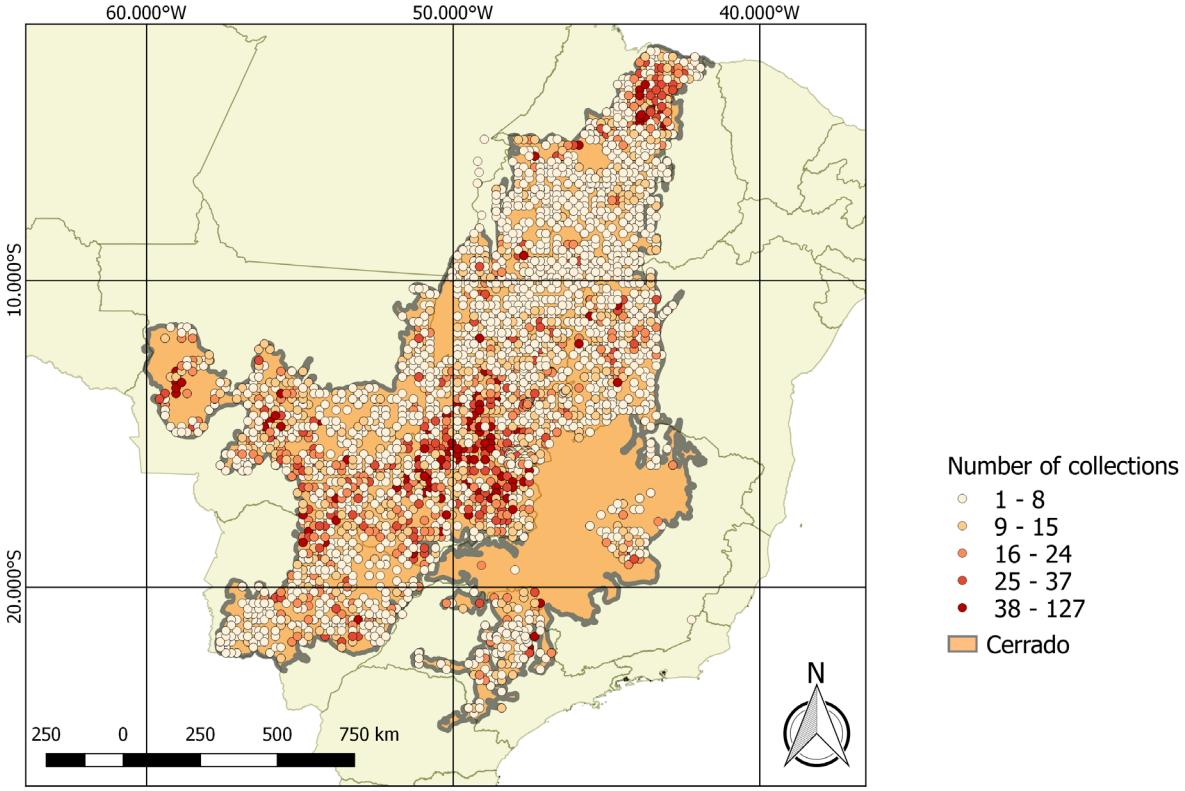

Figure 1. Geographic distribution of 2779 conglomerates (sampling sites) within the Cerrado showing the number of collections of woody plants identified at species level per conglomerate. The state of Minas Gerais was only partially sampled. Indigenous lands were not sampled, which correspond to large areas in Mato Grosso and Tocantins.

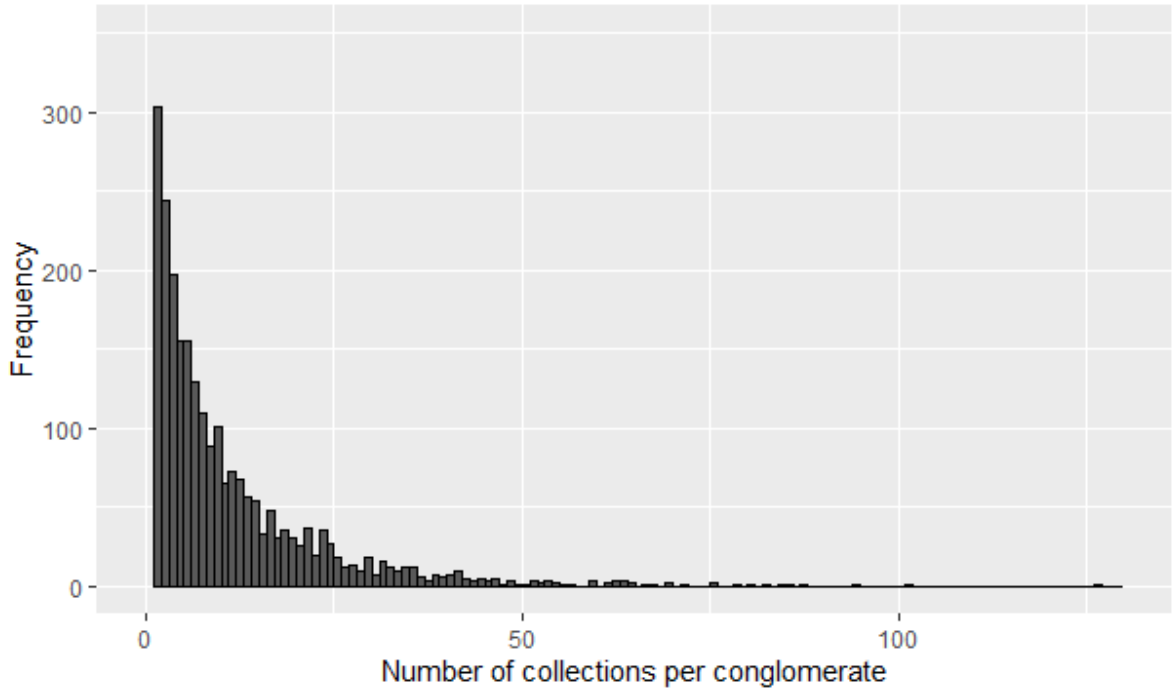

Figure 2. Histogram showing the number of collections of woody plants per sampling unit (conglomerate; 0.4 ha) in the IFN Cerrado. Among the 2779 conglomerates sampled, most were represented by less than ten collections.

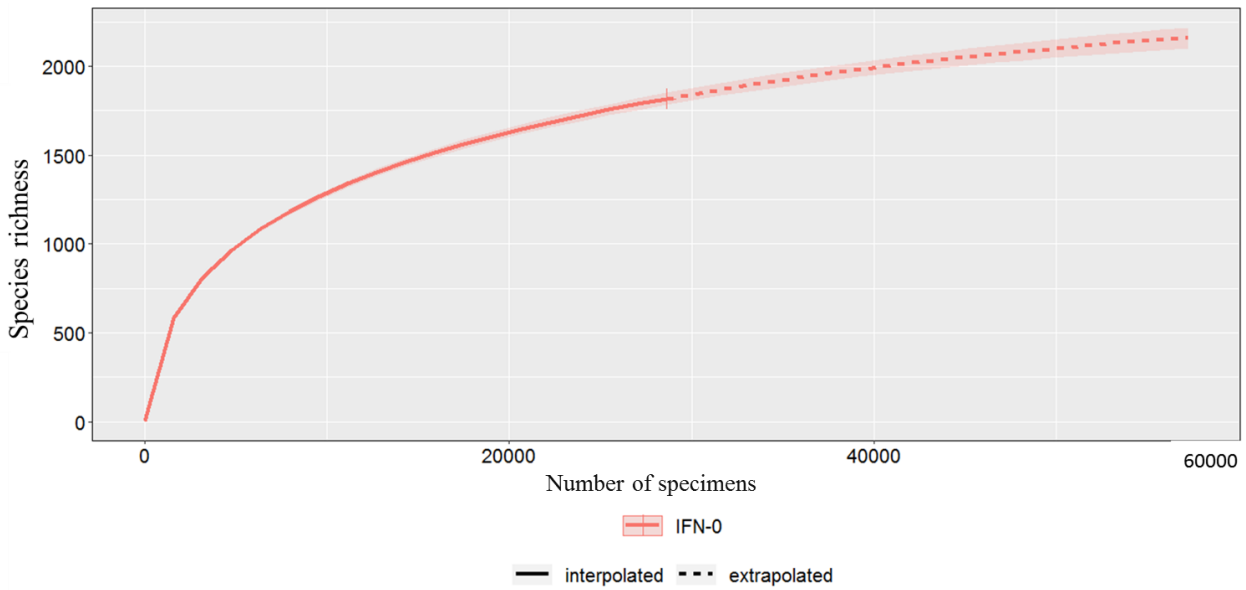

Figure 3. Rarefaction/extrapolation curve of richness of woody species based on the number of specimens (28,602) collected by the IFN Cerrado. Extrapolation of species richness is represented, considering a doubling of sampling effort.

Table 1. IFN Cerrado summary statistics by state. The total sampled area is the sum of sampled conglomerates (sampling units), each one with 0.4 ha. Figures are based on herbarium specimens belonging to woody species identified at the species level. The average of specimens is presented followed by its respective standard deviation. Habitat: G = grasslands, S = savannas, F = forests, A = anthropic areas, W = water.

State	Number of conglomerates	Total sampled area (ha)	Specimens collected	Average of specimens per conglomerate	Total number of species	Number of collected specimens per habitat (G/S/F/A/W)
Bahia	249	99.6	1,964	7.9 ± 8.2	513	122/1,551/137/100/54
Distrito Federal	34	13.6	275	8.1 ± 7.2	190	3/154/83/34/1
Goiás	641	256.4	10.618	16.6 ± 17.2	735	263/3,755/2,719/3,870/11
Maranhão	403	161.2	3,891	9.7 ± 11.2	647	80/1,276/2,157/336/42
Mato Grosso	446	178.4	4,625	10.4 ± 10.7	683	113/2,050/1,544/888/30
Mato Grosso do Sul	290	116.0	2,418	8.3 ± 9.5	382	57/519/993/841/8
Minas Gerais	56	22.4	419	7.5 ± 7.3	132	39/95/29/256/0
Piauí	148	59.2	751	5.1 ± 4.4	291	52/574/100/16/9
São Paulo	110	44.0	949	8.6 ± 9.4	314	14/49/393/465/28
Tocantins	402	160.8	2,692	6.7 ± 7.3	563	245/1,566/484/396/1
Total	2,779	1,111.6	28,602	10.3 ± 12.2	1,822	988/11,589/8,639/7,202/184

potentially new occurrence records for the Cerrado (64 species) and individual states (60), such as Tocantins (18), Mato Grosso do Sul (16), Goiás (11), and Maranhão (ten). Furthermore, 233 Cerrado endemics were recorded, as well as 36 endangered species (Table 2).

Discussion

Botanical collections made during IFN Cerrado surveys covered a broad geographic range that included poorly collected regions. However, the number of specimens collected varied greatly among sampling units (conglomerates) and states. The unbalanced number of collections per conglomerate could have been influenced by the number of species present within each conglomerate. For example, a conglomerate placed in a diverse, well-preserved forest is likely to produce more collections than a conglomerate situated in pastureland wherein only one or a few tree species occur. In addition, we observed that sampling effort varied among the field teams that conducted surveys in different regions within the Cerrado. Although all field teams are supposed to follow the same sampling protocol, we found that some teams were more likely to produce more collections per conglomerate than others. For example, sampling in Piauí averaged only 5.1 specimens per conglomerate, while in Goiás, this number was more than three times higher (16.6). Therefore, it is likely that differential sampling effort among regions may have biased our results. We recommend for future IFN surveys that field teams should increase the number of collections, assuring that a representative sample of the flora within each conglomerate is

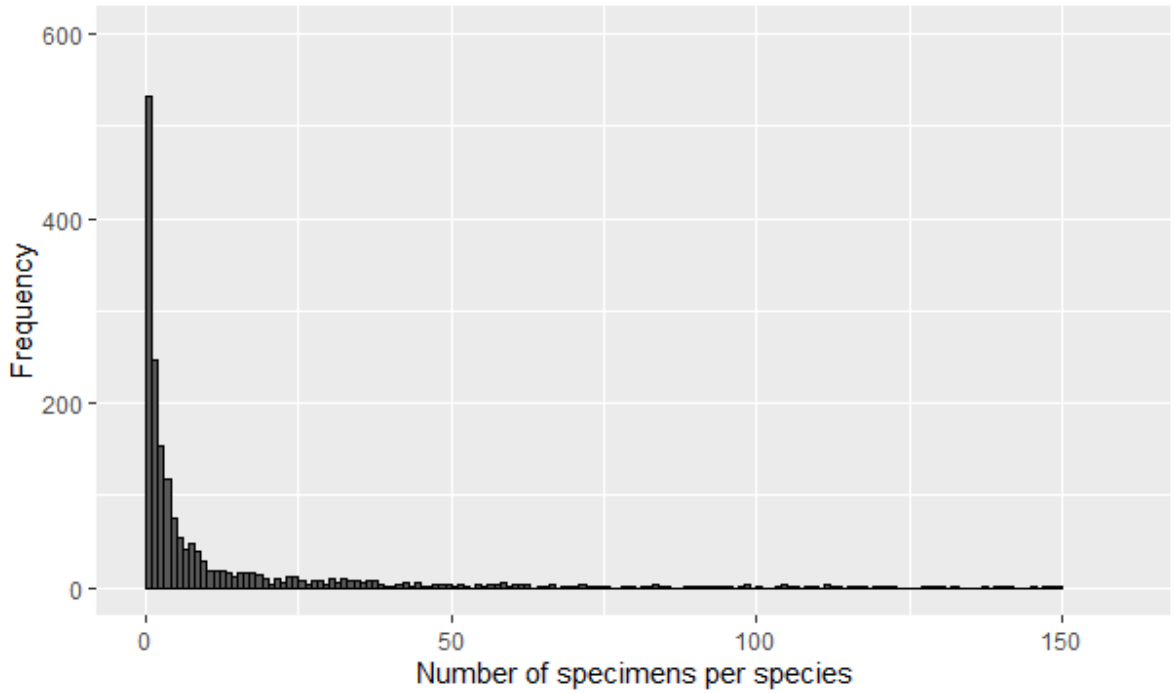

Figure 4. Histogram showing species frequency per range of number of collections made by the IFN Cerrado. Among the 1,822 species recorded, most were collected only once or twice, while 67 species are represented by more than 100 specimens.

represented by a set of herbarium specimens. This could be achieved by demanding field teams to collect a minimum number of vouchers per conglomerate, considering the peculiarities of each vegetation type. Such measures would reduce discrepancies in the number of specimens between conglomerates, resulting in a more even collecting effort across different regions. Increasing collecting effort would be particularly important for highly diverse sites where species identification tends to be more problematic (e.g., wet forests).

We listed a total of 1,822 woody species collected by the IFN Cerrado, which corresponds to 34% of the 5,373 woody species native to the Cerrado in the Flora do Brasil 2020 repository. These statistics indicate that the survey was not able to sample the rich Cerrado plant diversity in its entirety. It is likely that unsampled species are rare, i.e., having restricted geographic range and/or low abundance, since the most frequent species in the various habitats were sampled in the IFN Cerrado. The rarefaction curve clearly showed that additional collections would result in higher species richness. Doubling sampling effort would result in an estimated 2,380 species. However, we must recognise that a considerable number of collected specimens (20,806 or 39.4%) were not identified at species level. Improving the identification of these specimens would certainly result in an increased number of species sampled by the IFN Cerrado. Likewise, the completion of the survey in Minas Gerais would have also contributed to an increase in IFN Cerrado species numbers.

Accurate identification of specimens at the species level is clearly a challenge for many large and taxonomically complex plant families (e.g., Fabaceae, Lauraceae and Myrtaceae), and reliable identifications often require samples of fruits or flowers. The challenge of naming species is particularly difficult when identifications are based on sterile specimens, which make up 86.4% of the IFN Cerrado specimens analysed here. In many cases, we recognise that an accurate determination of sterile material at the species level is not possible, even for experienced taxonomists. Uncertainties underlying plant identifications pose a limitation to forest inventories in species-rich countries, and improving this situation demands innovative approaches (Drapper et al. 2020) that could be adopted by the IFN. Compared to our results, sampling efficiency of floristic diversity was apparently higher in the IFN survey carried out in Santa Catarina where 831 species of trees and shrubs were found (Vibrans et al. 2020). However, despite all collecting efforts, a considerable number (150 species) of trees and shrubs reported for Santa Catarina in previous studies remained unsampled by that survey.

In general, the most frequently collected species in the IFN Cerrado are among the most common species cited in the literature for the different vegetation types of the Cerrado. Therefore, we can assume that an elevated number of collections for a given species reflects its high natural abundance. For example, among the 38 species considered the most frequent (oligarchic) in the *cerrado sensu lato* (Ratter et al. 2003), all were recorded by the IFN Cerrado, including some highly collected (>100 records) species, such as *Agonandra brasiliensis, Bowdichia virgilioides, Byrsonima coccolobifolia, Connarus suberosus, Machaerium acutifolium, Myrcia splendens, Plathymenia reticulata, Pouteria ramiflora, Qualea grandiflora, Q. parviflora, Terminalia argentea* and *Vatairea macrocarpa*. Typical species of "*cerradão*", a forest formation composed of mostly savanna tree species, such as *Callisthene fasciculata, Emmotum nitens, Lafoensia pacari* and *Magonia pubescens* (Ribeiro & Walter 2008), were also highly collected in the IFN Cerrado.

Wet forests in the Cerrado are often associated with water courses. Among the species frequently found in Cerrado's riparian forests, several were highly collected in the IFN Cerrado, such as *Tapirira guianensis*, which was the most collected species in the whole survey, as well as *Calophylllum brasiliense, Chysophyllum marginatum,*

Table 2. Selected species collected by the IFN Cerrado highlighting those of high conservation value (threatened and endemics), as well as potential new occurrence records for states. Cerrado endemic species and new records of occurrence are based on information available in Flora do Brasil 2020. BA = Bahia, DF = Distrito Federal, GO = Goiás, MA = Maranhão, MG = Minas Gerais, MS = Mato Grosso do Sul, MT = Mato Grosso, PI = Piauí, SP = São Paulo, TO = Tocantins. Endangered species listed by the CNCFlora according to the categories of the International Union for Conservation of Nature (IUCN): CR = critically endangered, EN = endangered, VU = vulnerable.

Family/ species	Cerrado Endemic	New records (Cerrado)	New records (states)	IUCN category
Acanthaceae				
Justicia nodicaulis (Nees) Leonard	X			
Annonaceae				
Duguetia calycina Benoist		X		
Guatteria rigida R.E.Fr.			MS	
Oxandra reticulata Maas			MS	
Trigynaea duckei (R.E.Fr.) R.E.Fr.		X		
Xylopia discreta (L.f.) Sprague		X		
Apocynaceae				
Aspidosperma dispermum Müll.Arg.	X			
Aspidosperma melanocalyx Müll.Arg.			MS	
Aspidosperma spruceanum Benth. ex Müll.Arg.		X		
Aspidosperma rizzoanum Scudeler & A.C.D. Castello	X			
Aspidosperma verbascifolium Müll.Arg.	X			
Rauvolfia weddelliana Müll.Arg.	X			
Araliaceae				
Dendropanax denticulatus Fiaschi		X		
Didymopanax macrocarpus (Cham. & Schltdl.) Seem.			MA, TO	
Didymopanax vinosus (Cham. & Schltdl.) Marchal			TO	
Arecaceae				
Euterpe edulis Mart.				VU
Asteraceae				
Acilepidopsis echitifolia (Mart. ex DC.) H.Rob.	X			
Chromolaena chaseae (B.L.Rob.) R.M.King & H.Rob.	X			
Chromolaena myriocephala (Gardner) R.M.King & H.Rob.	X			
Chromolaena pungens (Gardner) R.M.King & H.Rob.	X			
Eremanthus brasiliensis (Gardner) MacLeish	X			
Eremanthus glomerulatus Less.	X			
Eremanthus goyazensis (Gardner) Sch.Bip.	X			
Eremanthus mollis Sch.Bip.	X			
Eremanthus uniflorus MacLeish & H.Schumach.	X			
Lepidaploa muricata (DC.) H.Rob	X			
Lepidaploa remotiflora (Rich.) H.Rob.	X			
Lepidaploa rufogrisea (A.St.-Hil.) H.Rob.	X			
Lessingianthus brevipetiolatus (Sch.Bip. ex Baker) H.Rob.	X			
Lessingianthus floccosus (Gardner) H.Rob.	X			
Lessingianthus ligulifolius (Mart. ex DC.) H.Rob.	X			
Lessingianthus myrsinites H.Rob.	X			
Lessingianthus obscurus (Less.) H.Rob.	X			
Lessingianthus obtusatus (Less.) H.Rob.	X			

Continued...

Family/ species	Cerrado Endemic	New records (Cerrado)	New records (states)	IUCN category
Lessingianthus zuccarinianus (Mart. ex DC.) H.Rob.	X			VU
Moquiniastrum barrosoae (Cabrera) G.Sancho	X			
Moquiniastrum blanchetianum (DC.) G.Sancho	X			
Moquiniastrum floribundum (Cabrera) G.Sancho	X			
Moquiniastrum paniculatum (Less.) G.Sancho	X			
Piptocarpha oblonga (Gardner) Baker	X		MS	
Piptocarpha rotundifolia (Less.) Baker	X			
Strophopappus glomeratus (Gardner) R.Esteves	X			
Vernonanthura ferruginea (Less.) H.Rob.	X			
Vernonanthura membranacea (Gardner) H.Rob.	X			
Wunderlichia crulsiana Taub.				EN
Bignoniaceae				
Anemopaegma arvense (Vell.) Stellfeld ex de Souza				EN
Fridericia cinerea (Bureau ex K.Schum.) L.G.Lohmann	X			
Handroanthus spongiosus (Rizzini) S.Grose				EN
Jacaranda copaia (Aubl.) D.Don		X		
Jacaranda grandifoliolata A.H.Gentry	X			EN
Jacaranda ulei Bureau & K.Schum.	X			
Xylophragma heterocalyx (Bureau & K.Schum.) A.H.Gentry	X			
Zeyheria tuberculosa (Vell.) Bureau ex Verl.				VU
Burseraceae				
Protium rhoifolium (Benth.) Byng & Christenh.		X	MA	
Calophyllaceae				
Kielmeyera grandiflora (Wawra) Saddi	X			
Kielmeyera lathrophyton Saddi			MA	
Kielmeyera neriifolia Cambess.	X			
Kielmeyera petiolaris Mart. & Zucc.	X			
Kielmeyera rubriflora Cambess.	X		PI	
Kielmeyera speciosa A.St.-Hil.	X			
Kielmeyera tomentosa Cambess.	X			
Cannabaceae				
Celtis fluminensis Carauta		X		
Caricaceae				
Jacaratia corumbensis Kuntze	X			
Caryocaraceae				
Caryocar brasiliense Cambess.	X			
Caryocar cuneatum Wittm.	X			
Celastraceae				
Monteverdia acanthophylla (Reissek) Biral				VU
Monteverdia gonoclada (Mart.) Biral			PI	
Monteverdia guyanensis (Klotzsch ex Reissek) Biral		X		
Salacia crassifolia (Mart. ex Schult.) G.Don	X			
Chrysobalanaceae				
Couepia ovalifolia (Schott) Benth. ex Hook.f.		X		
Exellodendron gardneri (Hook.f.) Prance	X			

Continued...

Family/ species	Cerrado Endemic	New records (Cerrado)	New records (states)	IUCN category
Hirtella hoehnei Pilg.	X		TO	
Leptobalanus parvifolius (Huber) Sothers & Prance		X		
Licania canescens Benoist		X		
Licania coriacea Benth.		X		
Licania gracilipes Taub.		X		
Licania nitida Hook.f.			MS, TO	
Clusiaceae				
Clusia criuva Cambess.	X			
Clusia renggerioides Planch. & Triana		X		
Symphonia globulifera L.f.			GO	
Combretaceae				
Combretum pyramidatum Ham.			GO	
Terminalia phaeocarpa Eichler	X			
Connaraceae				
Connarus suberosus Planch.	X			
Rourea induta Planch.	X			
Cunoniaceae				
Lamanonia brasiliensis Zickel & Leitão	X		GO	EN
Dilleniaceae				
Davilla elliptica A.St.-Hil.	X			
Davilla grandiflora A.St.-Hil. & Tul.	X			
Davilla lacunosa Mart.	X			
Davilla villosa Eichler	X			
Ebenaceae				
Diospyros coccolobifolia Mart. ex Miq.	X			
Diospyros tetrandra Hiern		X		
Elaeocarpaceae				
Sloanea subsessilis D.Sampaio e V.C.Souza	X			
Erythroxylaceae				
Erythroxylum argentinum O.E.Schulz		X		
Erythroxylum ayrtonianum Loiola & M.F.Sales			GO	
Erythroxylum betulaceum Mart.			MS	
Erythroxylum tianguanum Plowman				CR
Erythroxylum tortuosum Mart.	X			
Erythroxylum umbu Costa-Lima		X		
Euphorbiaceae				
Bernardia gardneri Müll.Arg.	X			
Croton micans Sw.	X			
Manihot anomala Pohl	X			
Manihot caerulescens Pohl	X			
Manihot cecropiifolia Pohl	X			
Manihot tripartita (Spreng.) Müll.Arg.	X			
Manihot triphylla Pohl	X			
Sapium laurifolium (A.Rich.) Griseb.		X		
Fabaceae				

Continued...

Family/ species	Cerrado Endemic	New records (Cerrado)	New records (states)	IUCN category
Abarema cochliacarpos (Gomes) Barneby & J.W.Grimes			GO	
Andira cordata Arroyo ex R.T.Penn. & H.C.Lima	X		MS	
Andira inermis (W.Wright) DC.			TO	
Apuleia leiocarpa (Vogel) J.F.Macbr.				VU
Bauhinia dumosa Benth.	X			
Bauhinia holophylla (Bong.) Steud.	X			
Bauhinia membranacea Benth.	X			
Bauhinia rufa (Bong.) Steud.	X			
Calliandra dysantha Benth.	X			
Calliandra silvicola Taub.	X			
Cassia fastuosa Willd. ex Benth.		X		
Cenostigma bracteosum (Tul.) Gagnon & G.P.Lewis			MS	
Chamaecrista acosmifolia (Mart. ex Benth.) H.S.Irwin & Barneby	X			
Chamaecrista ciliolata (Benth.) H.S.Irwin & Barneby	X		BA	
Chamaecrista claussenii (Benth.) H.S.Irwin & Barneby	X			
Chamaecrista conferta (Benth.) H.S.Irwin & Barneby	X			
Chamaecrista coradinii H.S.Irwin & Barneby	X			VU
Chamaecrista crenulata (Benth.) H.S.Irwin & Barneby	X			
Chamaecrista desvauxii (Collad.) Killip	X			
Chamaecrista geminata (Benth.) H.S.Irwin & Barneby	X			
Chamaecrista isidorea (Benth.) H.S.Irwin & Barneby	X			
Chamaecrista ramosa (Vogel) H.S.Irwin & Barneby	X			
Copaifera depilis Dwyer	X			
Copaifera luetzelburgii Harms	X			
Copaifera magnifolia Dwyer	X			
Copaifera malmei Harms	X			
Copaifera oblongifolia Mart. ex Hayne	X			
Copaifera sabulicola J.Costa & L.P.Queiroz	X			
Cratylia mollis Mart. ex Benth.		X		
Dalbergia cuiabensis Benth.	X			
Dalbergia elegans A.M.Carvalho				VU
Dalbergia glandulosa Benth.	X			
Dalbergia miscolobium Benth.	X			
Dalbergia nigra (Vell.) Allemão ex Benth.				VU
Dimorphandra gardneriana Tul.			MS	
Dipteryx alata Vogel	X			
Diptychandra aurantiaca Tul.	X			
Enterolobium timbouva Mart.			TO	
Guibourtia chodatiana Hassl.	X			
Harpalyce brasiliana Benth.	X			
Harpalyce magnibracteata São -Mateus, D.B.O.S.Cardoso & L.P.Queiroz	X			
Harpalyce minor Benth.	X			
Hymenaea maranhensis Lee & Lang.	X			
Hymenaea parvifolia Huber				VU
Hymenolobium heringerianum Rizzini	X			

Continued...

Family/ species	Cerrado Endemic	New records (Cerrado)	New records (states)	IUCN category
Leptolobium elegans Vogel	X		DF	
Luetzelburgia praecox (Harms) Harms	X			
Machaerium nigrum Vogel		X		
Machaerium opacum Vogel			MS	
Machaerium scleroxylon Tul.			TO	
Machaerium ternatum Kuhlm. & Hoehne		X		
Melanoxylon brauna Schott				VU
Mimosa claussenii Benth.	X			
Mimosa decorticans Barneby	X			
Mimosa densa Benth.	X			
Mimosa dichroa Barneby ex G.P.Lewis	X		MS	
Mimosa gardneri Benth.	X			
Mimosa gemmulata Barneby			MS	
Mimosa hapaloclada Malme	X			
Mimosa hebecarpa Benth.	X			
Mimosa hypoglauca Mart.	X			
Mimosa insignis (Hassl.) Barneby	X			
Mimosa interrupta Benth.	X			
Mimosa kalunga M.F.Simon & C.E.Hughes	X			
Mimosa laniceps Barneby	X			
Mimosa laticifera Rizzini & A.Mattos	X			
Mimosa melanocarpa Benth.	X			
Mimosa nitens Benth.	X			
Mimosa nothopteris Barneby		X		
Mimosa oedoclada Barneby	X			
Mimosa oligosperma Barneby	X			EN
Mimosa somnians Humb. & Bonpl. ex Willd.	X			
Mimosa xanthocentra Mart.	X			
Muellera montana (MJ.Silva & AMG.Azevedo) MJ.Silva & AMG. Azevedo	X			
Myrocarpus frondosus Allemão		X		
Ormosia coarctata Jacq.		X		
Peltogyne maranhensis Huber ex Ducke				VU
Schizolobium parahyba (Vell.) Blake		X		
Stryphnodendron fissuratum E.M.O.Martins	X			
Stryphnodendron polyphyllum Mart.	X			
Swartzia laurifolia Benth.		X		
Tachigali aurea Tul.	X			
Tachigali rubiginosa (Mart. ex Tul.) Oliveira-Filho	X			
Tachigali subvelutina (Benth.) Oliveira-Filho	X			
Zapoteca scutellifera (Benth.) H.M.Hern.			GO, TO	
Hypericaceae				
Vismia macrophylla Kunth		X		
Lacistemataceae				
Lacistema hasslerianum Chodat	X			

Continued...

Family/ species	Cerrado Endemic	New records (Cerrado)	New records (states)	IUCN category
Lamiaceae				
Hypenia calycina (Pohl ex Benth.) Harley	X			
Hypenia macrosiphon (Briq.) Harley	X			
Hyptidendron arbusculum (Epling) Harley	X			
Hyptidendron canum (Pohl ex Benth.) Harley	X			
Hyptidendron caudatum (Epling & Játiva) Harley	X			
Hyptidendron conspersum (Benth.) Harley	X			EN
Hyptidendron leucophyllum (Pohl ex Benth.) Harley	X			
Hyptis lutescens Pohl ex Benth.	X			
Hyptis pachyphylla Epling	X			VU
Hyptis rubiginosa Benth.	X			
Hyptis saxatilis A.St.-Hil. ex Benth.	X			
Medusantha multiflora (Pohl ex Benth.) Harley & J.F.B.Pastore			MA	
Mesosphaerum pectinatum (L.) Kuntze			MA	
Vitex flavens Kunth	X			
Lauraceae				
Aiouea macedoana Vattimo-Gil	X			
Aniba hostmanniana (Nees) Mez		X		
Aniba williamsii O.C.Schmidt		X		
Dicypellium caryophyllaceum (Mart.) Nees,				CR
Endlicheria lhotzkyi (Nees) Mez	X			
Nectandra warmingii Meisn.	X			
Ocotea leucoxylon (Sw.) Laness.		X		
Persea splendens Meisn.	X			
Lecythidaceae				
Cariniana legalis (Mart.) Kuntze				EN
Couroupita guianensis Aubl.		X		
Eschweilera grandiflora (Aubl.) Sandwith		X		
Eschweilera parviflora (Aubl.) Miers		X		
Loganiaceae				
Antonia ovata Pohl			MS	
Lythraceae				
Diplusodon virgatus Pohl	X			
Lafoensia pacari A.St.-Hil.	X			
Malpighiaceae				
Banisteriopsis argyrophylla (A.Juss.) B.Gates	X			
Banisteriopsis latifolia (A.Juss.) B.Gates	X			
Banisteriopsis malifolia (Nees & Mart.) B.Gates	X			
Banisteriopsis megaphylla (A.Juss.) B.Gates	X			
Banisteriopsis variabilis B.Gates	X			
Byrsonima affinis W.R.Anderson	X			
Byrsonima basiloba A.Juss.	X			
Byrsonima clausseniana A.Juss.	X			
Byrsonima guilleminiana A.Juss.	X			
Byrsonima variabilis A.Juss.			DF	

Continued...

Family/ species	Cerrado Endemic	New records (Cerrado)	New records (states)	IUCN category
Heteropterys byrsonimifolia A.Juss.	X			
Heteropterys dumetorum (Griseb.) Nied.	X			
Heteropterys procoriacea Nied.	X			
Heteropterys rhopalifolia A.Juss.	X			
Peixotoa glabra A.Juss.	X		PI	
Peixotoa magnifica C.E.Anderson	X			
Malvaceae				
Byttneria glazioui Hochr.	X			
Ceiba samauma (Mart.) K.Schum.			GO	
Eriotheca pubescens (Mart. & Zucc.) Schott & Endl.	X			
Hibiscus capitalensis Krapov. & Fryxell	X			
Luehea crispa Krapov.			TO	
Mollia lepidota Spruce ex Benth.			GO	
Matayba peruviana Radlk.			MT	
Pavonia immitis Fryxell	X			
Pavonia pohlii Gürke	X			
Pseudobombax longiflorum (Mart.) A.Robyns	X			
Pseudobombax tomentosum (Mart.) A.Robyns	X			
Theobroma speciosum Willd. ex Spreng.		X		
Marcgraviaceae				
Schwartzia adamantium (Cambess.) Bedell ex Gir.-Cañas	X			
Melastomataceae				
Cambessedesia hilariana (Kunth) DC.	X			
Lavoisiera pohliana O.Berg ex Triana	X			
Leandra chaetodon (DC.) Cogn.		X		
Leandra deflexa (Triana) Cogn.	X			
Miconia abbreviata Markgr.		X		
Miconia affinis DC.			TO	
Miconia burchellii Triana	X			
Miconia eugenioides Triana		X		
Miconia herpetica DC.	X			
Miconia pepericarpa DC.	X			
Miconia sclerophylla Triana	X		SP	
Microlicia euphorbioides Mart.	X			
Mouriri elliptica Mart.	X			
Mouriri gardneri Triana	X		MA	
Ossaea congestiflora (Naudin) Cogn.	X			
Pleroma stenocarpum (Schrank et Mart. ex DC.) Triana	X			
Meliaceae				
Cedrela fissilis Vell.				VU
Cedrela odorata L.				VU
Trichilia elegans A.Juss.			TO	
Trichilia stellato-tomentosa Kuntze				VU
Moraceae				
Ficus maxima Mill.		X		

Continued...

Family/ species	Cerrado Endemic	New records (Cerrado)	New records (states)	IUCN category
Sorocea hilarii Gaudich.			PI	
Myristicaceae				
Virola subsessilis (Benth.) Warb.	X			
Virola surinamensis (Rol. ex Rottb.) Warb.				VU
Virola urbaniana Warb.	X		MS	
Myrtaceae				
Eugenia cupulata Amshoff		X		
Eugenia matogrossensis Sobral	X			
Eugenia megaflora Govaerts	X			
Eugenia pyrifera Faria & Proença	X			
Eugenia stipitata McVaugh		X		
Myrcia camapuanensis N.Silveira	X			
Myrcia myrtillifolia DC.	X			
Myrcia neorubella A.R.Lourenço & E.Lucas		X		
Myrcia tortuosa (O.Berg) N.Silveira	X			
Psidium oligospermum Mart. ex DC.			MS, TO	
Psidium salutare (Kunth) O.Berg	X			
Psidium sessiliflorum (Landrum) Proença & Tuler	X			
Siphoneugena densiflora O.Berg			TO	
Nyctaginaceae				
Guapira campestris (Netto) Lundell	X			
Guapira noxia (Netto) Lundell	X			
Neea floribunda Poepp. & Endl.		X		
Ochnaceae				
Elvasia calophyllea DC.		X		
Elvasia canescens (Tiegh.) Gilg		X		
Ouratea acicularis R.G.Chacon & K.Yamam.				EN
Ouratea cauliflora Fraga & Saavedra		X		
Ouratea paraensis Huber		X		
Olacaceae				
Dulacia egleri (Bastos) Sleumer			GO	
Oxalidaceae				
Oxalis goyazensis Turcz.	X			
Peraceae				
Pera anisotricha Müll.Arg.			MA	
Polygalaceae				
Moutabea excoriata Mart. ex Miq.	X			
Polygonaceae				
Coccoloba brasiliensis Nees & Mart.	X			
Primulaceae				
Cybianthus cuneifolius Mart.		X		
Putranjivaceae				
Drypetes amazonica Steyerm.		X		
Rhabdodendraceae				
Rhabdodendron gardneranum (Benth.) Sandwith	X			

Continued...

Family/ species	Cerrado Endemic	New records (Cerrado)	New records (states)	IUCN category
Rhamnaceae				
Rhamnidium glabrum Reissek				VU
Rubiaceae				
Borreria crispata (K.Schum.) E.L.Cabral & Bacigalupo	X			
Calycophyllum spruceanum (Benth.) K.Schum.		X		
Cordiera myrciifolia (K.Schum.) C.H.Perss. & Delprete			PI	
Guettarda pohliana Müll.Arg.	X			
Palicourea guianensis Aubl.			TO	
Palicourea justiciifolia (Rudge) Delprete & J.H.Kirkbr.		X		
Psychotria guianensis (Aubl.) Rusby		X		
Rutaceae				
Pilocarpus trachylophus Holmes				EN
Salicaceae				
Casearia altiplanensis Sleumer	X			
Casearia rufescens Cambess.	X			
Casearia rupestris Eichler	X			
Xylosma benthamii (Tul.) Triana & Planch.			TO	
Xylosma venosa N.E.Br.			MA	
Sapindaceae				
Cupania castaneaefolia Mart.			MA, TO	
Dilodendron bipinnatum Radlk.			PI	
Matayba peruviana Radlk.		X		
Talisia subalbens (Mart.) Radlk.				VU
Sapotaceae				
Chrysophyllum lucentifolium Cronquist		X		
Ecclinusa ramiflora Mart.		X		
Elaeoluma schomburgkiana (Miq.) Baill.		X		
Micropholis egensis (A.DC.) Pierre		X		
Micropholis emarginata T.D.Penn.			GO, PI	EN
Pouteria anomala (Pires) T.D.Penn.		X		
Pouteria bangii (Rusby) T.D.Penn.		X		
Pouteria cladantha Sandwith		X		
Pouteria furcata T.D.Penn.			TO	EN
Pouteria macrocarpa (Mart.) D.Dietr.		X		VU
Pouteria procera (Mart.) K.Hammer		X		
Pouteria subcaerulea Pierre ex Dubard	X			
Pouteria torta (Mart.) Radlk.	X			
Pradosia granulosa Pires & T.D.Penn.				VU
Schoepfiaceae				
Schoepfia lucida Pulle	X		MA	
Schoepfia velutina Sandwith	X		MA	
Simaroubaceae				
Homalolepis ferruginea (A.St.-Hil.) Devecchi & Pirani	X			
Homalolepis warmingiana (Engl.) Devecchi & Pirani			BA	EN

Continued...

Family/ species	Cerrado Endemic	New records (Cerrado)	New records (states)	IUCN category
Solanaceae				
Solanum falciforme Farruggia	X			
Styracaceae				
Styrax ferrugineus Nees & Mart.	X			
Symplocaceae				
Symplocos nitens (Pohl) Benth.	X			
Symplocos rhamnifolia A.DC.				EN
Turneraceae				
Piriqueta breviseminata Arbo	X			
Turnera lamiifolia Cambess.	X			
Turnera melochioides Cambess.	X			
Verbenaceae				
Citharexylum poeppigii Walp.		X		
Lippia eupatorium Schauer	X			
Vochysiaceae				
Callisthene major Mart.	X		SP	
Callisthene mollissima Warm.	X			
Qualea cordata Spreng.	X			
Qualea dichotoma (Mart.) Warm.	X			
Qualea hannekesaskiarum Marc.-Berti	X			
Qualea selloi Warm.	X		GO	
Vochysia cinnamomea Pohl	X			
Vochysia discolor Warm.	X			
Vochysia gardneri Warm.	X			
Vochysia herbacea Pohl	X			
Vochysia palmirana F.França & Proença	X			
Vochysia pruinosa Pohl	X			
Vochysia pumila Pohl	X			
Vochysia rufa Mart.	X			
Vochysia sessilifolia Warm.	X			
Vochysia thyrsoidea Pohl	X			

Copaifera langsdorffii, Coussarea hydrangeifolia, Dendropanax cuneatus, Eugenia florida, Hirtella glandulosa, Protium heptaphyllum, P. spruceanum, Tapura amazonica, Vochysia haenkeana and *Xylopia emarginata*. These species are widely distributed in Brazilian wet forests, and their shared occurrence between central Brazil riparian forests, Amazon and Atlantic Forest reinforces the floristic links among these domains (Oliveira-Filho & Ratter 1995, Oliveira-Filho & Fontes 2000, Miranda et al. 2018).

Seasonally dry forests occur as scattered patches within the Cerrado, often associated with limestone outcrops and high-fertility soils, which stand in contrast to the acidic and nutrient-poor soils that predominate in the Cerrado region. As a consequence, central Brazil dry forests, which are mostly deciduous during the dry season, differ markedly in species composition compared to adjacent savannas and wet forests (Pennington et al. 2000, Bueno et al. 2018). The characteristic dry forest species *Aspidosperma subincanum* and *Tabebuia roseoalba* were among those highly collected species in the IFN Cerrado, which also recorded other typical dry forest representatives mentioned in the literature, such as *Aspidosperma pyrifolium, Commiphora leptophloeos, Machaerium scleroxylon* and *Schinopsis brasiliensis* (Scariot & Sevilha 2005, Pereira et al. 2011). Although occurring in discontinuous patches, Cerrado dry forests share several species in common with the Caatinga, highlighting the floristic link between these seasonally dry vegetation nuclei (Prado & Gibbs 1993, Neves et al. 2015). In addition, a large sample of sites located at the Cerrado/Caatinga boundary, particularly in Bahia, contributed to increased numbers of typical dry forests and shrublands in our list.

It is worth highlighting that the systematic sampling methodology of the IFN generated new plant occurrence records in areas little sampled in the Cerrado (Sousa-Baena et al. 2014), such as Piauí, Maranhão (the

second state in number of IFN specimens), Tocantins, Mato Grosso and southwestern Goiás, thereby filling some important gaps in species distributions. Another positive aspect of the IFN Cerrado methodology was the sampling in different physiognomies, which included habitats that are not frequently surveyed by botanists, such as riparian forests, swamps and seasonally dry forests, including remote areas difficult to access. Botanical exploration of these areas contributed to a number of new species occurrence records for the Cerrado and also for individual states, contributing floristic knowledge, particularly to some states, such as Maranhão, Piauí and Tocantins, for which floristic information is limited (BFG 2015). The contribution of IFN collections towards new state occurrence records has also been highlighted elsewhere for Rio Grande do Norte where 71 new angiosperm records were reported (Versieux et al. 2017).

A large number of new occurrence records for the Cerrado, such as *Aniba hostmaniana, Calycophyllum spruceanum, Elvasia calophyllea, Eugenia cupulata, Jacaranda copaia, Matayba peruviana, Miconia eugenioides, Pouteria anomala* and *Theobroma speciosum*, were mostly collected in wet forests located in northern Mato Grosso and Tocantins along the Cerrado/Amazonia boundary. This ecotone between the Cerrado and Amazonia, a complex transition zone, is composed of interdigitating patches of savannas and various forest types (Marques et al. 2020), and it has certainly incremented the number of species sampled by the IFN Cerrado. Coinciding with an area that lacks botanical records overall (Souza-Baena et al. 2014), this ecotone also helps to explain the large number of new occurrences in the Cerrado for species previously reported only to Amazonia. New occurrences for the Cerrado also comprised typical elements from the Caatinga (e.g., *Cratylia mollis, Pouteria furcata*) and Atlantic Forest (e.g., *Dendropanax denticulatus, Myrocarpus frondosus*), albeit to a lesser extent compared to Amazonia. These results highlight the contribution of marginal/ecotonal areas between the Cerrado and other biomes to the species richness of the Cerrado's tree flora, as reported in previous studies (Oliveira-Filho & Ratter 1995, Françoso et al. 2016, Miranda et al. 2018).

It is important to mention that new occurrence records should be viewed with caution since most were based on sterile specimens identified by non-specialists. Consequently, they may not represent accurate records. This means that potentially new occurrence records should be further confirmed, preferably based on fertile specimens determined by experts. Among the 214 species collected by the IFN Cerrado cited in the CNCFlora's red list, 36 are classified to some degree of threat, including 2 critically endangered (CR), 14 endangered (EN) and 20 vulnerable (VU). Another 179 species are classified as least concern (LC) or near threatened (NT). A total of 232 Cerrado endemic species were collected, representing 12.4% of 1,858 endemic woody species registered in the Flora do Brasil 2020 for this biome. New occurrence records for threatened, as well as rare and endemic species provide crucial data expanding knowledge of geographic ranges and, hence, enabling updates of species threat status and furthering efforts to subsidise conservation initiatives. In addition to new distribution records, specimens collected by the IFN Cerrado supported the description of a new *Harpalyce* (Fabaceae) species from western Bahia (São-Mateus et al. 2019). It is likely that ongoing taxonomic work by specialists based on IFN Cerrado collections deposited in herbaria will reveal more new species to science. Also, with progress in specimen identification in herbaria, new species occurrences for the Cerrado and states, as well as records for endemic and threatened species, are expected.

Conclusion

Although initially developed to assess land coverage, forest structure and wood production, national forest inventories have also played a role as a major source of data for monitoring forest biodiversity (e.g., Chirici et al. 2012). In the present study, focusing specifically on the biodiversity dimension, we showed that the IFN Cerrado has provided a useful source of occurrence data for woody species, spanning wide geographic and habitat coverage. The large number of woody species reported here reflects the floristic variation found in diverse vegetation types found in the Cerrado region, which includes savannas, seasonally dry forests, and wet forests. Our analyses, based on the latest dataset available, showed that about a third of the floristic diversity of the Cerrado woody plants was sampled in the IFN. Our results also show that the typical floristic composition of the different vegetation types of the Cerrado was captured by that survey, and that species cited in the literature as common appear in high numbers among IFN collections. However, differential sampling efforts between field teams and difficulties in naming specimens are expected to influence the floristic diversity reported here. The fact that 35% of conglomerates sampled were located in anthropic areas, which are likely to be less diverse than well-preserved areas, may have also influenced the great variation found in sampling units in terms of species richness. The floristic richness compiled by the IFN Cerrado, which included a number of potential new occurrence records, was greatly influenced by typical woody elements from surrounding biomes, such as Amazonia, Caatinga and Atlantic Forest. Species collected in these marginal/ecotonal zones greatly contributed to the overall number of species recorded here.

Although considered a biodiversity hotspot, it is estimated that the Cerrado will lose 31-34% of its remaining native vegetation by 2050, mostly from agricultural expansion and limited protected areas (Strassburg et al. 2017). Therefore, increasing Cerrado floristic knowledge is critical to support conservation planning in this threatened biome. We expect that the occurrence records derived from IFN collections, particularly those from rare, endemic and endangered species, will contribute to the identification of priority areas for further surveys and conservation of the rich Cerrado flora.

Supplementary Material

The following online material is available for this article:

Table S1 - Specialists that contributed with the identification of selected families, and generalist botanists that identified miscellaneous families (bottom of the table).

Table S2 - Herbarium specimens of woody species collected by the IFN Cerrado. Only records belonging to native species identified at the species level are listed.

Table S3 - List of woody species collected by the IFN Cerrado, including information on states of occurrence, number of specimens collected,

habit, vegetation type, and selected voucher specimen. A voucher specimen, either sterile or fertile, was chosen to represent each species.

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Author Contributions

Fernanda K. Kiataqui: Conceptualization, Formal analysis, Writing – original draft-, Writing – review & editing. Sérgio Eustáquio de Noronha: Formal analysis, Writing – review & editing. Marcelo F. Simon: Data curation, Formal analysis, Writing – review & editing.

Conflicts of Interest

The authors declare that they have no conflict of interest related to the publication of this manuscript.

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