Biota Neotropica 23(3): e20221445, 2023
www.scielo.br/bn

biotaneotropica
ISSN 1676-0611 (online edition)

Short Communication

Rediscovery of presumably extinct species of *Aristida* in São Paulo State, Brazil

***Lucas Dias Sanglade*[1*], *Maria Tereza Grombone Guaratini*[2], *Cíntia Kameyama*[3], *Regina Tomoko Shirasuna*[3], *Raquel Stucchi Boschi*[4], *Dalva Maria da Silva Matos*[5] & *Vânia Regina Pivello*[6]**

[1]*Universidade Federal de São Carlos, Programa de Pós-graduação em Ecologia e Recursos Naturais, 13565-905, São Carlos, SP, Brasil.*
[2]*Instituto de Pesquisas Ambientais, Núcleo de Uso Sustentável da Biodiversidade, C.P. 68041, 04301-902, São Paulo, SP, Brasil.*
[3]*Instituto de Pesquisas Ambientais, Núcleo de Conservação da Biodiversidade, C.P. 68041, 04301-902, São Paulo, SP, Brasil.*
[4]*Universidade Federal de São Carlos, Secretaria Geral de Gestão Ambiental e Sustentabilidade, 13565-905, São Carlos, SP, Brasil.*
[5]*Universidade Federal de São Carlos, Departamento de Hidrobiologia, 13565-905, São Paulo, Brasil.*
[6]*Universidade de São Paulo, Instituto de Biociências, Departamento de Ecologia, 05508-900, Brasil.*
[*]*Corresponding author: sangladelucas@gmail.com*

SANGLADE, L.D., GUARATINI, M.T.G., KAMEYAMA, C., SHIRASUNA, R.T., BOSCHI, R.S., MATOS, D.M.S., PIVELLO, V.R. **Rediscovery of presumably extinct species of *Aristida* in São Paulo State, Brazil**. Biota Neotropica 23(3): e20221445. https://doi.org/10.1590/1676-0611-BN-2022-1445

Abstract: Two species of Poaceae (Aristidoideae) *Aristida ekmaniana* Henrard and *A. macrophylla* Hack. considered "presumably extinct" in the Brazilian state of São Paulo were rediscovered during fieldwork. We hereby describe the location, ecosystem, and *habitat* type where the species were found. We suggest these grasses be removed from the list of extinct species and be placed in a category compatible with the current knowledge about their conservation status in the state of São Paulo.
Keywords: *Aristidoideae; native grass; Poaceae.*

Redescoberta de espécies presumivelmente extintas de *Aristida* no estado de São Paulo, Brasil

Resumo: Duas espécies de Poaceae (Aristidoideae), *Aristida ekmaniana* Henrard e *A. macrophylla* Hack., consideradas "presumivelmente extintas" no estado de São Paulo, Brasil, foram redescobertas durante trabalho em campo. Descrição, ilustração e observações ecológicas são apresentadas, incluindo locais de observação, ecossistemas e habitats. Sugerimos a revisão do status de conservação das espécies no estado de São Paulo.
Palavras-chave: *Aristidoideae; gramínea nativa; Poaceae.*

Introduction

Aristida L. (subfamily Aristidoideae) is a worldwide grass genus of annual and/or perennial plants containing almost 305 species distributed in grasslands, deciduous forests, arid and semi-arid ecosystems of the tropical and subtropical areas around the globe (Gallaher et al. 2022, Cerros-Tlatilpa et al. 2011). It is a monophyletic genus that include C3 and C4 grass species (Gallaher et al. 2022). In Brazil, *Aristida* native species can be easily recognized in the field by the lemma with 3 awns and uniflorous spikelets. Most species of *Aristida* have a peculiar Kranz anatomy, with double concentric layers of chlorenchyma cells formed by a bundle sheath containing most of the chloroplasts, surrounded by an outer layer consisting of a small number of mesophyll cells (Longhi-Wagner 1999, Cerros-Tlatilpa et al. 2011, Gallaher et al. 2022). The non-Kranz species is *A. longifolia* Trin. (Cerros-Tlatilpa & Columbus 2009).

Aristida species are important components of pastures, savannas, dry forests, deserts, and abandoned areas (de Winter 1963, Simon 1992, Freeman 2009, Fatima et al. 2018). Although *Aristida* displays considerable importance in the structural diversity of many biomes they can be harmful to the livestock and wildlife (Stubbendieck et al. 1992, Lazarides 2002).

The genus has four diversity centers – Africa, North America, South America, and Australia (de Winter 1965). They are especially abundant in Brazil, comprising 40 species, 11 of which are endemic (Longhi-Wagner 2020). *Aristida* species grow in anthropic areas, Caatinga (*sensu stricto*), grasslands vegetation on top of hills, floodplains, and

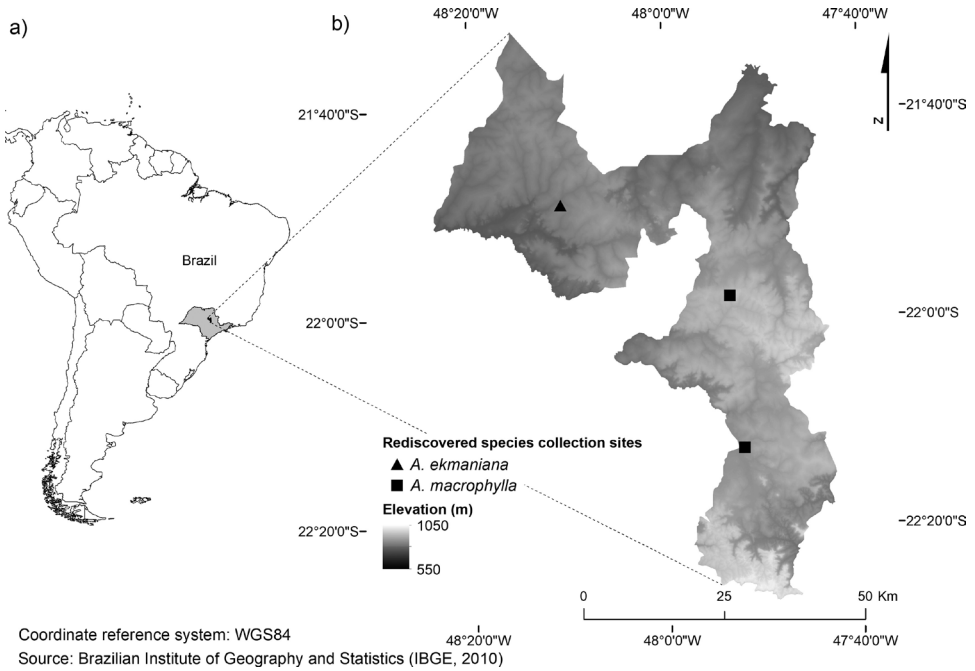

Figure 1. (a) Geographic area where the populations of *Aristida ekmaniana* Henrard and *A. macrophylla* Hack were registered in the state of São Paulo; (b) locations where specimens of *A. ekmaniana* and *A. macrophylla* were collected.

rocky fields, Cerrado (*sensu lato*) (Savanna), and Amazonian Savanna (Flora e Funga do Brasil 2023). In the state of São Paulo there are 18 native species (Longhi-Wagner 2020), of which eight are considered threatened in the state list (São Paulo-SMA 2016).

Cerrado is the most critically threatened domain in Brazil (Lopes et al. 2021). The main causes are loss of native vegetation due to land conversion to pasture and agriculture and invasion by African grasses (Pivello et al. 1999, Durigan et al. 2007, Strassburg et al. 2017, Lopes et al. 2021). Habitat loss is one of the largest current threats to the planet, causing biodiversity loss and species extinction (Roberts et al. 2021).

During field works in Cerrado areas in São Paulo in 2022, some individuals of Poaceae were collected, including two *Aristida* species listed as "presumably extinct" (EX) in the official list of endangered species in the State (São Paulo-SMA 2016). This study approaches the rediscovery of these species in the state of São Paulo.

Material and Methods

Field expeditions were carried out in 2022 in the central region of the state of São Paulo (Figure 1), where specimens of *Aristida* were collected and identified in uncovered soil, anthropic grasslands, and roadside areas. Fertile specimens were collected later, in December of 2022, to confirm the identification. The collected material was identified using the identification and description key from Wanderley et al. (2001) and Flora e Funga do Brasil (2023). The morphologic terminology follows Longhi-Wagner (1990, 1999).

The material was collected following the usual phanerogamic taxonomy procedures (Fidalgo & Bononi 1989) and using a Garmin® GPS device; complementary coordinates were obtained through Google Earth®. The material was deposited at the Maria Eneyda P. Kaufmann Fidalgo Herbarium – SP, at the Environmental Research Institute of São Paulo.

The climate and soil type characteristics at the locations where the specimens were found were obtained from specific maps. The climate types followed Köppen classification (Alvarez et al. 2013) and the soil types followed Brazilian Soil Classification System (Oliveira et al. 2000; Santos et al. 2018).

Assessment of the conservation status was made using the IUCN Standards and Petitions Comitee (2022) categories and criteria; the extent of occurrence (EOO) and area of occupancy (AOO) were determined with GeoCat (Bachman et al. 2011). The evaluation included new and old collections of both species whose data were available at Species Link data base and Herbarium SP.

Results and Discussion

We registered the occurrence of *Aristida ekmaniana* and *A. macrophylla* – considered "presumably extinct" according to Resolução SMA # 57 from June 5, 2016, from the Secretariat of the Environment (São Paulo-SMA 2016) in distrophic soils (dystrophic *Neossolos Quartzarênicos* and dystrophic *Latossolos*) (Oliveira et al. 2000) at altitudes from 569 to 861 m.a.s.l. within the Cerrado domain, in Cwa dry-winter humid subtropical climate, according to Köppen's climate classification (Alvares et al. 2013). (Table 1).

Aristida ekmaniana Henrard (1926: 54). (Figure 2).

Perennial, caespitose, (58-) 60-85 (-115 cm) tall. Sheaths glabrous to sparsely pilose; ligule ca. 0.2 mm, membranous-ciliated, short membranous at the base and long ciliated at the apex; blade (7-)11-34 cm long, 0.1-0.36 cm wide, linear-lanceolate, with leaf dimorphism, basal ones flat and curved when old, upper blades conduplicate and erect. Panicle contracted, 15-33 cm long, subdense, part interrupted, leaving the rachis visible. Glumes acute, the lower ones (6-)9.8-14.2 mm long, generally longer, rarely subequal or shorter than the upper

Table 1. List of rediscovered species and registration number (collector and voucher), location of collection, altitude, and substrate in which they were found.

Taxa	Collector(s), number and collection date	Voucher	Specimen collection sites (rediscovery)	Altitude (m.a.s.l.)	Köppen climate type*	Habitat	Substrate**
Aristida ekmaniana Henrard	*L.D. Sanglade & L.L. Vituri 9,* 23-III-2022	SP 526126	BRAZIL. SÃO PAULO: Araraquara, SP-310, km 271, 21°49'17,4"S, 48°10'46,9"W	661	Cwa	roadside area	clayish, dystrophic Latossolo
Aristida macrophylla Hack	*L.D. Sanglade & L.L. Vituri 6,* 09-VIII-2022	SP 526128	BRAZIL. SÃO PAULO: São Carlos, Pedro Muskat Street, no number, 21°58'7,3"S, 47°53'22,4"W	861	Cwa	roadside area	clayish, dystrophic Latossolo
	L.D. Sanglade & L.L. Vituri 7, 09-VIII-2022		BRAZIL. SÃO PAULO: Itirapina, SPA-097/225, km 5, 22°12'40,4"S, 47°52'6,1"W	739	Cwa	anthropic grassland	sandy, dystrophic Neossolo Quartzarênico

*Alvares, C.A., Stape, J.L., Sentelhas, P.C., Gonçalves, J.L.M.; Sparovek, G. 2013. Köppen's climate classification map for Brazil. Meteorologische Zeitschrift, v. 22, n. 6, p. 711-728. **Oliveira, J., Camargo, M., Calderano Filho, B. and Rossi, M. 2000. Mapa Pedológico do Estado de São Paulo. O Agronômico 52, 21–23.

Figure 2. *Aristida ekmaniana* Henrard. – A. Habit. – B. detail of glabrous sheath and tuft of trichomes on adaxial base. – C. detail of sheath with glabrous neck and base of the leaf blade with sparse trichomes. – + e * = fragment of the synflorescence. – D. spikelets. – E. upper glume. – F. lower glume. – G. lemma with column. – H. callus. (*Sanglade & Vituri 10* SP).

ones (5-)8.5-14 mm long and may vary within the same panicle. Lemma 6-7(-9) mm long (including (0.8-)1-1.2 mm acute callus); column 8-12 mm long, without a node of articulation at the apex, without ventral longitudinal groove, awns subequal, straight or slightly twisted at base, the central one 15-22 (-30) mm long, the lateral ones 13-25 mm long. Caryopsis with superficial ventral longitudinal groove.

The specimen recently collected from Araraquara presented subequal glumes (5-6 mm) and short column with 4-5 mm long. The set of characteristics of the lemna column length, callus morphology and inflorescence distinguish this species from the most similar ones.

Examined material: *BRAZIL. SÃO PAULO: Araraquara,* 23-III-2022, *L.D. Sanglade & L.L. Vituri 9,* SP-310, km 271, 21°49'17.4"S, 48°10'46.9"W, 661 m.a.s.l., Cwa, clayish dystrophic Latossolo in roadside area; Itirapina, 25-III-1963, T. Sendulsky 90, 5 km along road Washington Luiz – Rio Claro (road side); São José dos Campos, 31-V-1961, G. Eiten & T. Sendusky 2850, disjunct cerrado of several hundred sq.km surrounded by former forest. Ca. 7 km S of main plaza of São José dos Campos, along road to Paraibuna. Cerrado with trees to 5 m tall, 5-15 m apart, plus scattered shrubs & grasses. Soil light brown fine sand clay; id. 31-V-1961, G. Eiten & T. Sendusky 2859, 5.5 km S & 1.9 km E of main plaza in city of São José dos Campos (along road to Paraibuna). Cerrado low woodland with trees 3-5 m tall 5-15 m apart, scattered shrubs & grasses, soil light brown fine sandy clay.

Distribution, ecology, and conservation: Endemic to Brazil, confirmed for cerrado (*sensu lato*) in the Northeast region (BA, RN), Central-West Region (DF, GO, MT), Southeast (MG, SP), and South (PR) (Longhi-Wagner 2020). In this work, the species was newly registered in the municipality of Araraquara. In the state of São Paulo, the extension of occurrence (EOO) is 7,708 km² and the occupation area is 16 km². Until now, collection from only four locations have been registered – those from São José dos Campos are from 1961 and from Itirapina, from 1963. All locations are within or relatively close to urban areas and intensely affected by the presence of African Poaceae. The population is greatly fragmented and distant (at least 150 km) from places where the species was registered in the neighboring states of Minas Gerais and Paraná.

This species has not been evaluated at national level yet. Considering the new collection, for the state of São Paulo we suggest that

Figure 3. *Aristida macrophylla* Hack. – A. Habit. – B. detail of sheath with glabrous neck and membranous-ciliated ligule. – CD. fragment of the subdensiflora panicle, interrupted. – E. lower glume longer than upper glume. – F. upper glume. – G. lemma with column. – H. callus. (*Sanglade & Vituri 6* SP).

it is downgraded from "presumably extinct" category, to "endangered" [EN B2ab(i,ii,iii,iv)].

Aristida macrophylla Hack. (1906: 16). (Figure 3).

Perennial, caespitose, (-0.3) 0.5-1 m tall. Sheaths with glabrous neck, glabrous margin or with sparse trichomes at the base; hairy ligule, 0.5-0.8 mm long; blade 15-50 (-55) cm long, (0.08-) 0.15-0.25(-3) cm wide, glabrous or with sparse trichomes at the base of the adaxial surface, linear, without leaf dimorphism, conduplicate or convoluted, usually flexuous. Panicle contracted to subarbertate, (-14) 18-23 (-42) cm long. Glumes acute, the lower ones (9-)10-14(-16) mm long, longer than upper ones (6-)10-12 mm long. Lemma 6-7(-10) mm long (including 0.5-0.7 mm subacute callus), with ventral longitudinal groove; column (2-)5-7(8-) mm long, without a node of articulation at the apex; awns subequal or central longer, the central one 16-24(-28) mm long, the lateral ones 14-21(-22) mm long, connivent at the base 1-3 mm, then divergent, straight or flexuous. Caryopsis grooved.

The examined materials differed somewhat in measurements. L.D. Sanglade & L.L. Vituri 6 presented lower glume a little smaller (9 mm) than the average described 10-14(-16) mm and the column was a little smaller (2.5 mm) in relation to the average 5-7(- 8) mm. Sanglade, L.D. & Vituri, L.L. 07 had an inflorescence 42 cm long, blade 0.3 mm wide and the column was also smaller (0.2 mm long), with the central awn longer up to 28 mm and the side ones 22 mm long.

Examined material: *BRAZIL. SÃO PAULO: São Carlos*, 09-VIII-2022, *L.D. Sanglade & L.L. Vituri 6*, Rua Pedro Muskat, 21°58'7.3"S, 47°53'22.4"W, 861 m.a.s.l., Cwa, clayish dystrophic Latossolo in roadside area, SP 526128; *Itirapina*, 09-VIII-2022, *L.D. Sanglade & L.L. Vituri 7*, SPA 097/225, km 5, 22°12'40.4"S, 47°52'.1"W, 739 m.a.s.l., Cwa, sandy dystrophic Neossolo Quartzarênico in anthropic grassland; *Itirapina,* 23-III-1963, *T Sendulsky 713*, along road Washington Luiz, SP66011; *Capão Bonito*, 10-X-1966, *J. Mattos 13979*, Capão Bonito-Itararé highway, in campo sujo vegetation, SP102041; *São Paulo*, 31-X-1947, *A. Brandão Joly* 511, Butantan, grassland, SP69854.

Distribution, ecology, and conservation: This species occurs in Argentina, Paraguay, and Brazil and was confirmed in the Southeast (SP) and South Region (PR, SC, RS). It grows on grasslands in the Cerrado, Atlantic Forest, and Pampa domains (Longhi-Wagner 2020). In the state of São Paulo, it was collected in São Paulo metropolitan region, where its type comes from (Pilar, in Ribeirão Pires) in 1902, and in the municipality of São Paulo in 1947 and in Itapetininga in 1887, Capão Bonito and Itirapina in the 1960's, thus totaling 5 locations, all in currently threatened areas. Recent collections were done in São Carlos (2007 and 2022) and Itirapina. The areas of occurrence either have already or are becoming urban areas and are affected by the presence of African Poaceae.

Its risk of extinction has not been evaluated in Brazil yet. Because its occupation area extends 32 km² in the state of São Paulo and its population is greatly fragmented and threatened, we suggest the removal of the species from the "presumably extinct category", to be reclassified as "endangered" [EN B2ab (i,ii,iii,iv)].

The long time without collections of these Poaceae species classified as presumably extinct in the state of São Paulo, together with other recent rediscoveries (Filgueiras & Shirasuna 2009, Rodrigues & Filgueiras 2013), may be resultant to the fact that they are under-collected due to difficulty of non-expert to distinguish them from ruderal or invasive species. Another reason may be a certain bias that botanists have in not collecting in areas where the native vegetation, especially grasslands, is disturbed, but which still allow the growth of native rare species. This situation also brings to light that sampling deficiency interfere with a precise assessment of conservation status of many species and hinder the identification of priority conservation areas.

Acknowledgments

This research was funded by FAPESP (São Paulo State Research Support Foundation, FAPESP Project 2019/19293-4). Lucas Dias Sanglade received a PhD grant from CAPES (Coordination for the Improvement of Higher Education Personnel). We express our sincere thanks to Lincoln Laudelizio Vituri and Ulisses Gonçalves Fernandes for their help in the fieldwork. The authors also thank Klei Souza for preparing the illustrations and inking the microscopical features.

Associate Editor

Carmen Zickel

Authors Contributions

Lucas Dias Sanglade: Substantial contribution in the concept and design of the study; contribution to data collection; contribution to data

analysis and interpretation; contribution to manuscript preparation; and contribution to critical revision, adding intellectual content.

Maria Tereza Grombone Guaratini: Substantial contribution in the concept and design of the study; contribution to data analysis and interpretation; contribution to manuscript preparation; and contribution to critical revision, adding intellectual content.

Cíntia Kameyama: Substantial contribution in the concept and design of the study; contribution to data analysis and interpretation; contribution to manuscript preparation; and contribution to critical revision, adding intellectual content.

Regina Tomoko Shirasuna: Contribution to data analysis and interpretation; contribution to manuscript preparation; and contribution to critical revision, adding intellectual content.

Raquel Stucchi Boschi: Contribution to data collection; contribution to manuscript preparation; and contribution to critical revision, adding intellectual content.

Dalva Maria da Silva Matos: Contribution to critical revision, adding intellectual content.

Vânia Regina Pivello: Contribution to critical revision, adding intellectual content.

Conflicts of Interest

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

Ethics

This study did not involve human beings and/or clinical trials that should be approved by a Institutional Committee.

Data Availability

The exsiccates were deposited at the Maria Eneyda P. Kaufmann Fidalgo Herbarium – SP, at the Botanical Institute of São Paulo. The primary data analyzed during the current study is reported in the main text as Table 1. The authors confirm that all data necessary for reproducing the study findings are available in the designated dataset.

References

ALVARES, C.A., STAPE, J.L., SENTELHAS, P.C., GONÇALVES, J.L.M. & SPAROVEK, G. 2013. Köppen's climate classification map for Brazil. Meteorol. z. 22(6):711–728.

BACHMAN, S., MOAT, J., HILL, A.W., TORRE, J. & SCOTT, B. 2011. Supporting red list threat assessments with GeoCAT: Geospatial conservation assessment tool. ZooKeys. 150:117–126.

CEBALLOS, G., EHRLICH, P.R., BARNOSKY, A.D., GARCÍA, A., PRINGLE, R.M. & PALMER, T.M. 2015. Accelerated modern human–induced species losses: Entering the sixth mass extinction. Sci. Adv. 1(5):e1400253.

CERROS-TLATILPA, R. & COLUMBUS, J.T. 2009. C3 photosynthesis in Aristida longifolia: Implication for photosynthetic diversification in Aristidoideae (Poaceae). Am. J. Bot. 96(8):1379–1387.

CERROS-TLATILPA, R., COLUMBUS, J.T. & BARKER, N.P. 2011. Phylogenetic relationships of *Aristida* and relatives (Poaceae, Aristidoideae) based on noncoding chloroplast (trnL-F, rpl16) and nuclear (ITS) DNA sequences. Am. J. Bot. 98(11):1868–1886.

DE WINTER, B. 1963. Notes on the genus *Aristida* L. (Gramineae). Kirkia. 3:132–137.

DE WINTER, B. 1965. The South African Stipeae and Aristideae (Gramineae). Bothalia. 8:201–401.

DURIGAN, G., SIQUEIRA, M.F. & FRANCO, G.A.D.C. 2007. Threats to the cerrado remnants of the state of São Paulo, Brazil. Sci. Agric. 64: 355–363.

FATIMA, S., HAMEED, M., AHMAD, F., ASHRAF, M. & AHMAD, R. 2018. Structural and functional modifications in a typical arid zone species *Aristida adscensionis* L. along altitudinal gradient. Flora. 249:172–182.

FIDALGO, O. & BONONI, V.L.R. 1989. Técnicas de coleta, preservação e herborização de material botânico. Instituto de Botânica/Imprensa Oficial do Estado de São Paulo, São Paulo, p. 62.

FILGUEIRAS, T.S. & SHIRASUNA, R.T. 2009. Redescoberta de espécies presumivelmente extintas de Poaceae da Flora de São Paulo, Brasil. Hoehnea. 36(3):507–509.

FLORA E FUNGA DO BRASIL. https://floradobrasil.jbrj.gov.br/FB12994 (last access in 13/07/2023).

FREEMAN, C. 2009. The Genus *Aristida* (Poaceae) in Kansas. Trans. Kans. Acad. Sci. 104:144–157.

GALLAHER, T.J., PETERSON, P.M., SORENG, R.J., ZULOAGA, F.O., LI, D.Z., CLARK, L.G. & TEISHER, J.K. 2022. Grasses through space and time: An overview of the biogeographical and macroevolutionary history of Poaceae. J. Syst. Evol. 60(3):522–569.

IUCN STANDARDS AND PETITIONS COMITEE. 2022. Guidelines for using the IUCN Red List categories and criteria. Version 15.1. Prepared by the Standards and Petitions Committee. https://www.iucnredlist.org/documents/RedListGuidelines.pdf. (last access in 27/01/2023).

LAZARIDES, M. 2002. Economic attributes of Australian grasses. In Flora of Australia: Poaceae 1, Introduction and Atlas (K. MALLET & A.E. ORCHARD, eds). Australian Biological Resources Study/CSIRO Publishing, Canberra, v.43, p.213–244.

LONGHI-WAGNER, H.M. 1990. Diversidade e distribuição geográfica das espécies de *Aristida* L. (Gramineae) ocorrentes no Brasil Acta Bot. Bras. 4(1):105–124.

LONGHI-WAGNER, H.M. 1999. O gênero *Aristida* (Poaceae) no Brasil. Bol. Inst. Bot. 12:113–179.

LOPES, G.R., LIMA, M.G.B. & DOS REIS, T.N.P. 2021. Maldevelopment revisited: Inclusiveness and social impacts of soy expansion over Brazil's Cerrado in Matopiba. World Dev. 139:e105316.

OLIVEIRA, J., CAMARGO, M., CALDERANO FILHO, B. & ROSSI, M. 2000. Mapa Pedológico do Estado de São Paulo. O Agronômico. 52:21–23.

PIVELLO, V.R, CARVALHO, V.M.C., LOPES, P.F., PECCININI, A.A. & ROSSO, S. 1999. Abundance and distribution of native and alien grasses in a 'Cerrado' (Brazilian savanna) biological reserve. Biotropica. 31:71–82.

ROBERTS, L., HASSAN, A., ELAMER, A. & NANDY, M. 2021. Biodiversity and extinction accounting for sustainable development: A systematic literature review and future research directions. Bus. Strateg. Environ. 30(1):705–720.

RODRIGUES, R.S. & FILGUEIRAS, T.S. 2013. Redescoberta de *Hymenachne pernambucensis* (Poaceae: Paspaleae), espécie presumivelmente extinta no Estado de São Paulo, Brasil. Hoehnea. 40(2):403–405.

SANTOS, H.G., JACOMINE, P.K.T., ANJOS, L.H.C., OLIVEIRA, V.A., LUMBRERAS, J.F., COELHO, M.R., ALMEIDA, J.A., ARAÚJO FILHO, J.C., OLIVEIRA, J.B. & CUNHA, T.J.F. 2018. Sistema Brasileiro de Classificação de Solos. 5 ed. Embrapa, Brasília.

SÃO PAULO-SMA. 2016. Resolução SMA nº 57 de 2016. Diário Oficial do Estado de São Paulo, Secretaria de Meio Ambiente, São Paulo, SP, 30 jun. 2016. Seção I, p. 55–57.

SIMON, B.K. 1992. A revision of the genus *Aristida* (Poaceae) in Australia. Australian Syst. Botany. 5:129–226.

STRASSBURG, B.B.N., BROOKS, T., FELTRAN-BARBIERI, R., IRIBARREM, A., CROUZEILLES, R., LOYOLA, R., LATAWIEC, A.E., OLIVEIRA FILHO, F.J.B., SCARAMUZZA, C.A.M., SCARANO, F.R., SOARES-FILHO, B. & BALMFORD, A. 2017. Moment of truth for the Cerrado hotspot. Nat. Ecol. Evol. 1(4):e0099.

STUBBENDIECK, J.L., HATCH, S.L. & BUTTERFIELD, C.H. 1992. North American range plants. 4 ed. University of Nebraska Press, Lincoln.

WANDERLEY, M.G.L., SHEPERD, G.J. & GIULIETTI, A.M. (Coord.). 2001. Flora Fanerogâmica do Estado de São Paulo. FAPESP-HUCITEC, São Paulo, v.1.

Received: 16/11/2022
Accepted: 30/07/2023
Published online: 08/09/2023