Phytotaxa 452 (4): 250–267
https://www.mapress.com/j/pt/

Article

ISSN 1179-3155 (print edition)
PHYTOTAXA
ISSN 1179-3163 (online edition)

https://doi.org/10.11646/phytotaxa.452.4.1

The importance of the Brazilian Subtropical Highland Grasslands evidenced by a taxonomically verified endemic species list

CÁSSIA PLÁ[1,6], JOSIMAR KÜLKAMP[2,7], GUSTAVO HEIDEN[1,3,8], EIMEAR NIC LUGHADHA[4,9] & JOÃO R. V. IGANCI[1,5,10]

[1] *Programa de Pós-Graduação em Botânica, Universidade Federal do Rio Grande Sul.*
[2] *Programa de Pós-Graduação em Botânica, Escola Nacional de Botânica Tropical.*
[3] *Embrapa Clima Temperado.*
[4] *Conservation Science, Royal Botanic Gardens, Kew.*
[5] *Universidade Federal de Pelotas, Instituto de Biologia.*
[6] *cassiapla@gmail.com; https://orcid.org/0000-0003-1084-8008*
[7] *josimarbotanica@gmail.com; https://orcid.org/0000-0001-5919-2930*
[8] *gustavo.heiden@gmail.com; https://orcid.org/0000-0002-0046-6500*
[9] *e.niclughadha@kew.org; https://orcid.org/0000-0002-8806-4345*
[10] *joaoiganci@gmail.com; https://orcid.org/0000-0002-5740-3666*

Abstract

The Brazilian Subtropical Highland Grasslands (Campos de Cima da Serra) is one of the main areas of endemism in southern Brazil. The complex biogeographic history that resulted in the floristic composition of the region is directly linked to the high degree of plant endemism found there. Here we present a current checklist for the endemic plants – the first taxonomically verified endemic species list for the region. The list comprises 273 endemic taxa (23.5% of its flora) representing 40 families and 117 genera, highlighting fifty-seven taxa reported as endemic from the region for the first time in recent years. Voucher specimens, original publication, locality information and distribution data are provided for each endemic taxon. Botanical collections in the Brazilian Subtropical Highland Grasslands have increased exponentially during the last four decades. However, 41 taxa are known only from the original collection record reported in their protologue. Our results emphasize the importance of the Brazilian Subtropical Highland Grasslands in terms of conservation of its flora and the importance of providing complete information on botanical collection labels as source for a robust knowledge of the flora.

Keywords: angiosperms, biodiversity, botanical collections, endemism, floristics, taxonomy

Introduction

Development of efficient strategies for the conservation and sustainable use of biodiversity depends fundamentally on understanding the biological richness within a region (Schmeller *et al.* 2009, Lepetz *et al.* 2009, Barboza *et al.* 2016). In this context, conducting thorough surveys of the species occurring in a given area and reporting their natural history highlights the relevance of their conservation (Zuloaga 2005). The Brazilian Subtropical Highland Grasslands (BSHG) is an important centre of regional diversity due to the uniqueness of its habitats. In this region, rocky outcrops are especially important because of their richness in endemic species, the presence of rare species, and their function as refuge for threatened species. However, despite their scientific and functional interest, these montane ecosystems are poorly known (Barboza *et al.* 2016), making it difficult to establish conservation priorities and achieve recognition by policy-makers.

The BSHG, also known as Campos de Cima da Serra, covers the whole Serra Geral mountain range, located in the Paraná Basin of southern Brazil (Scheibe 1986, Iganci *et al.* 2011). These subtropical grasslands are related to the high altitude tropical grasslands of the Atlantic Forest and the temperate low altitude grasslands of the Pampas (Bilenca & Miñarro 2004, Heiden & Iganci 2009). The concept and boundaries of the Campos de Cima da Serra were explained by Iganci *et al.* (2011), and subsequently confirmed by Külkamp *et al.* (2018). Their revised concept considers the BSHG as a distinct vegetation type defined by numerous endemic taxa, restricted to isolated patches

surrounded by ecologically and floristically distinct forest formations located in southern Brazil. The BSHG are part of the Brazilian complex of Highland Grasslands which includes the campos de altitude (Tropical Highland Grasslands along the Serra do Mar and Serra da Mantiqueira ranges) and the campos rupestres (Tropical Quarzitic Mountaintop Grasslands from the Espinhaço Range) and can be distinguished from the former based on geological and climate grounds. Although confined to the South of Brazil, the BSHG is not delimited by political boundaries, as has been assumed by some critics misunderstanding its circumscription. For example Tropical Highland Grasslands belonging to the Tropical High Altitude Grasslands that predominate in southeastern Brazil also occur along the southern tip of the Serra do Mar range in eastern Paraná and northeastern Santa Catarina with their southern tip at Serra do Quiriri within the political borders of southern Brazil. Similarly the open grasslands associated with the Tropical Savannas of the Cerrado Biome extend across the northeastern border between Paraná (Jaguariaiva region) and São Paulo (Bom Sucesso de Itararé region) states. The Brazilian Flora 2020 (under construction) adopts a broad circumscription of High Altitude Grasslands encompassing the tropical and subtropical grassland areas of the Atlantic Rainforest domain and excluding the tropical grasslands of the Cerrado and Caatinga domains. A checklist of endemic highland grassland flora from the Atlantic Rainforest domain can be easily retrieved based on this database. However, it is not possible to obtain such a list from Brazilian Flora 2020 in the case of the subtropical flora (latitudes higher than the Tropic of Capricorn), as well as the tropical flora (north of the Tropic of Capricorn). The BSHG formation is circumscribed within the Serra Geral Mountain range, which covers much of the southern Brazilian plateau. Over the study area, the soils have a basaltic origin, different of the mostly granitic and limestone mountain ranges of eastern Brazil. Moreover, the climate is subtropical, resulting in specific edaphoclimatic abiotic characteristics for the region.

The current list of flowering plants endemic to southern Brazil recognizes 1007 taxa at species, subspecies or variety level corresponding to about 12% of all angiosperms known from southern Brazil (8103 taxa) (Brazilian Flora 2020 under construction, BFG 2015). Considering only the BSHG, the most important families in terms of their numbers of endemic taxa are Asteraceae, Fabaceae and Poaceae (Iganci *et al.* 2011, Brazilian Flora 2020 under construction, BFG 2015). Four major areas correlated with altitude were identified by Barros *et al*. (2015). These represent stable niches and areas rich in endemic plant species, confirming that these highlands are important centres of endemism (Külkamp *et al.* 2018). However, the BSHG have been neglected and not considered as a conservation priority (Overbeck *et al.* 2007), as some tropical highland grasslands are (Bitencourt *et al*. 2016). The BSHG are suffering loss of natural habitats, being quickly replaced by large mechanized agricultural areas and forestry, activities which increase extinction risks for grassland species (Lopes *et al*. 2010, Boldrini *et al*. 2009).

In order to assist with the conservation and advancement of knowledge of the BSHG flora we present here an updated taxonomically verified list of plant species endemic to the BSHG. Our aims are to (1) re-evaluate the diversity of endemic plants in the study area, (2) taxonomically verify each species name by checking their protologues and data on type specimens, and (3) collate type specimen distribution data.

Material and methods

Study area

The BSHG comprises around 1,374,000 ha in southern Brazil (Fig. 1) (Boldrini *et al.* 2009), reaching up to 1800 m altitude at its eastern edge. It is located south of the Tropic of Capricorn, between 24° 52' 11" S and 29° 26' 40" S, and between 49° 27' 11" W and 53° 43' 51" W (Iganci *et al.* 2011). The BSHG covers the effusive rocks of the Serra Geral highlands, which originated around 120–135 million years ago (Almeida 2009). It represents a mosaic vegetation, often adjacent to the Ombrophilous Mixed Forest dominated by *Araucaria angustifolia* (Bertoloni) Kuntze (1898: 375) and comprises different vegetation formations including highland grasslands and associated vegetation types such as wet grasslands and rocky outcrops as found in the eastern edge of the Serra Geral range (Iganci *et al.* 2011). The climate is subtropical humid (Cfa) and temperate humid (Cfb) (Peel, Finlayson & McMahon 2007), with rainfall distributed throughout the year. The average temperature is between 12°C and 18°C, with minimum temperature in July, 10°C and maximum temperature in January, 27°C (Behling 2002, Almeida 2009, INMET 2018). The extent of these grasslands is influenced by the local topography, drainage network, and the soil distribution and composition (Safford 1999). The BSHG covers mostly the highest areas and dry slopes within the Serra Geral, while the *Araucaria* Jussieu (1789: 413) forest occupies the more humid slopes and valleys (Safford 1999).

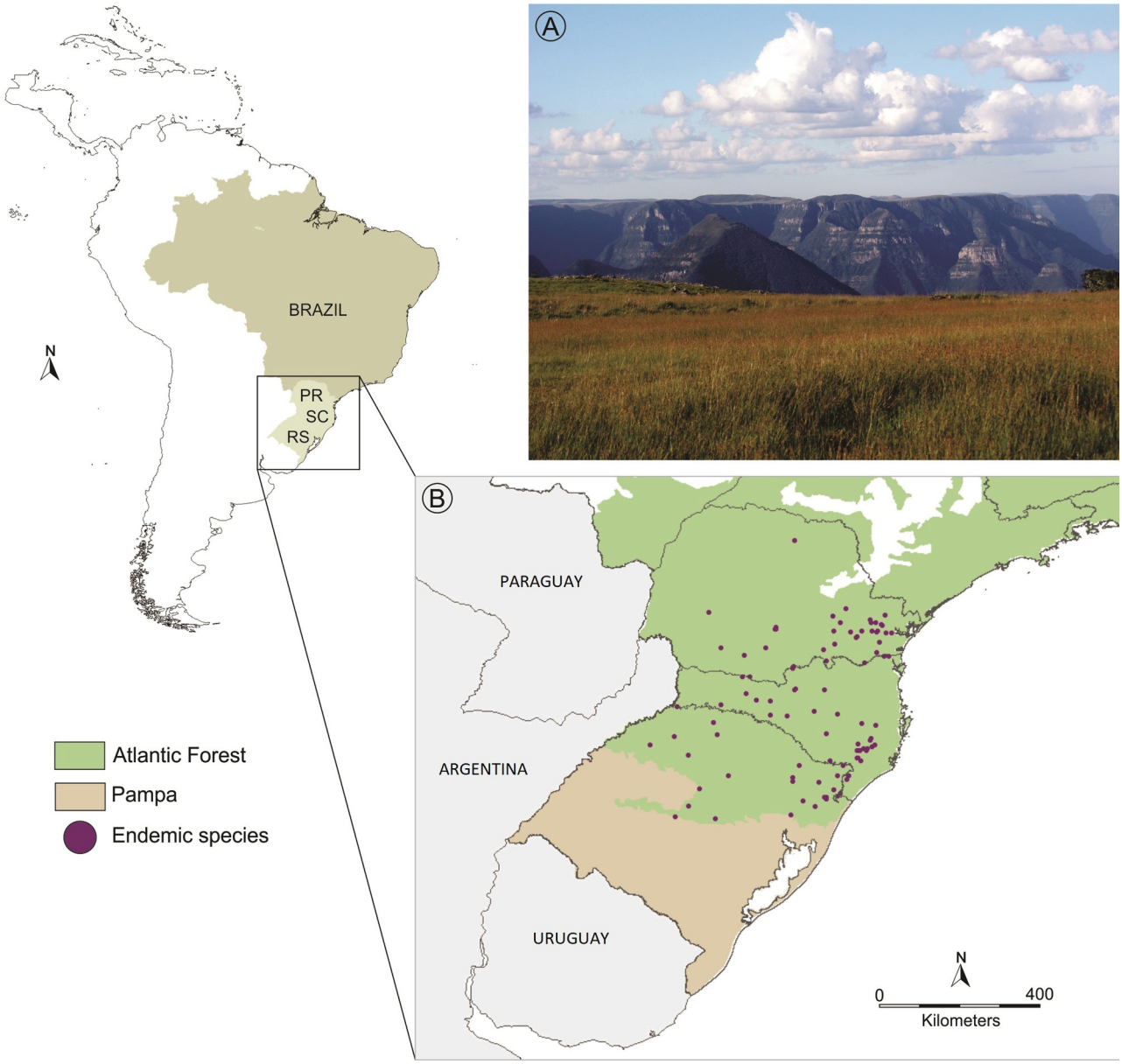

FIGURE 1. Brazilian Subtropical Highland Grasslands region. **A.** Serra da Rocinha (between Rio Grande do Sul and Santa Catarina states) in the study area. Photograph by Plá. **B.** Distribution of the type specimens of 273 species endemic to the BSHG. Delimitation of Atlantic Forest and Pampa follows IBGE (2004). Rio Grande do Sul, RS; Santa Catarina, SC; Paraná, PR.

Datasets

Compilation of the endemic species list was based on the species lists for southern Brazil (Iganci *et al.* 2011), the Brazilian Flora 2020 (under construction, BFG 2015) and publications of new species since 2011 reported in The International Plant Names Index (IPNI). An updated consensus list of endemic plants from the BSHG was thus produced. A complete verified dataset including species protologues and taxonomic revisions, type specimen images and herbarium specimens for each endemic taxon from the BSHG was compiled through an exhaustive search of nomenclatural databases (IPNI 2017, Tropicos 2017), species lists and herbarium databases (Stehmann *et al*. 2009, CRIA 2017, GBIF 2017, Brazilian Flora 2020 under construction, BFG 2015, REFLORA 2017), herbaria, fieldwork observations, scientific publications and personal communication with taxonomists. The most recent changes in taxonomy and nomenclature were applied according to APG IV (2016) at family and genus levels, while at species level updates followed recent taxonomic revisions, monographs and protologues. Images of type specimens and other information from herbarium collections were incorporated in the database, including all known specimens of each endemic species. This collection of information provided the basis for an historical account of the most

important collections and naturalists who documented the endemic flora of the BSHG, including their main expeditions, localities visited and sampling effort. Fieldwork expeditions were targeted to complement the database information, focusing on less sampled areas and on endemic species under-represented in herbaria. Our collections were deposited in the ICN herbarium, at the Universidade Federal do Rio Grande do Sul. For each taxon, geographic distribution data, including vegetation type, were compiled from the Brazilian Flora 2020 (under construction, BFG 2015), herbaria (HBR, ICN, MBM, PACA, RB, SPF) (acronyms following Thiers 2020, continuously updated), and the online herbarium databases of MO, US and NY, accessed via speciesLink (CRIA 2017). Specimens deposited in Brazilian herbaria were also consulted via the website REFLORA (2017).

Data analysis

All names were organized in tables with the information contained in protologues, type specimens, voucher specimens and distribution information. Scanned images from protologues and type specimens were organized in databases according to families. Counts and lists were collated for collections per species and decade, species by family and number of specimens representing them, and how many new species were represented in the collections of each collector.

The occurrence data cited in protologues were plotted on maps using the Diva-GIS 7.5 software (Hijmans *et al.* 2012). Additional occurrence data were collected from herbarium specimens, speciesLink (CRIA 2017), GBIF (2017) and the scientific literature. For taxa with no locality indicated in the protologue, a geo-referenced site was created based on the known taxon distribution data from herbarium sample labels (Fig. 1).

Results

Revisiting BSHG endemic plant species diversity

The updated list of endemic plants from the BSHG includes 273 taxa at species, subspecies or variety level, corresponding to 3.4% of all angiosperms reported for southern Brazil (8103 taxa) (Brazilian Flora 2020, under construction, BFG 2015). The complete list of endemic flowering plants from the Brazilian Subtropical Highland Grasslands is provided as Supplementary Material (Table S1).

The new records at family level are for Commelinaceae and Caprifoliaceae, each represented by one endemic taxon, *Tradescantia seubertiana* Pellegrini (2016: 80) and *Valeriana gilgiana* Graebner (1899: 435) respectively. Also among the new records are 33 species and one subspecies (*Cypella hauthalii* (Kuntze) R.C.Foster subsp. *minuticristata* Chauveau & L.Eggers (2014: 33) recently described as new to science and published between 2011–2017. Representatives of the families Iridaceae, Asteraceae and Orchidaceae are particularly prominent among the new records, and at genus level *Sisyrinchium* Linnaeus (1753: 954) and *Baccharis* Linnaeus (1753: 860) stand out with six and four species respectively.

The families with highest numbers of endemic taxa are Asteraceae (45), Poaceae (29) and Fabaceae (26). The best represented genera are *Baccharis* L. (Asteraceae) with 15 taxa, *Nothoscordum* Kunth (1843: 457) (Amaryllidaceae) with 13 taxa, and *Mimosa* Linnaeus (1753: 516) (Fabaceae) with 11 taxa. According to the digital platform Brazilian Flora 2020 (under construction, BFG 2015), the majority of the taxa (81%) occur in highland grassland vegetation, followed by rocky outcrop vegetation (20%) and wetlands (5%).

Botanical collections and naturalists in southern Brazil

Friedrich Sellow (1789–1831), Gustaf Oskar Andersson Malme (1864–1937) and Per Karl Hjalmar Dusén (1855–1926) are amongst the main historical collectors who recorded the flora of southern Brazil, with expeditions carried out between 1814 and 1913 (Manizer 1967, Pillar & Boldrini 1996, Baptista 1996). Through intensive fieldwork from 1945–1970, Hatschbach added another 43,000 specimens collected in southern Brazil, followed by Reitz with more than 23,000 specimens and Smith with about 11,000 specimens. For the BSHG, Hatschbach, Reitz and Smith collected more type specimens of endemic plants than any other collector, with 30, 27 and 24 taxa respectively. Langsdorff is responsible for the oldest record of an endemic BSHG plant, *Poa umbrosa* Trinius (1830: 386), collected in 1829 (Figs 2 & 3). The most recent record of a new species by the time our survey was done is that of *Chaetogastra riograndensis* Meyer (2016: 253), collected by F.S. Meyer, D.P. Volet & M. Monge, in 2014 (Fig.4).

FIGURE 2. *Poa umbrosa* Trin. Type from Paraná and collected by G.H. von Langsdorff in 1829.

V. spp. Taur. — In speciminibus ab ipso ill. auctore missis ligula, quae ipsi in descriptione *vix ulla* dicitur, superior elongata.

** Vivipara, v. spp. Alt.

Obs. Gramen satis polymorphum per formas quasdam in *P. nemoralem* manifeste transit. — In planta Americana, absque ullo dubio huc pertinente, radix aperte repens.

Poa pratensis **L.** *sp. pl. ed.* 1. Paniculae pl. min. apertae radiis subquinis, filiformibus, scabris laevibusve, inferne nudis; Spiculis 3— 5-floris, pedicello longioribus; Perianthiis distinctiuscule nervosis, elliptico-lanceolatis, acutis, ad carinam et longe plerumque etiam ad nervos marginales villosis, basi contortiplicato-lanatis (rarissime undique nudis); Ligulis brevibus aut obsoletis; Radice repente.

Poa pratensis. R. et S. II. p. 532.

Poa glabra Ehrh.

Poa trivialis Roth.

Occurrit latifolia, angustifolia (*P. angustifolia Poll.*), longifolia, macra (radiis binis tantum), dealbata, vivipara. — Parvula, foliis brevibus, latis (*P. depressa Presl!*). — Spiculis minoribus, flosculorum nervis marginalibus nudis (*P. strigosa Hoffm.*).

V. spp. Gall. Helv. Germ. Angl. Petrop. Ross. austr. Cauc. Alt. Sib. Lapp. Am. bor.

* Flosculis nudis, et cultura talis persistens; v. spp. Alt.

Poa umbrosa. Paniculae laxiusculae radiis quinis, angulato-filiformibus, pl. min. scabris, rarius (vel aliis) inferne nudis, plerumque (vel aliis) fere a basi compositis; Spiculis 6— 7-floris, pedicello longioribus; Perianthiis distincte nervosis, lineari-lanceolatis, acutis, nudis villosve rarissimos rectos e callo emittentibus; Ligulis productis; Radice repente.

V. spp. Brasil. (in umbrosis arenosis rivi Parana).

Culmus cum panicula (circiter spithamaea) bipedalis, ima basi erecto-ramosus. Folia plana, lineam lata, flaccidula. Ligulae inferiores lineam, superior lineas fere duas longae. Panicula subelongata, albida. Flosculi distantes. Villi, si adsunt, ex anteriori calli parte potius emittuntur, perpauci, longiusculi.

Poa lanuginosa Poir. Paniculae contractae, sublobatae radiis subquinis, angulatis, asperis, a basi floriferis; Spiculis 5- (—10) floris, brevissime pedicellatis; Perianthiis distinctiuscule nervosis, lanceolatis, acuminatis, ad carinam nervosque marginales lanuginosis, basi dense longeque contortiplicato-lanatis; Ligulis productis; Radice subrepente.

Poa lanuginosa. R. et S. II. p. 569. Nees ab Es. Agr. Bras. p. 490.

Festuca lanata Spr. S. V. 1. p. 353.

V. spp. Bras. Chil.

Poa albida Turcz. ined. Paniculae oblongo-coarctatae (parvae) radiis binis, crassiusculo-filiformibus, laeviusculis (brevissimis), fere a basi floriferis; Spiculis sub- 6-floris, brevipedicellatis; Perianthiis satis distincte nervosis, lineari-lanceolatis, acutiusculis, dorso hispidulis, nudis; Ligulis obsoletis; Radice fibrosa.

V. spp. Transbaical.

Caespitosa, 1 — sesqui-pedalis. Culmus compressiusculus, glaber, cum foliis stricto-erectus. Folia radicalia plurima, involuta, nunc culmum totum nunc duas tertias partes ejusdem aequantia, culmea breviora, saepissime complanata. Panicula plerumque pollicaris, rarius duplo et quod excedit longior, lineari-oblonga, albens vel ex amethystino varia.

Poa plebeja Br. Paniculae patulae radiis 2—5, pl. min. filiformibus, scabris, inferne nudis; Spiculis sub- 5-floris, brevi-brevissimeque pedicellatis; Perianthiis distincte nervosis, lineari-ovatis (l. elliptico-linearibus), ad carinam lateraque inferne villosulis, basi parce lanatis; Ligulis brevissimis; Radice subrepente?

FIGURE 3. *Poa umbrosa* Trin. Original publication: "Mémoires de l'Académie Imperiale des Sciences de St.-Pétersbourg" in 1830.

FIGURE 12. Illustration of the holotype of *Chaetogastra riograndensis*. A: Branch; B: Detail of the indumentum on the leaf (adaxial surface); C: Detail of the indumentum on the leaf (abaxial surface); D: Part of inflorescence; E: Bracteole (abaxial surface); F: Petal; G: Hypanthium in longitudinal section (adaxial surface); H: Antesepalous stamen; I: Antepetalous stamen; J: Gynoecium.

Phytotaxa 282 (4): 239–258
http://www.mapress.com/j/pt/

Article

ISSN 1179-3155 (print edition)
PHYTOTAXA
ISSN 1179-3163 (online edition)

http://dx.doi.org/10.11646/phytotaxa.282.4.1

Four new species of *Chaetogastra* (Melastomeae, Melastomataceae) from Southern Brazil

FABRÍCIO SCHMITZ MEYER[1*] & RENATO GOLDENBERG[2]

1- Universidade Estadual de Campinas, Pós-Graduação em Biologia Vegetal, Cidade Universitária Zeferino Vaz, Campinas, SP, 13083-970, Brazil.

2-Universidade Federal do Paraná, Departamento de Botânica, Caixa Postal 19031, Curitiba, PR, 81531-970, Brazil.

**Corresponding author: schmitzmeyer@gmail.com*

Abstract

Four new species of *Chaetogastra* are described: *C. cordeiroi*, *C. crassifolia*, *C. cristaensis* and *C. riograndensis*, recognized during a taxonomic study of the genus in Brazil. All of them come from southern Brazil, in the Atlantic Forest biome, at the states of Rio Grande do Sul, Santa Catarina and Paraná. All four species are threatened, under different categories.

Key words: Neotropical, taxonomy, *Tibouchina*

Introduction

The genus *Chaetogastra* De Candolle (1828: 131) was synonymized under *Tibouchina* Aublet (1775: 177) in a classical reference for the family (Cogniaux 1885). In this treatment its species were placed in *Tibouchina* sections *Pseudopterolepis* Cogniaux (1885: 403), *Diotanthera* Triana (1871: 45), *Simplicicaules* Naudin (1849: 127) and *Purpurella* (Naudin 1850: 301) Cogniaux (1885: 411). This broad concept for the genus *Tibouchina* was accepted in subsequent works, and all species of *Chaetogastra* described heretofore have been recognized under *Tibouchina*.

The arguments favoring the revalidation of *Chaetogastra* come from the fact that *Tibouchina* is a polyphyletic genus, with species included in four different clades within tribe Melastomeae (Michelangeli *et al.* 2013). One of these clades includes *Chaetogastra longifolia* (Vahl 1797: 39) De Candolle (1828: 132) [=*Tibouchina longifolia* (Vahl) Baillon (1877:74)], which is the type of *Chaetogastra* (Wurdack 1953), as well as other species of *Tibouchina* from the sections mentioned above. Moreover, one of the subclades in this group also has species from another genus, *Brachyotum* (De Candolle 1828: 136) Triana (1867: 743), intermixed with some species of *Tibouchina* (Michelangeli *et al.* 2013). It seems feasible to accommodate these particular species of *Tibouchina* in *Brachyotum* (Meyer 2016), and then *Chaetogastra* and *Brachyotum* could be considered distinct genera. If not, *Chaetogastra* has priority over *Brachyotum*.

Apart from molecular evidence, there are some morphological features that corroborate the recognition of *Chaetogastra* (Michelangeli *et al.* 2013, Meyer 2016). The species in this genus can be recognized by the subshrub habit, and erect (not pendulous) flowers with 1.9–4.8 cm in diameter that are usually smaller than flowers in the other clades within *Tibouchina sensu latu* (see Michelangeli *et al.* 2013). The petals are reflexed, the stamens have glabrous filaments in most species, and the pedoconnective appendages lack nectaries. The anthers are exclusively yellow, or yellow with pink, red or purple spots, and have truncate or attenuate apices. The ovary is covered with trichomes or projections with trichomes on their apices, and the style is usually glabrous. The fruits have persistent sepals, and the seeds are cochleate, with a tuberculate testa (Michelangeli *et al.* 2013; Meyer 2016).

Chaetogastra has about 165–190 species, from which several have not been transferred to it yet, and it is the largest genus in Melastomeae (Michelangeli *et al.* 2013; Meyer 2016). It is restricted to the Neotropics, from Mexico and Antilles to Uruguay (Meyer 2016). The Atlantic Forest in southern Brazil, in the states of Rio Grande do Sul, Santa Catarina and Paraná, is one center of endemism for the genus (see Wurdack 1962, Souza 1986, Meyer *et al.* 2010; Figure 1). The Atlantic Forest in this region includes Rain Forests ("Floresta Ombrófila Densa", following the official

Accepted by Marcos Sobral: 3 Oct. 2016; published: 1 Nov. 2016

FIGURE 4. *Chaetogastra riograndensis* F.S.Mey. Illustration and original publication by Phytotaxa in 2016.

The time elapsed between the collection of a species not previously known to science and its formal description in the scientific literature has varied from less than a year to more than 50 years (Fig. 5). For instance, about one-third of the BSHG endemic plants have been described as new species within the five years following their collection. On the other hand, some taxa have been described more than 50 years after their first collection such as *Baccharis scabrifolia* Heiden (2008: 6) (67 years), *Mimosa oblonga* var. *pinetorum* Barneby (1991: 600) (77 years) and *Brachystele bicrinita* Szlachetco (1996: 849) (105 years). It is important to note that type specimens do not always represent the oldest collections available for a species. Overall, since 1800, more than 4000 specimens of plants endemic to BSHG have been collected. Sampling efforts intensified in the 1980s and have increased in each successive completed decade thereafter to the moment (Fig. 6).

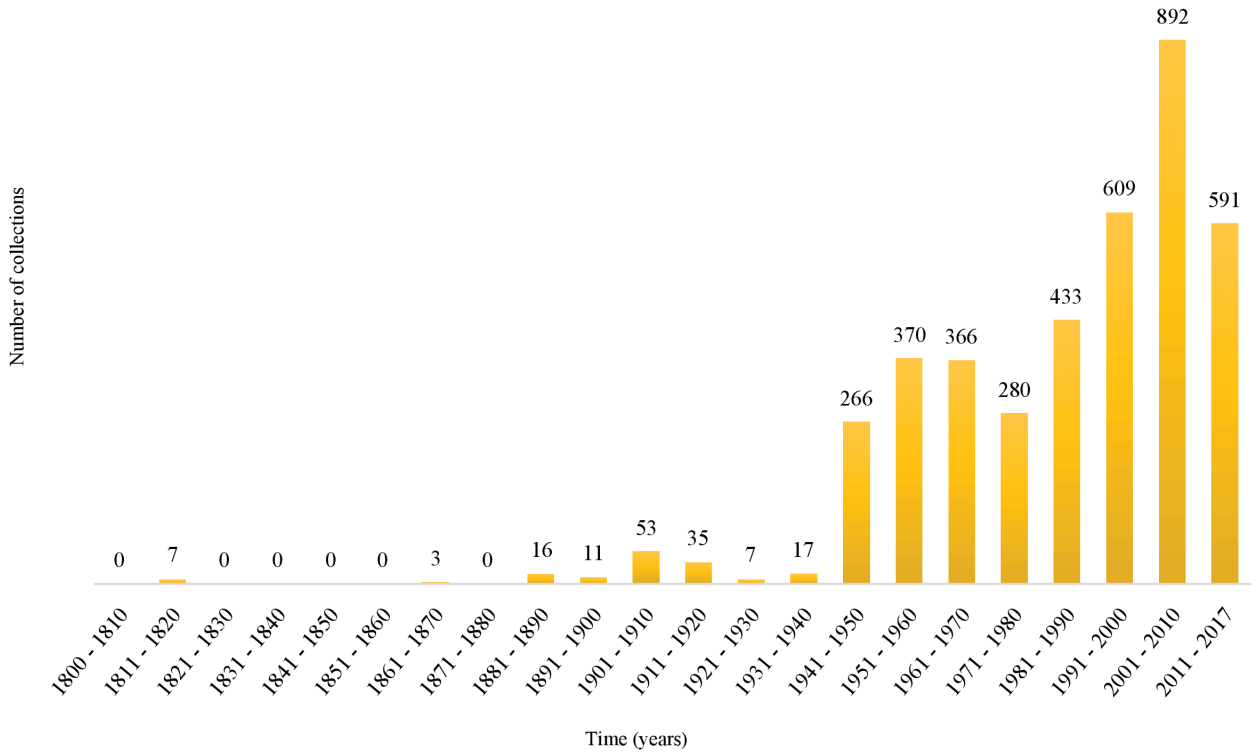

FIGURE 5. Time between the collection of the type specimen and the original publication of the 230 taxa that had date of collection in the type specimen.

Knowledge gaps for BSHG endemics

The presence of endemic taxa at the BSHG was confirmed against original publications, types, and vouchers. All taxa included in our list have at least one occurrence record. For 31.5% of the taxa there are three or fewer occurrence records, and, of these, 41 taxa (14.7%) have only one locality indicated in their protologue (Table 2). The genus *Nothoscordum* presents eight species known only from two localities reported in their original publications.

For more than half of the endemic plants of the BSHG (about 58%), the information available on digital platforms includes incomplete records. Most of these taxa lack digitized type specimens and/or links to their original publications. In addition, there are taxa for which typification issues require resolution, such as 15 species and one subspecies that do not have types correctly indicated or that have a protologue with incomplete information (Table S1). Among the families represented in this list of endemics, Amaryllidaceae (15 taxa), Poaceae (15 taxa), Asteraceae (12 taxa) and Iridaceae (11 taxa) have the most taxa with confusing or incomplete taxonomic information. In Cactaceae and Fabaceae there are the largest number of typification problems.

Discussion

Diversity of the Brazilian Subtropical Highland Grasslands

Boldrini *et al.* (2009) estimated the total plant diversity of the Brazilian Subtropical Highland Grasslands to be 1161 plant taxa (including 107 endemic taxa; 9.2%, only considering Rio Grande do Sul and Santa Catarina states). Iganci *et al*. (2011) reported a higher level of endemism for a more broadly defined concept of the Brazilian Subtropical Highland Grasslands (296 endemic taxa; 25.5%, including the whole Serra Geral range). In our study, the level of endemism remains high, despite a slight reduction in the total number of endemic species (273 endemic taxa; 23.5%). However, the most significant difference between this list and earlier BSHG inventories is in the species composition. Offsetting the new records of endemic species, 85 taxa which appear in Iganci *et al*. (2011) checklist of endemic plants are excluded from our list based on newly available herbarium data and new citations of occurrence for these taxa in regions outside the BSHG domain. Thus, the final number of taxa in the updated list is smaller than in previous estimates.

The work presented here aimed to catalogue seed plant species endemic to the BSHG based entirely on taxonomically verified herbarium specimens. For this, it was necessary to check all possible ways of having repeated data, such as synonyms, misspelled names and incorrect occurrence data. This data-quality control was necessary as it is known that using datasets incorporating many taxonomic, geographic and ecological errors may result in inflated estimates of diversity for the study region (Cardoso *et al.* 2017). Checklists and floras, when checked and taxonomically verified, provide essential information on which new work from different areas can be based, increasing and disseminating knowledge (Funk 2006, Thomas *et al.* 2012).

Herbarium databases with georeferenced collection sites have recently experienced rapid growth (Markos *et al*. 2016). These resources allow a much more robust evaluation of floristic hotspots than was previously possible. The constant revision and updating of the information disseminated via the online platform of Brazilian Flora 2020 (under construction, BFG 2015) and speciesLink (CRIA 2017) was very important for the verification of new occurrence records for the BSHG (Table 1), as well as for the exclusion of taxa whose distribution was no longer considered to be restricted to this region. For instance, through the incorporation of new information by taxon specialists, many species formerly considered as endemic to the BSHG (Iganci *et al.* 2011), are now known to have a wider distribution and were therefore also excluded from our list of endemic taxa (Table S1).

The importance of the historic and modern collections

One way to report the history of discoveries and exploration of a region is through its scientific collections. Over many decades, naturalists embarked on expeditions into the unknown and collected numerous specimens of plants and animals that would later be described, providing evidence of their journeys as well as documenting the diversity of environments they visited (Marchiori *et al.* 2016). Amongst the main collectors who recorded the flora of southern Brazil, we can highlight Malme, Dusén and Sellow (Manizer 1967, Baptista 1996, Pillar & Boldrini 1996).

Malme was the first to receive a travel grant funded by Regnell (1807–1884), together with Lindman, and they travelled through Brazil (Rio Grande do Sul and Mato Grosso do Sul) and central Paraguay to collect plants during 1892–1894. This expedition was repeated seven years later (1901–1903), by Malme on his own and his itinerary included Argentina (Aconcagua, Mendoza). Malme collected *ca*. 2600 specimens during his South American expeditions. Dusén collected in Brazil three times (1902–1904, 1908–1912 and 1913–1916) and extensively studied the Paraná state flora. Dusén described almost 250 species and most of his collections can be found in the Swedish Museum of Natural History in Stockholm, as well as in Brazilian herbaria in Rio de Janeiro and Curitiba. Sellow arrived in Brazil in 1814, following an invitation by Langsdorff, and made several expeditions to southern and south-eastern Brazil and to Uruguay. Sellow collected about 12,500 specimens of plants during the 14 years that he travelled through the Brazilian territory and part of Uruguay (Marchiori *et al.* 2018). Between 1823–1825, Sellow also collected in Rio Grande do Sul and travelled through various regions of the state (Marchiori *et al*. 2016, 2018). During this time he collected more than 250 specimens. Unfortunately, about 80% of his collections lack collector numbers, description of the specific collection locality or date of collection. For instance, of the 273 endemic taxa listed in this paper, 19 (7%) were collected by Sellow and none has a collection date. Many of his collections were deposited at the Berlin Natural History Museum (Marchiori *et al.* 2016) and were lost during World War II (Santos *et al.* 2016). However, many nineteenth-century researchers have studied specimens from Sellow's collection, with hundreds of species being described from the material he collected (Marchiori & Durlo 1998, Santos *et al*. 2016). Hatschbach

(1923–2013) collected more than 80,000 specimens and conducted numerous expeditions across the BSHG between 1945–2000 (Krapovickas 2013). Smith (1904–1997) was a specialist in Bromeliaceae and participated in expeditions to Brazil in 1928, 1952, 1956 and 1964 (Stafleu & Cowan 1976). His contributions to the knowledge of the BSHG flora occurred mainly during the last two expeditions; many of his collections from this region date from 1956–1965. Reitz (1919–1990) was also a great collector. He collected more than 30,000 specimens and contributed to the description of five genera and 327 plant taxa (Marchiori 2013). Most of Reitz's botanical records for the BSHG were collected in the 1950s, although his earliest collection for the region dates from 1946; *Glandularia catharinae* (Moldenke) N.O'Leary & P.Peralta collected in Santa Catarina state, in the eastern edge of the Serra Geral plateau. Most the collections made by Smith, Reitz and Klein in the 1950s and 1960s result from the Flora Ilustrada de Santa Catarina project, for which botanists carried out monthly expeditions throughout the state (Klein 1990).

After a period of extensive collecting, the number of descriptions of new species tends to increase (Costello *et al*. 2012). In the 1950s and 1960s there were many expeditions by foreign collectors who came to Brazil to expand their collections and find out more about the country's biodiversity (Acot *et al*. 1996). It would be natural to expect that researchers would then describe and publish new taxa based on these collections as soon as possible. However, there were many species to describe and not many researchers to do the work. This would explain why taxa such as *Baccharis scabrifolia* took 67 years to be described (Fig. 5). The type specimen of this species was collected by Rambo (1905–1961) in 1941. His research covered several areas of science, and despite having concentrated most of his efforts in Botany, he did not have the time to complete all his projects due to his premature death at 56 years of age (Marchioretto 2013).

Nowadays, species description can still be a long process but incentives to conduct taxonomic work, the availability of tools that aid research as well as current databases help rapid and efficient descriptive work. Furthermore, digital repositories of data provide fast, easy and cheap access to millions of specimens, making it possible to obtain updated and large-scale datasets (Soltis 2017). In recent years, Brazil has put in place a series of initiatives that have enabled a great accumulation of information on plant diversity and distribution. For example, the REFLORA Program's (Nic Lughadha *et al.* 2016) main objectives include the retrieval of images of specimens of the Brazilian flora and associated information deposited in foreign herbaria, for the construction of the Reflora Virtual Herbarium, the first of its kind to have conservation as a primary focus (Canteiro *et al.* 2019). From this platform, and via other similar sources (CRIA 2017, IPNI 2017) it was possible to obtain copies and images of the protologues and type specimens of the endemic taxa of the BSHG. Through these initiatives and dynamic updating of the resulting databases we can see changes in knowledge and eventually changes in the flora over time, advancing knowledge of biodiversity. As digital resources grow, the potential number of specimen records for a study will be large enough to improve the reliability of the results and to narrow the gaps in information contained in the records (Soltis 2017). However, regrettably, due to the current lack of support for the maintenance and updating of Brazil's digital platforms, many of the annotations made by specialists examining the physical specimens in herbaria, including corrections to the identification of plant material are not being captured as updates to digital records, impeding optimal use of researcher expertise to inform plant conservation.

Richness, Environmental Specificity and Conservation

Compared to the previous list (Iganci *et al*. 2011), our checklist includes 57 additional endemic species and subspecies and two families with endemic species not previously recorded for the BSHG (Table 1). Moreover, 85 taxa cited by Iganci *et al*. (2011) as BSHG endemics do not appear in the current list because they are now known to have a wider distribution than was previously recorded.

In the BSHG region, 81 endemic taxa have three or fewer occurrence records, including their type specimens (Table S2). Since population size data was missing for most species in this table, we considered those species that show habitat specificity within a restricted geographical range as rare (for further discussion on this category see Stebbins 1942, Rabinowitz 1981, Gaston 1998, Lomba *et al.* 2010). For some of these, only the collection locality is recorded, such as *Nothoscordum aparadense* Ravenna (2001: 36), collected by Ravenna in 1998 in the National Park of São Joaquim, Urubuci, SC. The scarcity of collection data makes it difficult, if not impossible, to analyse the conservation status (or extinction risk) of many taxa. In addition, taxa such as *Mecardonia pubescens* Rossow (1987: 464) and *Bernardia geniculata* Allem & Waechter (1977: 88) are known only from their type locality where they were collected more than 50 years ago (1947). Such taxa may already be extinct in the wild or may simply have been under sampled or overlooked by collectors. Further fieldwork is required to ascertain the conservation status of these and other taxa.

TABLE 1. Endemic species for the Brazilian Subtropical Highland Grasslands not reported in previous studies. Taxa published from 2011 to 2017 inclusive are highlighted in bold.

Family	Taxa
Amaryllidaceae	*Nothoscordum gibbatum* Ravenna
Asteraceae	***Baccharis floccosa* Deble & A.S.Oliveira**
	***Baccharis napaea* G.Heiden**
	***Baccharis sphagnophila* A.A.Schneid. & G.Heiden**
	Baccharis suberectifolia A.S.Oliveira & Deble
	***Chevreulia revoluta* A.A.Schneid. & R.Trevis.**
	Conyza catharinensis Cabrera
	Fleischmannia dissolvens (Baker) R.M.King & H.Rob.
	***Hysterionica matzenbacherii* A.A.Schneid.**
	Hysterionica nebularis Deble, A.S.Oliveira & Marchiori
	***Senecio irgangii* Matzenb. & Mondin**
	Stevia catharinensis Cabrera
	***Vernonanthura nana* A.J.Vega & Dematt.**
Bromeliaceae	***Dyckia walteriana* Leme**
	***Tillandsia chasmophyta* Büneker, R.Pontes & K.Soares**
Campanulaceae	*Lobelia stellfeldii* R.Braga
Caprifoliaceae	*Valeriana gilgiana* Graebn.
Commelinaceae	***Tradescantia seubertiana* M.Pell.**
Convolvulaceae	***Convolvulus ensifolius* P.P.A.Ferreira & Sim.-Bianch.**
Cyperaceae	***Eleocharis atrobrunnea* R.Trevis. e S.González**
	***Eleocharis guaglianoniana* J.P.R.Ferreira, Silv.Venturi & R.Trevis.**
	Eleocharis ramboana R.Trevis. & Boldrini
	Rhynchospora catharinensis Barros
Fabaceae	***Mimosa eurystegia* Barneby ex M.Morales, Ribas & Santos-Silva**
	Stylosanthes vallsii Sousa Costa & Van den Berg
Gesneriaceae	***Sinningia ramboi* G.E.Ferreira, Waechter & Chautems**
Hypericaceae	***Hypericum austrobrasiliense* Vog.Ely, Boldrini & Bordignon**
Iridaceae	***Cypella altouruguaya* Chauveau & L.Eggers**

...continued on the nest page

TABLE 1. (Continued)

Family	Taxa
	Cypella catharinensis Ravenna
	***Cypella hauthalii* (Kuntze) R.C.Foster subsp. *minuticristata* Chauveau & L.Eggers**
	***Sisyrinchium albilapidense* Ravenna**
	Sisyrinchium congestum Klatt
	Sisyrinchium elegantulum Ravenna
	Sisyrinchium eserrulatum I.M.Johnst.
	***Sisyrinchium flabellatum* Aita & L.Eggers**
	Sisyrinchium purpurellum Ravenna subsp. *trichospathum* Ravenna
Lamiaceae	*Glechon discolor* Epling
	***Rhabdocaulon grandiflorum* (Funez & Hassemer) Bräuchler**
Malvaceae	***Pavonia salmonea* Grings & Boldrini**
	***Sida parva* Krapov.**
Melastomataceae	***Chaetogastra crassifolia* F.S.Mey. & R.Goldenb.**
	***Chaetogastra cristaensis* F.S.Mey. & R.Goldenb.**
	***Chaetogastra riograndensis* F.S.Mey.**
	Tibouchina goldenbergii F.S.Mey., P.J.F.Guim. & Kozera
Orchidaceae	*Brachystele scabrilingua* Szlach.
	***Habenaria australis* J.A.N.Bat., A.A.Vale & Menini**
	***Habenaria kleinii* Menini & J.A.N.Bat.**
	***Habenaria sobraliana* J.A.N.Bat., A.A.Vale & Menini**
	Pelexia gracilis Schltr.
	***Sarcoglottis catharinensis* Mancinelli & E.C.Smidt**
Plantaginaceae	***Plantago corvensis* Hassemer**
	***Plantago rahniana* Hassemer & R.Trevis.**
Poaceae	***Bothriochloa catharinensis* Dalmolim & A.Zanin**
	Chascolytrum latifolium Essi, Souza-Chies & Longhi-Wagner
	Cortaderia vaginata Swallen
	Poa sellowii Nees
	***Zizaniopsis longhi-wagnerae* Dalmolim, A.Zanin & R.Trevis.**

TABLE 2. Endemic taxa for the Brazilian Subtropical Highland Grasslands known only from the type locality and the year in which that record was made.

Family	Taxa	Record year
Amaryllidaceae	*Nothoscordum aparadense* Ravenna	1998
	Nothoscordum cambarense Ravenna	no date
	Nothoscordum curvipes Ravenna	no date
	Nothoscordum gibbatum Ravenna	1960
	Nothoscordum leptogynum Ravenna	1962
	Nothoscordum nutans Ravenna	1983
	Nothoscordum tibaginum Ravenna	no date
Apocynaceae	*Oxypetalum morilloanum* Fontella	1963
Asteraceae	*Aldama meridionalis* (Magenta) E.E.Schill. & Panero	1979
	Hysterionica matzenbacherii A.A.Schneid.	1996
	Vernonia viminea Ekman ex Malme	1909
	Vernonanthura nana A.J.Vega & Dematt.	1980
Bromeliaceae	*Tillandsia chasmophyta* Büneker, R.Pontes & K.Soares	2012
Cactaceae	*Parodia haselbergii* (Haage ex Rümpler) F.H.Brandt subsp. *graessneri* (K.Schum.) Hofacker & P.J.Braun	1903
	Parodia rechensis (Buining) F.H.Brandt	no date
Cyperaceae	*Eleocharis atrobrunnea* R.Trevis. & S.González	2003
	Eleocharis guaglianoniana J.P.R.Ferreira, Silv.Venturi & R.Trevis.	2012
	Rhynchospora catharinensis Barros	1962
	Rhynchospora pseudomacrostachya Gerry Moore, Guagl. & Zartman	1956
Eriocaulaceae	*Paepalanthus catharinae* Ruhland var. *catharinae*	1890
	Paepalanthus kleinii (Moldenke & L.B.Sm.) Trovó	1956
Euphorbiaceae	*Bernardia alarici* Allem & Irgang	1974
	Bernardia geniculata Allem & Waechter	1947
	Croton catharinensis L.B.Sm. & Downs	1958
	Croton kleinii L.B.Sm. & Downs	1957
Fabaceae	*Mimosa pseudolepidota* (Burkart) Barneby	1957
	Vicia hatschbachii Burkart ex Vanni & D.B.Kurtz	1945

...continued on the next page

TABLE 2. (Continued)

Family	Taxa	Record year
Iridaceae	*Cypella catharinensis* Ravenna	1967
	Sisyrinchium eserrulatum I.M.Johnst.	1904
Lamiaceae	*Rhabdocaulon grandiflorum* (Funez & Hassemer) Bräuchler	2016
Lythraceae	*Cuphea iguazuensis* Lourteig	1969
Malvaceae	*Pavonia reitzii* Krapov. & Cristóbal	1948
	Sida parva Krapov.	2009
Orchidaceae	*Brachystele bicrinita* Szlach.	1891
	Habenaria ulaei Cogn.	1891
	Pelexia gracilis Schltr.	no date
	Sarcoglottis catharinensis Mancinelli & E.C.Smidt	2010
Plantaginaceae	*Mecardonia pubescens* Rossow	1947
Poaceae	*Panicum magnispicula* Zuloaga, Morrone & Valls	1987
Rubiaceae	*Galium rubidiflorum* Dempster	1966
Verbenaceae	*Lippia paranensis* (Moldenke) T.R.S.Silva & Salimena	1910

By July 2018, 25,462 plant species were assessed using IUCN criteria worldwide: 5725 were vulnerable (VU); 4269 were endangered (EN), and with 2787 deemed critically endangered (CR) (IUCN 2018). However, extinction is very difficult to detect (Diamond 1987). For a species to be listed as Extinct, exhaustive surveys are required to have been done in all known or likely habitat throughout its historic range. This must be done at appropriate times (diurnal, seasonal, annual) and over a timeframe appropriate to the life cycle and life form of the taxon of interest (IUCN 2018). According to the criteria of the National Center for the Conservation of Brazilian Flora (CNCFlora), taxa known only from the type collection, which do not have accurate information about the collection locality, recent records, population size, distribution and known current threats should be classified as Deficient Data (DD) (Martinelli & Moraes 2013). When classified in this category, the taxon may be excluded from initiatives that establish measures of protection and conservation of the flora (Silva *et al.* 2015). The "Procura-se" (Wanted) initiative, that aims to collect potentially threatened plant species known from fewer than 3 collection records and / or last collected more than 30 years ago, targets 156 rare species endemic to the state of Rio de Janeiro and many are classified as Deficient Data (Rosa *et al*. 2018). Encouraging research on rare or "disappeared" taxa contributes to the possible rediscovery of these taxa, providing more efficient conservation, and avoiding them being considered extinct prematurely (Lavor *et al*. 2016, Marinho *et al*. 2017, Almeida *et al*. 2018, Humphreys *et al.* 2019). Therefore, more detailed studies of each taxon classified as rare in our study would be necessary to determine which, if any, are likely to be already extinct.

Gathering knowledge and distribution data is important for conservation of rare species. However, datasets on rare species distribution are usually characterized by small numbers of observations with limited spatial accuracy (Engler *et al.* 2004, Pearson *et al.* 2004). As a result, despite the importance of these species, modelling studies of rare species distribution are lacking in the scientific literature (Lomba *et al*. 2010). During our fieldwork we observed that, in certain areas, habitat degradation has led to habitat loss suggesting that the endemic species of the BSHG may become seriously threatened in the near future.

Conclusions

Our data on the BSHG strengthens the position of Iganci *et al*. (2011) by stating that the region has a distinct vegetation type defined by numerous endemic taxa to which we draw attention here by presenting an updated and taxonomically verified list. We observed a small difference in relation to the number of endemic species listed to the region, a slight decrease in diversity, when compared to the previous study of Iganci *et al.* (2011). The major issue we identified in our study when working with published literature and databases is the lack of updates and deficit of information related to collection locality, often neglected by the collectors themselves. However, many collections still need to be digitized and certainly many others are awaiting accurate identification by specialists. More investment is needed to maintain and update digital platforms.

Checklists and floras, when checked and taxonomically verified, provide essential information on which new studies from different areas can be based, multiplying and spreading knowledge (Funk 2006, Thomas *et al.* 2012). Furthermore, species lists based on accurate taxonomic knowledge increase the reliability and stability of data and reinforce the need for conservation prioritisation for grasslands plant species in the BSHG by providing reliable data as fundamental knowledge necessary to produce species conservation assessments and by highlighting taxa that lack taxonomic treatments. Field trips have not covered 100% of this area, but from our study of current data the great diversity of species and the threats due to anthropic pressure are evident. Future studies and fieldwork expeditions should focus on the least well known species highlighted here (Table S2). To conserve species, it is necessary first to know how to identify them, and for this it is necessary to have access to any data gathered about them.

Acknowledgements

CP and JK would like to thank the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brasil (CAPES) Finance Code 001. CP would like to thank the Programa de Pós Graduação em Botânica UFRGS – PPGBot UFRGS for the provision of grants and post-graduate scholarship support. JRVI thanks CNPq (407147/2018-7) and Neotropical Grassland Conservancy for the grants received.

References

Acot, P., Lourteig, A., Gastal Jr., C.V.S., Marchiori, J.N.C., Waechter, J.L., Pillar, V.P., Boldrini, I.I., Baptista, L.R.M., Schultz, C.L. & Holz, M. (1996) Viajantes Naturalistas. *Revista Ciência & Ambiente* 13: 1–118.

Allem, A.C. & Waechter, J.L. (1977) Nuevas especies de Euphorbiaceae. *Revista Brasileira de Biologia* 37: 75–89.

Almeida, J.A. (2009) Fatores Abióticos. *In: Boldrini. Biodiversidade dos Campos do Planalto das Araucárias*. Brasília, MMA, pp. 19–38.

Almeida, R.F., Maurenza, D., Negrão, R., Rosa, P., Baez, C. & Martinelli, G. (2018) Rediscovery of Banisteriopsis magdalenensis (Malpighiaceae): Notes on morphology, distribution, and ecology of an endemic and threatened species from the Atlantic Forest of Brazil. *Brittonia* 70: 1–5.
https://doi.org/10.1007/s12228-018-9526-4

Angiosperm Phylogeny Group (APG) IV (2016) An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG IV. *Botanical Journal of the Linnean Society* 181: 1–20.
https://doi.org/10.1111/boj.12385

Baptista, L.R.M. (1996) Gustav Malme e a Flora do Rio Grande do Sul. *Ciência e Ambiente* 13: 97–106. Barboza, G.E., Cantero, J.J., Chiarini, F.E., Chiapella, J., Freire, S., Nuñez, C.O., Palchetti, V. & Espinar, L.A. (2016) Vascular plants of Sierra de Famatina (La Rioja, Argentina): an analysis of its biodiversity. *Phytotaxa* 248 (1): 001–123.
https://doi.org/10.11646/phytotaxa.248.1.1

Barneby, R.C. (1991) Sensitivae Censitae: A Description of the genus *Mimosa* Linnaeus (Mimosaceae) in the New World. *Memoirs of the New York Botanical Garden* 65: 1–835.

Barros, M.J.F., Silva-Aria, G.A., Fregonezi, J.N., Turchetto-Zolet, A.C., Iganci, J.R.V., Diniz-Filho, J.A.F. & Freitas, L.B. (2015) Environmental drivers of diversity in Subtropical Highland Grasslands. *Perspect Plant Ecology* 17 (5): 360–368.
https://doi.org/10.1016/j.ppees.2015.08.001

Behling, H. (2002) South and southeast Brazilian grasslands during Late Quaternary times: a synthesis. *Palaeogeography,*

Palaeoclimatology, Palaeoecology 177: 19–27.
https://doi.org/10.1016/S0031-0182(01)00349-2

BFG—The Brazil Flora Group (2015) Growing knowledge: an overview of seed plant diversity in Brazil. *Rodriguésia* 66: 1085–1113. https://doi.org/10.1590/2175-7860201566411

Bilenca, D. & Miñarro, F. (2004) *Identificación de áreas valiosas de pastizal en las pampas y campos de Argentina, Uruguay y sur de Brasil.* Buenos Aires: Fundación Vida Silvestre Argentina.

Bitencourt, C., Rapini, A., Damascena, L.S. & Marco-Junior, P. (2016) The worrying future of the endemic under flora of a tropical mountain range climate change. *Flora* 218: 1–10.
https://doi.org/10.1016/j.flora.2015.11.001

Boldrini, I.I., Eggers, L., Mentz, L.A., Miotto, S.T.S., Matzenbacher, N.I., Longhi-Wagner, H.M., Trevisan, R., Schneider, A.A. & Setúbal, R.B. (2009) Flora. *In:* Boldrini, I. (Ed.) *Biodiversidade dos Campos do Planalto das Araucárias*. MMA, Brasília, pp. 39–94.

Brazilian Flora 2020 under construction (2020) Rio de Janeiro Botanical Garden. Available from: http://floradobrasil.jbrj.gov.br/ (accessed 3 April 2020)

Canteiro, C., Barcelos, L., Filardi, F., Forzza, R., Green, L., Lanna, J., Leitman, P., Milliken, W., Pires Morim, M., Patmore, K., Phillips, S., Walker, B.E., Weech, M-H., & Nic Lughadha, E. (2019) Enhancement of conservation knowledge through increased access to botanical information. *Conservation Biology* 33 (3): 523–533.
https://doi.org/10.1111/cobi.13291

Cardoso, D., Särkinen, T., Alexander, S., Amorim, A.M., Bittrich, V., Celis, M., Daly, D.C., Fiaschi, P., Funk, V.A., Giacomin, L.L., Goldenberg, R., Heiden, G., Iganci, J., Kelloff, C.L., Knapp, S., de Lima, H.C., Machado, A.F.P., dos Santos, R.M., Mello-Silva, R. Michelangeli, F.A., Mitchell, J., Moonlight, P., de Moraes, P.L.R., Mori, S.A., Nunes, T.S., Pennington, T.D., Pirani, J.R., Prance, G.T., de Queiroz, L.P.Rapini, A., Riina, R., Rincon, C.A.V., Roque, N., Shimizu, G., Sobral, M., Stehmann, R.J., Stevens, W.D., Taylor, C.M., Trovó, M., van den Berg, C., van der Werff, H., Viana, P.L., Zartman, C.E. & Forzza, R.C. (2017) Amazon plant diversity revealed by a taxonomically verified species list. *Proceedings of the National Academy of Sciences* 114 (40): 10695–10700.
https://doi.org/10.1073/pnas.1706756114

Chauveau, O., Pastori, T., Souza-Chies, T.T. & Eggers, L. (2014) Overlooked diversity in Brazilian *Cypella* (Iridaceae, Iridoideae): four new taxa from the Río de la Plata grasslands. *Phytotaxa* 174 (1): 25–42.
https://doi.org/10.11646/phytotaxa.174.1.2

Costello, M.J., Wilson, S. & Houlding, B. (2012) Predicting Total Global Species Richness Using Rates of Species Description and Estimates of Taxonomic Effort. *Systematic Biology* 61 (5): 871–883.
https://doi.org/10.1093/sysbio/syr080

CRIA. (2017) Centro de Referência em Informação Ambiental. Available from: http://splink.cria.org.br/ (accessed 23 November 2017)

Diamond, J.M. (1987) Extant unless proven extinct? Or, extinct unless proven extant? *Conservation Biology* 1: 77–79.
https://doi.org/10.1111/j.1523-1739.1987.tb00012.x

Engler, R., Guisan, A. & Rechsteiner, L. (2004) An improved approach for predicting the distribution of rare and endangered species from occurrence and pseudoabsence data. *Journal of Applied Ecology* 41: 263–274.
https://doi.org/10.1111/j.0021-8901.2004.00881.x

Funk, V. (2006) Floras: A model for biodiversity studies or a thing of the past? *Taxon* 55: 581–588.
https://doi.org/10.2307/25065635

Gaston, K.J. (1998) Biodiversity. *In:* Sutherland, W.J. (Ed.) *Conservation Science and Action*. Chapter 1. BlackwellPublishing Ltd., Oxford, UK, pp. 1–19.
https://doi.org/10.1002/9781444313499.ch1

GBIF (2017) GBIF. Available from https://www.gbif.org/ (accessed 15 May 2017)

Graebner, K.O.R.P.P. (1899) *Botanische Jahrbücher für Systematik, Pflanzengeschichte und Pflanzengeographie* 26 (3–4): 435.

Heiden, G. (2008) A New Species of *Baccharis* subgen. *Tarchonanthoides* Heering (Asteraceae-Astereae) from Rio Grande do Sul, Brazil. *Bradea* 13 (2): 6.

Heiden, G. & Iganci, J.R.V. (2009) Sobre a paisagem e a flora. *In:* Romano, C.M., Stumpf, E.R.T., Heiden, G., Iganci, J.R.V., Corrêa, L.B., Barbieri, R.L. & Perleberg, T.D. (Eds.) *Cores e formas no Bioma Pampa, plantas ornamentais nativas*. Ed. 2. Embrapa Clima Temperado, Pelotas, , pp. 23–35.

Humphreys, A.M., Govaerts, R., Ficinski, S.Z., Nic Lughadha, E. & Vorontsova, M.S., 2019. Global dataset shows geography and life form predict modern plant extinction and rediscovery. *Nature ecology & evolution* 3 (7): 1043–1047.

Hijmans, R.J., Guarino, L. & Mathur, P. (2012) DIVA-GIS, version 7.5. Manual. Available from: http://www.diva-gis.org/ (accessed 23 November 2017)

IBGE. (2004) Mapa da vegetação do Brasil e Mapa de Biomas do Brasil. Available from: http://www.ibge.gov.br/ (accessed 23 November

2017)
Iganci, J.R.V., Heiden, G., Miotto, S.T.S. & Pennington, R.T. (2011) Campos de Cima da Serra: the Brazilian Subtropical Highland Grasslands show an unexpected level of plant endemism. *Botanical Journal of the Linnean Society* 167: 378–393. https://doi.org/10.1111/j.1095-8339.2011.01182.x
INMET. (2018) Instituto Nacional de Meteorologia. Eixo Monumental Sul Via S1 - Sudoeste – Brasília. Available from: http://www.inmet.gov.br/ (accessed 5 November 2017)
IPNI. (2017) The international plant names index. Available from: http://www.ipni.org/ (accessed 12 September 2017)
IUCN (2018) The IUCN Red List of Threatened Species. Version 2018-1. Available from: http://www.iucnredlist.org/ (accessed 16 July 2018)
Joly, C.A., Aidar, M.P.M., Klink, C.A, McGrath, D.G., Moreira, A.G., Moutinho, P., Nepstad, D.C., Oliveira, A.A., Pott, A., Rodal, M.J.N. & Sampaio, E.V.S.B. (1999) Evolution of the Brazilian phytogeography classification systems: implications for biodiversity conservation. *Ciência e Cultura* 51: 331–348.
Jussieu, A.L. (1789*) Genera plantarum: secundum ordines naturales disposita, juxta methodum in Horto regio parisiensi exaratam*. https://doi.org/10.5962/bhl.title.284
Klein, R.M. (1990) *Espécies raras ou ameaçadas de extinção do estado de Santa Catarina.* Rio de Janeiro, IBGE, Diretoria de Geociências. 287 pp.
Krapovickas, A. (2013) Gert Guenther Hatschbach. *Bonplandia* 22 (2): 217. https://doi.org/10.30972/bon.2221251
Külkamp, J., Heiden, G. & Iganci, J.R.V. (2018) Endemic plants from Southern Brazilian Highland Grasslands. *Rodriguésia* 69 (2): 429–440. https://doi.org/10.1590/2175-7860201869214
Kunth, K.S. (1843) *Enumeratio Plantarum Omnium Hucusque Cognitarum* 4. 752 pp.
Kuntze, O. (1898) *Revisio generum plantarum*. Vol. 3 (2). Artur Felix, Leipzig, pp. 1–576.
Laffan, S.W. & Crisp, M.D. (2003) Assessing endemism at multiple spatial scales, with an example from the Australian vascular flora. *Journal of Biogeography* 30: 511–520. https://doi.org/10.1046/j.1365-2699.2003.00875.x
Lavor, P., Oliveira Perdiz, R.O., Versieux, L.M. & Calvente, A. (2016) Rediscovery of Pilosocereus oligolepsis (Cactaceae) in the State of Roraima, Brazil. *Cactus and Succulent Journal* 88 (3): 137–143. https://doi.org/10.2985/015.088.0306
Lepetz, V., Massot, M., Schmeller, D.S. & Clobert, J. (2009) Biodiversity monitoring: Some proposals to adequately study species' responses to climate change. Biodiversity and Conservation 18: 3185–3203. https://doi.org/10.1007/s10531-009-9636-0
Linnaeus, C. (1753) *Species Plantarum*. Vol. 2. Laurentius Salvius, Stockholm, 1200 pp.
Lomba, A., Pellissier, L., Randin, C., Vicente, J., Moreira, F., Honrado, J. & Guisan, A. (2010) Overcoming the rare species modelling paradox: A novel hierarchical framework applied to an Iberian endemic plant. *Biological Conservation* 143: 2647–2657. https://doi.org/10.1016/j.biocon.2010.07.007
Lopes, F., Mielniczuk, J., Oliveira, E.S. & Tornquist, C.G. (2010) Evolução do uso do solo em uma área piloto da região de Vacaria, RS. *Revista Brasileira de Engenharia Agrícola e Ambiental* 14: 1038–1044. https://doi.org/10.1590/S1415-43662010001000003
Manizer, G.G. (1967) A Expedição do Acadêmico G.I. Langsdorff ao Brasil (1821-1828). *Companhia Nacional* 329: 1–244. Available from: http://www.brasiliana.com.br/obras/a-expedicao-do-academico-g-i-langsdorff-ao-brasil-1821-1828/ (accessed 19 October 2017)
Marchiori, J.N.C. & Durlo, M.A. (1998) Friedrich Sellow e sua contribuição para as Ciências Naturais. *Ciência & Ambiente* 16: 29–50.
Marchiori, J.N.C. (2013) *Elementos de dendrologia*, 3ª Edição. Editora UFSM, Santa Maria, 216 pp.
Marchiori, J.N.C., Pontes, R.C. & Marchiori Neto, D.L. (2016) Textos inéditos de Friedrich Sellow. Viagem às missões jesuíticas da Província de São Pedro do Rio Grande do Sul. *Balduinia* 51: 12–24. https://doi.org/10.5902/2358198021422
Marchiori, J.N.C., Büneker, H.B. & Marchiori Neto, D.L. (2018) Textos inéditos de Friedrich Sellow. 3 – Viagem pela Província de São Pedro do Rio Grande do Sul (1823–1825). *Balduinia* 61: 01–22. https://doi.org/10.5902/2358198032386
Marchioretto, M.S. (2013) Balduíno Rambo - O Botânico. *Balduinia* 40: 27–31. https://doi.org/10.5902/2358198013989
Marinho, A.M., Delgado-Júnior, G.C. & Buril, M.T. (2017) The rediscovery of Ipomoea macedoi (Convolvulaceae). *Phytotaxa* 302 (1):

71–76.
https://doi.org/10.11646/phytotaxa.302.1.7

Markos, S., Moe, R.L. & Baxter, D. (2016) A powerful resource for plant conservation efforts: The Consortium of California Herbaria reaches two million specimens. *Fremontia* 44: 16–19.

Martinelli, G. & Moraes, M.A. (2013) *Livro vermelho da flora do Brasil*. Jardim Botânico do Rio de Janeiro, Brasil. Available from: http://cncflora.jbrj.gov.br (accessed 17 December 2017)

Nic Lughadha, E., Canteiro, C., Filardi, F., Leitman, P., Accardo Filho, M., Allkin, R., Amaral, H., Budden, A., Carretero, J., Chowdhury, S., Clarke, L., Clubbe, C., Cossu, T.A., Ferreira, C.G., Green, L., Haigh, A., Harvey-Brown, Y., Hillebrecht, W., Klitgaard, B. & Forzza, R. (2016) *Reflora.* Royal Botanic Gardens, Kew, 20 pp. [http://aplicacoes.jbrj.gov.br/divulga/reflora_booklet.pdf]

O´Leary, N. & Peralta, P. (2007) Nuevas combinaciones en el género *Glandularia* (Verbenaceae). *Darwiniana* 45 (2): 218–230.

Overbeck, G.E., Müller, S.C., Fidelis, A., Pfadenhauer, J., Pillar, V.D., Blanco, C.C., Boldrini, I.I., Both, R. & Forneck, E.D. (2007) Brazil's neglected biome: The South Brazilian Campos. *Perspectives in Plant Ecology, Evolution and Systematics* 9: 101–116.
https://doi.org/10.1016/j.ppees.2007.07.005

Pearson, R.G., Dawson, T.P. & Liu, C. (2004) Modelling species distributions in Britain: a hierarchical integration of climate and land-cover data. *Ecography* 27: 285–298.
https://doi.org/10.1111/j.0906-7590.2004.03740.x

Peel, M.C., Finlayson, B.L. & McMahon, T.A. (2007) Updated world map of the Köppen-Geiger climate classification. *Hydrology and Earth System Sciences* 11: 1633–1644.
https://doi.org/10.5194/hess-11-1633-2007

Pellegrini, M.O.O. (2016) A new species of Tradescantia L. sect. *Austrotradescantia* D.R.Hunt (Commelinaceae) from Southern Brazil. *Phytotaxa* 265 (1): 79–84.
https://doi.org/10.11646/phytotaxa.265.1.8

Pillar, V.D. & Boldrini, I.L. (1996) Lindman e a ecologia da vegetação campestre do rio grande do sul. *Ciência e Ambiente* 13: 87–97.

Rabinowitz, D. (1981) Seven forms of rarity. *In:* Synge, H. (Ed.) The Biological Aspects of Rare Plant Conservation. John Wiley & Sons, Ltd. New York, pp. 205–217.

Ravenna, P.F. (2001) New species of Nothoscordum (Alliaceae). *Onira, Botanical Leaflets* 7: 37.

Ravenna, P. (2002) Revisional studies in the genus *Sisyrinchium* – IX. *Onira, Botanical Leaflets* 7 (6): 20–41.

REFLORA (2015) Virtual Herbarium. Available from: http://floradobrasil.jbrj.gov.br/reflora/herbarioVirtual/ (accessed 3 June 2015)

Rosa, P., Baez, C., Martins, E. & Martinelli, G. (2018) *Guia procura-se: flora endêmica do Estado do Rio de Janeiro*. Rio de Janeiro: I Graficci, 200 pp.

Rossow, R.A. (1987) Revisión del género *Mecardonia* (Scrophulariaceae). *Candollea* 42 (2): 431–474.

Safford, H.D. (1999) Brazilian Páramos I. An introduction to the physical environment and vegetation of the campos de altitude. *Journal of Biogeography* 26: 693–712.
https://doi.org/10.1046/j.1365-2699.1999.00313.x

Santos, M.F., Sano, P.T. & Lucas, E. (2016) Lectotypifications of some Nineteenth Century names and other nomenclatural updates in Myrcia s.l. (Myrtaceae). *Phytotaxa* 257 (1): 1–33.
https://doi.org/10.11646/phytotaxa.257.1.1

Scheibe, L.F. (1986) *A geologia de Santa Catarina.* Florianópolis. Geosul: 1. Available from: https://periodicos.ufsc.br/index.php/geosul/article/viewFile/12542/11811/ (accessed 12 July 2017)

Schmeller, D.S., Henry, P.–Y., Julliard, R., Clobert, J., Gruber, B., Dziock, F., Lengyel, S., Nowicki, P., Déri, E., Budrys, E., Kull, T., Tali, K., Bauch, B., Settele, J., van Swaay, C., Kobler, A., Babij, V., Papastergiadou, E. & Henle, K. (2009) Advantages of volunteer-based biodiversity monitoring in Europe. *Conservation Biology* 23 (2): 307–316.
https://doi.org/10.1111/j.1523-1739.2008.01125.x

Silva, W.L.S., Soares, M.V.B., Bonadeu, F., Morim, M.P., Iganci, J.R.V. & Santos, J.U.M. (2015) Rediscovery of *Macrosamanea macrocalyx* (Leguminosae: Mimosoideae), a threatened endemic species from the Middle Xingu River, Amazonia, Brazil. *Phytotaxa* 224 (3): 276–282.
https://doi.org/10.11646/phytotaxa.224.3.6

Soltis, P.S. (2017) Digitization of herbaria enables novel research. *American Journal of Botany* 104 (9): 1–4.
https://doi.org/10.3732/ajb.1700281

Stafleu, F.A. & Cowan, R.S. (1976) *Taxonomic literature: a selective guide to botanical publications and collections with dates, commentaries and types*. Vol. 1. 2ed. Utrecht: Bohn, Scheltema; Holkema.
https://doi.org/10.5962/bhl.title.48631

Stehmann, J.R., Forzza, R.C., Salino, A., Sobral, M., Costa, D.P. & Kamino, L.H.Y. (2009) *Plantas da Floresta Atlântica.* Rio de Janeiro: Jardim Botânico do Rio de Janeiro, 516 pp.

Stebbins, L.G. (1942) The Genetic Approach to Problems of Rare and Endemic Species. *Madroño* 6: 241–272.

Szlachetko, D.L. (1996) *Fragmenta Floristica et Geobotanica* 41 (2): 1–850.

Thiers, B. (2019) Index Herbariorum: A global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium. Available from: http://sweetgum.nybg.org/science/ih/ (accessed 17 July 2020)

Thomas, W.W, Forzza, R.C., Leitman, P., Michelangeli, F. & Giulietti, A.M. (2012) Large-scale monographs and floras? The sum of local floristic research. *Plant Ecology Diversity* 5: 217–223. https://doi.org/10.1080/17550874.2011.622306

Trinius, C.B. (1830) *Mémoires de l'Académie Imperiale des Sciences de St.-Pétersbourg. Sixième Série. Sciences Mathématiques, Physiques et Naturelles* 1 (4): 1–698.

Tropicos. (2017) Tropicos.org. Missouri Botanical Garden. Available from: http://www.tropicos.org/ (accessed 17 July 2016)

Zuloaga, F.O. (2005) Prólogo. *In:* Pensiero, J.F., Gutiérrez, H.F., Luchetti, A.M., Exner, E., Kern, V., Brnich, E., Oakley, L.J., Prado, D.E. & Lewis, J.P. (Eds.) *Flora Vascular de la Provincia de Santa Fe*. Universidad Nacional del Litoral, Santa Fe, 403 pp.

Phytotaxa 454 (2): 159–160
https://www.mapress.com/j/pt/

Erratum

ISSN 1179-3155 (print edition)
PHYTOTAXA
ISSN 1179-3163 (online edition)

https://doi.org/10.11646/phytotaxa.454.2.8

Plá, C., Külkamp, J., Heiden, G., Nic Lughadha, E. & Iganci, J. (2020) The importance of the Brazilian Subtropical Highland Grasslands evidenced by a taxonomically verified endemic species list. *Phytotaxa* 452 (4): 250-267.

Please note that Figure 5 on page 7:

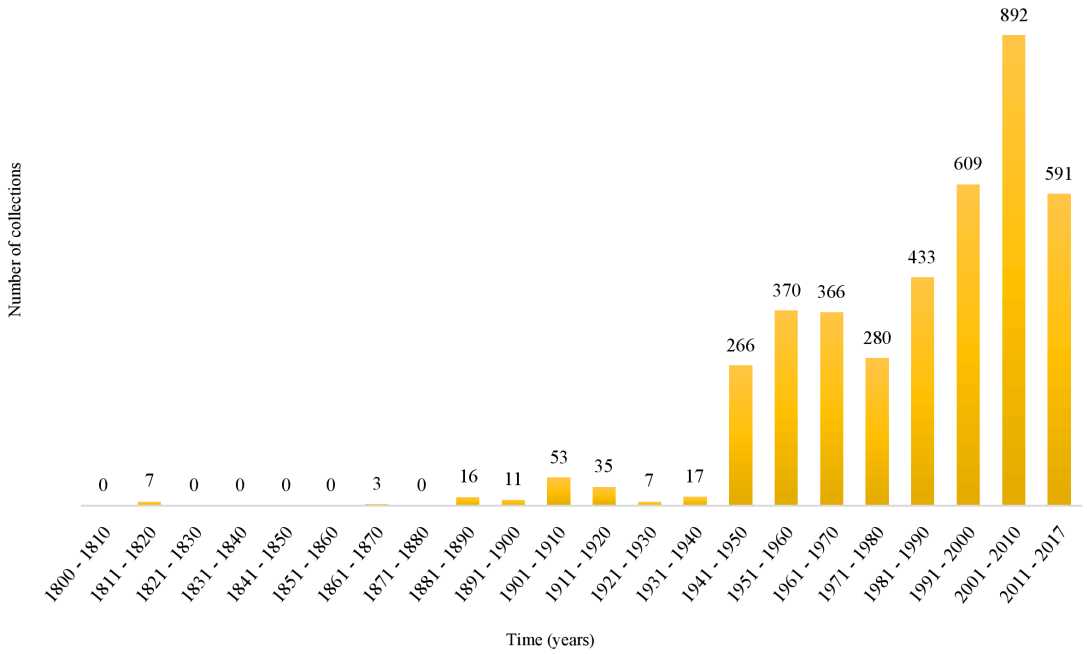

FIGURE 5. Time between the collection of the type specimen and the original publication of the 230 taxa that had date of collection in the type specimen.

Should read:

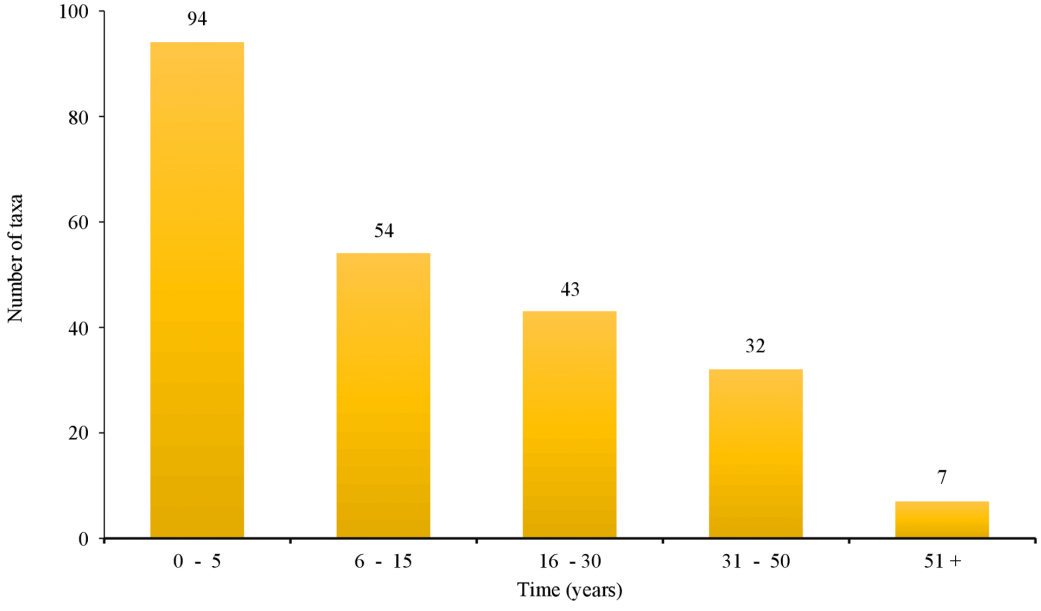

FIGURE 5. Time between the collection of the type specimen and the original publication of the 230 taxa that had date of collection in the type specimen.

Accepted by Carlos Lehnebach: 24 Jul. 2020; published: 29 Jul. 2020

Please note that Figure 6, mentioned on page 7, was entirely omitted from the published version but **should read:**

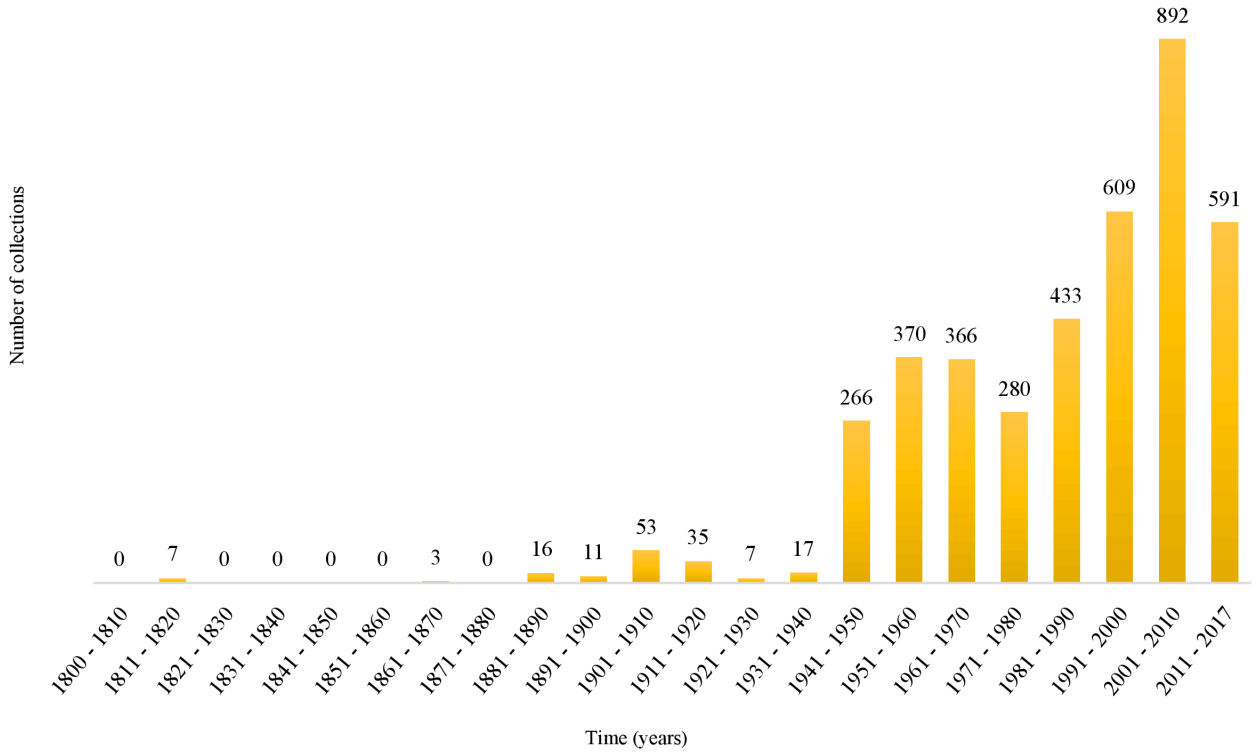

FIGURE 6. Number of specimens of endemic species collected in the Southern Brazilian Subtropical Highland Grasslands from 1800 to 2017.