

DIVERSITY OF CYPERACEAE IN BRAZIL

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ABSTRACT

(Diversity of Cyperaceae in Brazil) The purpose of this catalogue was to combine the available data from publications, theses, databases, and herbarium specimens from around 120 Herbaria, and collections sampled in Brazilian vegetation during the last 15 years to produce the most complete list, as possible as, of Cyperaceae species for Brazil. We catalogued ca. 1,700 names for 678 species in 42 genera occurring in Brazil. These values represent ca. 15 percent of the species and 40 percent of the genera found in the world. Both subfamilies of Cyperaceae are found in Brazil with Cyperoideae being the most diverse at both generic and specific levels. Although lower species were recorded for the tribes Cryptangieae, Sclerieae, and Trilepideae, these tribes represent a much higher percentage of the world's totals for genera and species. The most diverse genera are *Rhynchospora* (157 spp.), *Cyperus* (101 spp.), *Scleria* (82 spp.) and *Eleocharis* (69 spp.). Fifteen genera have one species in Brazil, although five of them are monospecific. The most species-rich regions in Brazil are the North and Southeast. There are no genera endemic to Brazil. There are, however, around 200 endemic species, of which 40 are in the genus *Rhynchospora*. Taxonomic and nomenclatural problems found are pointed under the species. For each catalogued species, the principal synonyms, bibliographic references, distribution within Brazil's five regions, vegetation type, and citation of selected material examined are provided.

Key words: monocotyledons, conservation, Cyperales, neotropics, taxonomy.

RESUMO

(Diversidade de Cyperaceae no Brasil) Esta obra foi elaborada a partir da reunião de informações oriundas de publicações, teses, bancos de dados e visitas realizadas a cerca de 120 herbários, além de amostras coletadas nos últimos anos em diversos biomas no Brasil. Estão aqui catalogados cerca de 1.700 nomes para as 678 espécies registradas de Cyperaceae no Brasil e distribuídas em 42 gêneros. Estes valores representam cerca de 15% do total de espécies e 40% do total de gêneros da família ocorrentes no mundo. As duas subfamílias de Cyperaceae estão representadas no Brasil, sendo que Cyperoideae é a mais diversa em termos genéricos e específicos. No entanto, quando considerado em termos comparativos com a flora ciperológica mundial, Cryptangieae, Sclerieae e Trilepideae são as tribos com maior riqueza de gêneros e espécies no Brasil. Os gêneros com maior riqueza de espécies no Brasil são *Rhynchospora* Vahl (157 spp.), *Cyperus* L. (101 spp.), *Scleria* Berg. (82 espécies) e *Eleocharis* R. Br. (69 spp.). Quinze gêneros estão representados por apenas uma espécie no Brasil, sendo cinco deles monoespecíficos. As regiões Norte e Sudeste despontam como as de maior riqueza genérica e específica. Não foram constatados gêneros endêmicos do Brasil. Foram catalogadas cerca de 200 espécies endêmicas do país, das quais 40 pertencem a *Rhynchospora*. Os problemas taxonômicos e nomenclaturais encontrados estão indicados para cada espécie. Para cada espécie catalogada são apresentados os principais sinônimos, referências bibliográficas, distribuição geográfica nas cinco regiões político-geográficas do país, material examinado de referência e comentários gerais quando pertinentes.

Palavras-chave: monocotiledôneas, conservação, Cyperales, neotrópicos, taxonomia.

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INTRODUCTION

Cyperaceae has around 5,000 species, well distributed and with highest diversity in Africa and the Neotropics (Goetghebeur 1998; Govaerts *et al.* 2007). Many species are known from savanna marshes and other wetland vegetation, but many others are found in forests and drier habitats (Souza & Lorenzi 2006; Govaerts *et al.* 2007; Guaglianone *et al.* 2008). Bruhl (1995) recognized two subfamilies, and Goetghebeur (1998) recognised four subfamilies. The major clades on these are partially supported in most recent molecular phylogenies (*e.g.*, Simpson *et al.* 2007). Simpson *et al.* (2008), however, support the recognition of only two subfamilies: Mapanioideae and Cyperoideae (= Cyperoideae + Sclerioideae + Caricoideae).

In Brazil, Cyperaceae are very well represented. Nees (1842) published the first complete study of Cyperaceae of Brazil in Martius's masterpiece – *Flora Brasiliensis*, and reported more than 300 names. Since then, however, much has changed. During the last few years, there has been considerable research on the taxonomy of Cyperaceae in Brazil (Araújo 2001; Alves 2003; Gil 2004; Prata 2004; Trevisan 2005, 2009; Vitta 2005; Hefler 2007). This activity has also produced useful checklists and floristics studies (Muniz 1987, 2001; Muniz & Shepher 1987; Luceño *et al.* 1997; Martins *et al.* 1998; Prata 2002; Thomas *et al.* 2006; Alves 2006; Alves *et al.* 2007; Araújo *et al.* 2007; Gil *et al.* 2007; Trevisan *et al.* 2007; Ferreira & Egger 2008; Guaglianone *et al.* 2008; Silveira & Longhi-Wagner 2008; Thomas & Alves, 2008; Alves & Martins 2009; Silva *et al.* 2009), highlighting new species and new records for Brazil (Koyama 1972a; Kral & Thomas 1988; Simpson 1989a, 1995; Luceño & Alves 1997; Alves *et al.* 2002; Moore *et al.* 2002; Araújo *et al.* 2003, 2004, 2008; Rocha & Luceño 2002).

As an important contribution to the knowledge of the Brazilian flora and the diversity of Cyperaceae of the world, the Catalogue proposed here was first presented as a series of drafts

(Alves *et al.* 2007, 2008a, b). The main goal of this Catalogue is to combine the available complementary data from publications, theses, databases, and herbarium specimens to produce the most complete specimen-backed list of species of Cyperaceae as possible for Brazil.

MATERIALS AND METHODS

This catalogue is a compilation of information collected by the authors over the last 15 years. In most cases, the taxa reported here are based on specimens collected in Brazil with vouchers deposited in Brazilian herbaria. In a few cases, taxa are included which were reported in the literature as occurring in Brazil but for which specimens have not been located. In addition, selected taxa reported in the literature as occurring outside of Brazil, but in the border regions around the country were also included.

Brazil is divided in five geographical regions: North (N), Northeast (NE), Central West (CO), Southeast (S) and South (S). Each of these region comprises different vegetation types. The North region (including the states of Acre, Amapá, Amazonas, Pará, Rondônia, Roraima, and Tocantins) is the largest area and essentially covers the Amazon Basin – it is mostly covered by Amazonian forest but has also areas of savanna vegetation. The Northeast (including the states of Alagoas, Bahia, Ceará, Maranhão, Paraíba, Pernambuco, Piauí, Rio Grande do Norte, and Sergipe) is the driest area in the country and includes the “caatinga” and parts of the “cerrado” and Atlantic Forest. The Central West region (including the states of Goiás, Mato Grosso, and Mato Grosso do Sul) has the world's largest fresh-water wetland, the Pantanal, a large area of “cerrado” vegetation, and a large area to the north covered by Amazonian forest. The Southeast (including the states of Espírito Santo, Minas Gerais, Rio de Janeiro, and São Paulo) is the most urbanized area in the country and includes a variety of ecosystems including Atlantic Forest and “cerrado”. Finally, the South (including the states of Paraná, Santa Catarina,

and Rio Grande do Sul) comprises the smallest area composed of subtropical vegetation.

Up to five vouchers are cited for the geographic regions of Brazil, and they are in alphabetical order of collectors. Herbarium acronyms follow Thiers (continuously updated). The following herbaria were visited by the authors and most of them are represented by at least one cited specimen: AAU, ALCB, ASE, B, BHCB, BLA, BM, BP, BOTU, C, CAY, CEN, CESJ, CEPEC, CEUL, CGMS, CH, CPAP, CTES, CVRD, DAV, E, EAC, EAN, ESA, ESAL, F, FLOR, FUEL, G, GENT, GH, GUA, HAMAB, HAS, HB, HBR, HC, HCF, HEPH, HMS, HRB, HRCB, HRJ, HST, HTO, HUEFS, HUEM, IAC, IAN, IBGE, ICN, INPA, IPA, JPB, K, L, LE, LIL, LPB, M, MA, MAC, MBM, MBML, MEXU, MG, MHN, MICH, MO, MPUC, MVFA, NLH, NY, P, PACA, PEL, PEUFR, PMSP, R, RB, RFA, RFFP, RUSU, S, SI, SP, SPF, TAES, TCD, TEPB, TEX, U, UB, UC, UEC, UFG, UFP, UFRN, UFRR, UPCB, UPS, US, VEN, VIC, VIES, WAG, W, WU, Z, and ZT. Other herbaria (ECOSUR, HPZ, HRR, HUEPG, SJPR, and UESC) listed at www.ufrgs.br/taxonomia were also visited by the authors.

The most used synonyms are included under the currently accepted name. They are also listed alphabetically with a reference to the accepted name in this article.

Species which occur in bordering regions of adjacent countries but for which records of collections from Brazil have not been found, are included here marked with “(?)” in the geographic region of possible occurrence. Thus, the authors accept the taxa and think it likely those species occur in Brazil. For each of these taxa predicted to occur in Brazil, the literature citation noting its presence in an adjacent area is given.

The protologue of each taxon, when not accessed directly by the authors, was obtained from the information available on the W3Tropicos (www.tropicos.mobot.org) and IPNI (www.ipni.org) websites and other taxonomic works (including Govaerts *et al.* 2007; Guaglianone *et al.* 2008, and unpublished

theses and dissertations). The abbreviations of classic works follows those proposed in TL-2 by Stafleu & Cowan (1976-1988), while authors of species follow www.ipni.org. For each species, a list of selected bibliographic references is presented in which the taxon has been described, illustrated, or at least cited.

For each referenced species, notes on its geographic distribution, habitats, taxonomic delimitation, infraspecific taxa, and nomenclatural questions were added whenever pertinent. An indication of the endemic status in Brazil is provided under the comments on each species. For some species, however, the data are insufficient to support such conclusions.

RESULTS AND DISCUSSION

After analyzing approximately 40,000 specimens, we have catalogued 678 species of Cyperaceae occurring in Brazil (Appendix). These are grouped into 42 genera and are distilled from ca. 1,700 names previously cited for Brazil. Using Goetghebeur (1998) and Govaerts *et al.* (2007), these figures represent almost 20% of the species and 40% of the genera in the family. Both two subfamilies (Simpson *et al.* 2007, 2008 or all four, if it is based in Goetghebeur 1998) are represented in Brazil with Cyperoideae the most diverse both at the specific and generic levels. However, when considered relative to the diversity of the world's Cyperaceae, Brazil is richest in Cryptangieae, Sclerieae, and Trilepideae at both the generic and specific levels.

Data presented in this work corroborate in part the estimation of Luceño & Alves (1997) for Brazil. They estimated that there were 44 genera and 500-600 species of Cyperaceae in Brazil. Several genera accepted by Goetghebeur (1998) and Luceño & Alves (1997) are synonymized here or recircumscribed. *Micropapyrus* and *Syntrinema* are included in *Rhynchospora*. The monospecific genus *Websteria* has been submerged within *Eleocharis* (Roalson & Hinchliff 2007). The circumscription of *Lagenocarpus* follows that proposed by Vitta (2005) with the recognition

and separation of *Cryptangium* which, in turn, includes the genus *Didymiandrum*.

The most species-rich genera in Brazil are *Rhynchospora* (157 spp.), *Cyperus* (101 spp.), *Scleria* (82 spp.), *Eleocharis* (69 spp.), *Bulbostylis* (50 spp.), *Carex* (30 spp.), *Hypolytrum* (28 spp.), *Pleurostachys* (21 spp.), *Lagenocarpus* and *Pycneus* (16 spp. each), *Fimbristylis* (15 spp. each), and *Mapania* (12 spp. each). Fifteen genera are represented by a single species in Brazil. Of these, *Diplasia*, *Egleria*, *Exochogyne*, *Koyamaea* and *Remirea* are monospecific.

There are no genera endemic to Brazil. On the other hand, 203 are endemic species to Brazil, of which 40 are belonging to *Rhynchospora*, 28 to *Cyperus*, 25 to *Scleria*, 22 to *Bulbostylis*, 19 to *Pleurostachys*, 16 to *Eleocharis* and 11 to *Hypolytrum*.

Several genera are distinguished for their high percentage of endemic species, with at least 50 percent of their species endemic to Brazil. These include the following: *Abildgaardia* (25%), *Cryptangium* (87%), *Machaerina* (100%), *Pleurostachys* (90%) and *Trilepis* (75%). The endemic species of these genera, with the exception of *Abildgaardia*, are specific to the Atlantic coastal forest or the rupestrian fields.

Of the five geographical regions of Brazil used here, the richest in number of genera is the North with 34 genera. For species richness, the most diverse regions are the Southeast and North with around 350 species present in each. This similarity in numbers probably does not reflect the actual diversity of the family in Brazil, because the North is much larger and much less well-collected.

Some genera are apparently restricted to a single vegetation type. *Mapania*, for example, is restricted to the Amazon region. *Bisboecklera*, *Cephalocarpus*, *Diplasia*, and *Everardia* are endemic to the Amazon forest. *Androtrichum* and *Remirea* are restricted to coastal dunes. *Machaerina* is found exclusively in clearings at high elevations in the coastal mountains of the South and Southeast. With

the exception of three species, *Pleurostachys* is entirely restricted to the Atlantic forest. Several genera are disjunct between the Amazonian and Atlantic coastal forests. These including *Becquerelia*, *Calyptracarya*, *Diplacrum*, *Hypolytrum* and *Pleurostachys*.

A remarkable number (around 50% of species) of Cyperaceae are found in moist forests of both the Amazon Basin and the coastal forests. Genera diverse in these habitats include *Pleurostachys* and *Hypolytrum*. Some genera such as *Pleurostachys* and *Hypolytrum*, have disjunction between the Amazon and the Atlantic forests. A disjunction between the Neblina Massif and the coastal area of the state of Bahia, is reported here for the first time for *Oreobolus goeppingeri* Suess.

The diversity of Cyperaceae on Brazil's oceanic islands is relatively low. *Bulbostylis nesiotis* is endemic to the Ilhas de Trindade (state of Espírito Santo) and *Cyperus atlanticus* is endemic to oceanic islands including the Fernando de Noronha archipelago (state of Pernambuco).

Several genera and many species are exclusively associated with aquatic and wetland habitats. Among the genera are *Bolboschoenus*, *Egleria* and *Oxycaryum*. *Eleocharis* and *Fuirena* are aquatic or wetland genera with the largest number of species in Brazil.

Several species (around 110 spp.) are widely distributed in all five geographical regions of Brazil, and they are in generally weedy and invasive plants. *Cyperus*, with 25 spp., *Rhynchospora*, with 23 spp., *Eleocharis* with 14 spp, and *Scleria* with 11 spp. have the highest number of widespread species.

Although Cyperaceae are often thought of as weedy and invasive plants, there are a large number of species that are specific to a narrow range of habitats and, therefore, appear to be excellent bioindicators of healthy ecosystems. Also, many sedges are used by local people in handicrafts (Simpson & Inglis 2001), as the basis for perfumes (i.e., *Cyperus articulatus*, Zoghbi et al. 2006).

Many species are very poorly represented in Brazilian herbaria. Greater effort is needed in collecting these species to better understand their distribution and ecology. These poorly known species include those known from a single collection (e.g., *Rhynchospora paranaensis*) or those collected in areas difficult to reach (e.g., *Koyamaea neblinensis*).

Some species (e.g., *Bulbostylis brevifolia*) have not been collected for many years. Although this may be the result of lack of collecting effort, many species are rare, have a limited distribution, and have not been encountered for a long time.

Even though these are all criteria for including a species on the IUCN Red List, few Cyperaceae were included in the most recent version of the list of endangered species of the Brazilian flora (Biodiversitas 2008). Two species (*Cryptangium humile* and *Hypolytrum lucennoi*) are listed as Endangered and 17 as Vulnerable: *Bulbostylis distichoides* Lye, *B. latifolia* Kral & M. Strong, *B. nesiotis* (Hemsl.) C.B. Clarke, *B. smithii* Barros, *Cryptangium clausenii* C.B. Clarke, *C. comatum* Boeck., *Cyperus atlanticus* Hemsl., *Hypolytrum amorinii* M. Alves & W.W. Thomas, *H. bahiense* M. Alves & W.W. Thomas, *H. lucennoi* M. Alves & W.W. Thomas, *H. paraense* M. Alves & W.W. Thomas, *Lagenocarpus bracteosus* C.B. Clarke, *Pleurostachys angustifolia* Boeck., *Rhynchospora paranaensis* A.C. Araújo & W.W. Thomas, *R. warmingii* Boeck., and *Trilepis tenuis* Vitta.

Recently, Alves *et al.* (2009) increased the number of rare species of Cyperaceae for Brazil to 47. Nevertheless, the number remains low. This shortage of listed species is due not only to the lack of collections, but to taxonomic uncertainty as to what species should be recognized. It is our hope that this catalogue will help stimulate better recognition of threatened species of Cyperaceae.

CONCLUSIONS

We catalogued 42 genera and 678 species of Cyperaceae occurring in Brazil. These

represent almost 20% of the species and 40% of the genera around the world. When compared to the diversity of the world's Cyperaceae, Brazil is richest in the genera Cryptangieae, Sclerieae, and Trilepideae at both the generic and specific levels. There are 203 endemic species of Cyperaceae in Brazil, occurring specifically at the Atlantic coastal forest and rupestrian fields. Some genera are apparently restricted to a single vegetation type in Brazil as *Bisboecklera* to the Amazon forest; *Androtrichum* to coastal dunes and *Machaerina* to coastal mountains of the South and Southeast regions.

These data indicate a high diversity of Cyperaceae in Brazil, with many species occurring at impacted habitats. This is a serious problem considering that a large number of Cyperaceae species are useful as potential bioindicators of healthy ecosystems and as handicraft material, and also present potential pharmacological activity.

This becomes more serious when we perceive that many Cyperaceae species are very poorly represented in Brazilian herbaria while some others have not been collected for many years. Although this may be the result of lack of collecting effort, as many species are rare or have a limited distribution, this can be an indicative of a potential extinction. In this sense, although there are clear enough criteria for including more Cyperaceae species on the IUCN Red List, until now few were included in the most recent version of the list of endangered species of the Brazilian flora.

This shortage of listed species is due not only to the lack of collections, but also to taxonomic uncertainty as to what species should be recognized. In this sense we conclude that: i) more extensive good collections of Cyperaceae are necessary to better understand their distribution and ecology in Brazil; ii) scientific investigations in different botanical areas should be produced in order to clear taxonomical problems. We hope that the catalogue presented here could stimulate these investigations, improving the Brazilian strategies to protect endangered and unknown Cyperaceae species and respective lineages.

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