New Brazilian Floristic List Highlights Conservation Challenges

RAFAELA C. FORZZA, JOSÉ FERNANDO A. BAUMGRATZ, CARLOS EDUARDO M. BICUDO, DORA A. L. CANHOS, ANIBAL A. CARVALHO JR., MARCUS A. NADRUZ COELHO, ANDREA F. COSTA, DENISE P. COSTA, MICHAEL G. HOPKINS, PAULA M. LEITMAN, LUCIA G. LOHMANN, EIMEAR NIC LUGHADHA, LEONOR COSTA MAIA, GUSTAVO MARTINELLI, MARIÂNGELA MENEZES, MARLI PIRES MORIM, ARIANE LUNA PEIXOTO, JOSÉ R. PIRANI, JEFFERSON PRADO, LUCIANO P. QUEIROZ, SIDNEI SOUZA, VINICIUS CASTRO SOUZA, JOÃO R. STEHMANN, LANA S. SYLVESTRE, BRUNO M. T. WALTER, AND DANIELA C. ZAPPI

A comprehensive new inventory of Brazilian plants and fungi was published just in time to meet a 2010 Convention on Biological Diversity target and offers important insights into this biodiversity's global significance. Brazil is the home to the world's richest flora (40,989 species; 18,932 endemic) and includes two of the hottest hotspots: Mata Atlântica (19,355 species) and Cerrado (12,669 species). Although the total number of known species is one-third lower than previous estimates, the absolute number of endemic vascular plant species is higher than was previously estimated, and the proportion of endemism (56%) is the highest in the Neotropics. This compilation serves not merely to quantify the scale of the challenge faced in conserving Brazil's unique flora but also serves as a key resource to direct action and monitor progress. Similar efforts by other megadiverse countries are urgently required if the 2020 targets of the Convention on Biological Diversity and the Global Strategy for Plant Conservation are to be attained.

Keywords: biodiversity, biogeography, botany, conservation, mycology

Biodiversity hotspots (Mittermeier et al. 1999, Myers et al. 2000) have captured the imagination of the general public and policymakers alike and have been a major focus of discussions about conservation priorities over the past decade. Estimates of total plant diversity and of species endemism underpin both hotspot circumscription and the recognition of megadiverse countries and regions (Mittermeier et al. 1997, 2004). Therefore, the accuracy with which hotspots can be circumscribed and ranked is limited by the reliability of the diversity data available for each area.

Brazil, long acknowledged as a world leader in floristic diversity, encompasses two biodiversity hotspots—the Cerrado and the Atlantic rainforest (Mata Atlântica)—and ranks high among the most-diverse countries (Mittermeier et al. 1997, 2004). However, published estimates of described diversity are widely divergent because the country lacked an authoritative inventory of plant, algal, and fungal species. Here, we present analyses of new results from a landmark project that indicate that Brazil has fewer described species of plants, algae, and fungi but higher levels of endemism than were previously reported.

Documenting the flora of Brazil

An authoritative census of the Brazilian flora with sufficient scientific credibility to guide conservation planning has long been needed. The last complete inventory of Brazilian plants was the detailed and comprehensive *Flora brasiliensis*, published between 1833 and 1906, in which 19,958 species of plant, algae, and fungi were reported for Brazil (von Martius 1833, Urban 1906). Over the following century, thousands of new species and new distribution records for Brazil were published, but no subsequent comprehensive survey of the Brazilian flora was completed. Reviews of existing knowledge include estimates of the number of described species of plants and fungi ranging from 60,700 to 70,210 (Lewinsohn and Prado 2005). The most recent figures cited for vascular plants are 56,108 species, with 12,400 (22%) endemic (Giam et al. 2010).

Target 1 of the Global Strategy for Plant Conservation (GSPC), adopted by the parties to the Convention on Biological Diversity in 2002, called for a working list of all known plant species by 2010 (CBD 2010a). GSPC Target 1 stimulated diverse responses at the global and national

BioScience 62: 39–45. ISSN 0006-3568, electronic ISSN 1525-3244. doi:10.1525/bio.2012.62.1.8

levels, among the most ambitious of which was a Brazilian initiative begun only in late 2008 to assemble and review the existing data on Brazilian plants, algae, and fungi and to deliver a complete list of known species by 2010. Here, we present headline statistics from that work and analyze them in national and global contexts.

Taxonomic data and procedures

The taxonomic scope of the project included vascular plants, bryophytes, algae, and fungi, although it was accepted that coverage for the latter two groups would be patchy because of the uneven distribution of sampling effort and taxonomic expertise. A database and a Web interface to support the project were developed in partnership with the Centro de Referência em Informação Ambiental. Data sets were obtained from published sources (Gradstein and da Costa 2003, Hennen et al. 2005, Barbosa et al. 2006, Procopiak et al. 2006, Queiroz et al. 2006, Cáceres 2007, de Oliveira et al. 2007, Mendonça et al. 2008, Daly and Silveira 2009, Stehmann et al. 2009), as well as from existing Web resources (Royal Botanic Gardens, Kew 2009, IPNI 2009) and from some unpublished sources provided by specialists. All of the data sets were fed into the system and integrated, totaling roughly 90,000 name citations. All of the original sources are acknowledged in the system.

Taxonomic subsets of the combined data set were made available to invited specialists for review and correction through an online Web interface over a nine-month period ending 31 December 2009. The specialists were invited to update the taxonomic status of each name (*accepted* or *synonym*) and to cite voucher specimens or literature to indicate the distribution of each accepted species across political units (the 27 states of Brazil) and major biomes, following the *domínios* concept *sensu* Veloso and colleagues (1991) and Ab'Sáber (2003) with territorial coverage from IBGE (2010). Although each of these biomes hosts a wide range of vegetation types, physiognomies, habitats, and microhabitats, they can be characterized in broad terms as outlined in table 1 and illustrated in figure 1. To check species distribution and locate suitable vouchers, the specialists used the speciesLink (2010) network, which contains online herbarium data.

The compiled data were reviewed and refined online by a network of 413 taxonomists during 2009. This remarkably comprehensive and rapid collaboration was possible only through advances in information and communication technology and increased Internet speed, which allowed many people to work remotely and simultaneously. The list was then edited and was released online in May 2010.

Summary statistics were extracted from the database by major taxonomic group and by biome. Current species diversity and endemism totals for other megadiverse countries were obtained from recent literature and personal correspondence.

Diversity of Brazilian plants and fungi

The resulting list, published as *The Brazilian Catalogue of Plants and Fungi* (Forzza et al. 2010a) documents 40,989 species of Brazilian algae, land plants, and fungi, of which 18,932 (46.2%) are endemic to the country (table 2). The species totals are lower than recently published estimates by 32%–42% (Lewinsohn and Prado 2005). We did not find comparable endemism estimates for the groups encompassed in our study as a whole. Coverage of algae and fungi in our data set was less consistent and less comprehensive than for land plants (bryophytes and vascular plants). Furthermore, the totals for all land plants were also sparsely noted in the literature; therefore, we focused further comparisons on the vascular plant data. The number of vascular plants totaled 32,364 species, 21% below the lowest previous estimate for known Brazilian vascular plant species and 43% below the highest previous estimate (see table 2 for absolute numbers and sources).

Although our reported number of known vascular plant species is lower than that previously reported, placed in the context of other recently published national estimates (table 3), it shows Brazil as clearly the most diverse country in the world. Its documented vascular plant diversity is greater than what

Table 1. Brazilian biomes according to Veloso and colleagues (1991) and IBGE (2010).

Biome	Description and location	Coverage
Amazônia (Amazon rainforest)	Found in northern and central-western Brazil, and comprising a great variety of vegetation forms, of which the flooded and tall terra firma lowland forest predominate (Ter Steege et al. 2003)	49.3% of the Brazilian territory, extending well beyond Brazil through to Bolivia, Peru, Ecuador, Colombia, Venezuela, and the Guianas (Kress et al. 1998)
Cerrado (central Brazilian savanna)	Predominantly a grassland with woody elements and comprising a diverse mosaic of vegetations known as *campos rupestres* (Giulietti and Pirani 1988)	23.9% of the Brazilian territory, with marginal continuous extensions in northeastern Paraguay and Bolivia (Ab'Sáber 1983, Mendonça et al. 2008)
Mata Atlântica (Atlantic rainforest)	A narrow strip of forest from sea level to the eastern highlands of Brazil, becoming broader toward the south	13% of the Brazilian territory, and 95% of it occurs within Brazil (Stehmann et al. 2009), extending marginally into Argentina and Uruguay, of which only 12% of the original area still remains (Ribeiro et al. 2009)
Caatinga	Xerophilous thorny forest and scrub of the drylands of northeastern Brazil	9.9% of the Brazilian territory, exclusively Brazilian (Andrade-Lima 1981)
Pampa	Grasslands from southern Brazil	2.1% of the Brazilian territory, found also in Argentina, Uruguay, and eastern Paraguay (Boldrini 2009)
Pantanal	Periodically flooded grasslands by the rivers Paraná and Paraguay in central-western Brazil	1.8 % of the Brazilian territory, continuing into Bolivia, Paraguay, and Argentina (Pott and Pott 1997)

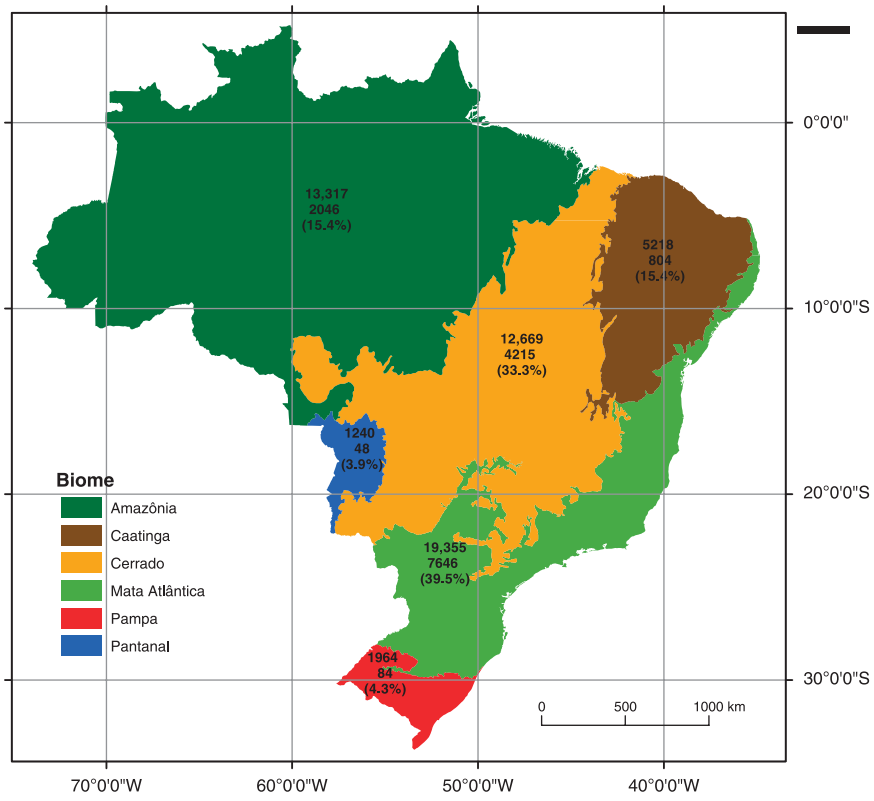

Figure 1. Map of Brazilian biomes showing the total number of species (top number), the number of endemic species (middle number), and the percentage endemism for each biome.

might be predicted by comparison with other megadiverse countries, even allowing for Brazil's exceptionally large area (figure 2). Because the number of herbarium specimens of Brazilian plants collected to date is far from sufficient to adequately represent the native plant diversity as a whole (Sobral and Stehmann, 2009) and major initiatives are underway to increase the size and availability of the collections (CNPq 2010, DCBio 2010, GPI 2011), the total number of vascular plant species for Brazil can be expected to rise significantly over the coming years. Of critical importance in this process is the recognition by the Brazilian government that increased taxonomic capacity to accelerate the analysis of materials in Brazilian collections is necessary to provide up-to-date scientific information on national biodiversity (DCBio 2010, p. 35).

Vascular plant endemism

In total, 18,082 vascular plant species (56%) have been recorded as endemic to Brazil. This proportion of endemism is higher than that reported for

Table 2. Synthesis of the species estimates for Brazil.

Species group	Number of species listed in von Martius (1833)	Lowest previous estimate for Brazil	Highest previous estimate for Brazil	Number of species listed in Forzza and colleagues (2010a)	Number of species in von Martius (1833) as a percentage of the number of species in Forzza and colleagues (2010a)	Number of endemic species listed in Forzza and colleagues (2010a)
All groups	19,958	63,456[a]	73,956[a]	40,989	48.7	18,932
Fungi	177	12,914[a]	13,914[a]	3,608	4.9	523
Algae	80	7,527[a]	10,527[a]	3,496	2.3	52
Plants (terrestrial and algae)	19,781	50,542[a]	60,042[a]	37,381	52.9	18,409
Land plants	19,701	43,015[a]	49,515[a]	33,885	58.1	18,357
Bryophytes	268	1,650[b]	3,200[c]	1,521	17.6	275
Vascular Plants	19,433	41,215[a]	56,415[a]	32,364	60.0	18,082
Ferns and lycophytes	576	1,200[a]	1,400[a]	1,176	49.0	450
Seed plants	18,857	35,664[d]	45,015[a]	31,188	60.5	17,632
Gymnosperms	11	14[e]	16[e]	26	42.3	2
Angiosperms	18,846	30,000[e]	45,000[e]	31,162	60.5	17,630

[a]Lewinsohn and Prado 2005.
[b]Gradstein and da Costa 2003.
[c]Giulietti et al. 2005.
[d]Govaerts 2001.
[e]Shepherd 2005.

Table 3. Vascular plant species diversity and area data for 16 megadiverse countries (adapted from Giam et al. 2010).

Country	Area (in square kilometers)	Total number of species	Number of endemic species	Percentage of endemism
Brazil	8,514,880	32,364	18,082	56
Australia	7,741,220	15,638	14,182	91
China	9,598,088	29,650	14,013	47
Indonesia	1,904,570	29,375	13,750	47
South Africa	1,219,090	20,407	13,265	65
Papua New Guinea	462,840	14,522	13,250	91
Mexico	1,964,380	25,036	11,250	45
Colombia	1,141,750	24,500	10,500	43
Madagascar	587,040	9753	7250	74
India	3,287,260	17,832	6113	34
Peru	1,285,220	18,055	5676	31
Ecuador	283,560	17,517	4179	24
United States	9,632,030	18,737	4036	22
Malaysia	329,740	15,250	3600	24
Philippines	300,000	8931	3500	39
Venezuela	912,050	15,820	2964	19

Note: The species totals for Brazil are updated to reflect those reported in the present article. Those for South Africa follow Von Staden and colleagues (2009), and those for Colombia follow Bernal (2009).

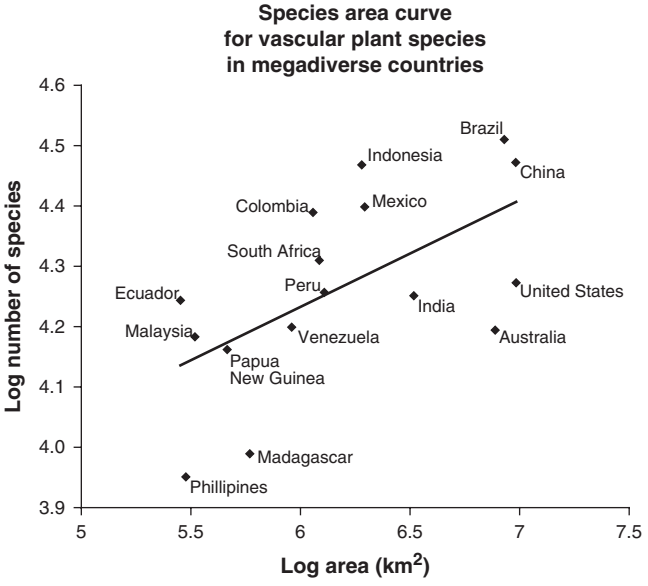

Figure 2. A log–log plot of the numbers of vascular plant species for megadiverse countries shows that Brazil's vascular plant diversity is exceptional, even when its greater area is taken into account. The data were log transformed to permit a meaningful comparison of diversity among countries, despite their widely differing areas. Abbreviation: km², square kilometers.

any other Neotropical country (table 3) and greatly in excess of previously published endemism estimates for Brazilian vascular plants, which ranged from 22% (Giam et al. 2010) to 29%–37% (Mittermeier et al. 1997 and MMA 1998 for higher plants only). Giulietti and colleagues (2005) reported higher levels of endemism (66%) for a selection of dicotyledonous families, although they cited an unpublished list that indicated only 28% endemism in Brazilian dicotyledons.

In the global context, Brazil has more endemic vascular plant species than any other country (table 3) and now ranks eighth in the world for percentage endemism, exceeded only by countries with essentially island floras (i.e., Australia and Papua New Guinea, both 91%; Madagascar, 74%), by other countries or administrative regions consisting of islands or archipelagos (New Caledonia, 88%; New Zealand, 81%; French Polynesia, 58%), and by South Africa (65%)—the only other continental country with flora with levels of endemism over 50%. Given the large expanses of Brazil still awaiting detailed botanical exploration and the relatively narrow distribution of the majority of recently described species, levels of endemism in the known Brazilian vascular plant flora can be expected to rise in the coming years.

Biome comparisons

For the six biomes recognized (table 1, figure 1), the total number of species, the total number of endemic species, and the proportion of endemism in each biome are presented in table 4 and mapped on figure 1.

Brazil's Atlantic forest, already recognized as one of the world's hottest hotspots (Mittermeier et al. 1999, Myers et al. 2000, Brummitt and Nic Lughadha 2003) has 19,355 species in our list, including 40% of all known Brazilian endemics (tables 1 and 4, figure 1).

The Cerrado, also a hotspot (Mittermeier et al. 2004), although not among the very hottest (Brummitt and Nic Lughadha 2003), is confirmed as home to the richest savanna flora in the world, with 12,669 species (4215 Brazilian endemics). Although neither the Atlantic rainforest nor the Cerrado biomes are exclusive to Brazil (see table 1), the fact that the great majority of their extent is within Brazilian boundaries explains their large contribution of endemic species.

In contrast, the Amazon extends far beyond Brazilian national boundaries, encompassing large areas of Bolivia, Peru, Ecuador, Colombia, Venezuela, and the Guianas, and,

Table 4. Species of fungi, epicontinental algae, and land plants distributed by Brazilian biomes.

		Biome					
Species group	**Species statistic**	**Atlantic forest**	**Amazon**	**Cerrado**	**Caatinga**	**Pampa**	**Pantanal**
Fungi	Number of species	1664	519	291	734	1	28
	Number of endemic species	100	35	7	56	0	0
	Percentage of species endemic to this biome	6	1.3	12	7.6	0	0
Algae	Number of species	1545	444	308	44	505	130
	Number of endemic species	22	8	0	0	6	0
	Percentage of species endemic to this biome	1.4	0	2.6	0	1.2	0
Bryophytes	Number of species	1333	561	433	93	107	179
	Number of endemic species	189	24	9	2	2	1
	Percentage of species endemic to this biome	14.2	1.6	5.5	2.2	1.9	0.6
Ferns and lycophytes	Number of species	834	428	245	25	5	18
	Number of endemic species	321	31	48	2	0	1
	Percentage of species endemic to this biome	38.5	11.2	12.7	8	0	5.6
Seed plants	Number of species	13,979	11,365	11,392	4322	1346	855
	Number of endemic species	7014	1948	4151	744	76	46
	Percentage of species endemic to this biome	50.2	36.5	17.1	17.2	5.6	5.2
All groups total	Number of species	19,355	13,375	12,669	5218	1964	1240
	Number of endemic species	7646	2046	4215	804	84	48
	Percentage of species endemic to this biome	39.5	15.4	33.3	15.4	4.3	3.9
Percentage of all Brazilian endemic species confined to this biome		40.4	10.9	22.3	4.2	0.4	0.2

Note: The endemism totals for each biome do not add up to the total number of endemic species for Brazil because some Brazilian endemic species occur in more than one biome and because biome data are lacking for some species.

unsurprisingly, of the 13,375 species documented for the Brazilian Amazon, only 2046 are endemic to Brazil. These biome comparisons, made using species totals for all groups included in our list (land plants, algae, and fungi), reflect undersampling, particularly of the latter groups; the angiosperm number for the Brazilian Amazon (11,349 species) is more comparable to that for the Atlantic rainforest (13,972). Furthermore, the Amazon is known to have a relatively low density of preserved collections of plants and fungi, and these are skewed toward a handful of geographical centers. Schulman and colleagues (2007) suggested that, for vascular plants, as much as 43% of the area of the Amazon may be effectively uncollected. Increased collecting activity is urgently needed and expected to considerably augment the number of species recorded for this biome (Milliken et al. 2011).

Maintaining and using the list

The Brazilian Catalogue of Plants and Fungi (Forzza et al. 2010a) represents a snapshot of our current understanding of Brazilian plant diversity at a critically important time. With a new species being added to the inventory each working day, on average (Sobral and Stehmann 2009), the hard-copy version will soon be outdated, but the Rio de Janeiro Botanical Garden will coordinate continuous updating of the Web version (Forzza et al. 2010b) and yearly online releases. Maintenance of the list will require continued support for and recognition of the network of taxonomic specialists who created it. Enhancements to the coverage of fungi and microalgae should be prioritized and will require investment in taxonomic capacity for these neglected groups.

This landmark achievement by the Brazilian scientific community not only provides a robust new baseline for

taxonomic and floristic work, but it is also a key tool for policymakers and land managers seeking to direct and implement conservation actions on a scale sufficient to safeguard the world's most-important flora. It will serve as an inventory of resources to be assessed for conservation status and prioritized for conservation action, which will aid in avoiding duplication of effort and accidental oversight (Secretariat of the Convention on Biological Diversity 2009). South Africa provides a clear example of how a national list of plant species can form the foundation for a range of practical information products and can establish a baseline for more applied socioeconomic initiatives (Crouch and Smith 2011). In the Brazilian context, the list's relevance is illustrated by the fact that more than two-thirds of plant species considered by expert botanists as *threatened* in 2005 were deemed to lack sufficient reliable information to be officially recognized as conservation priorities (DCBio 2010, p. 39). The existence of the list will also enable information on Brazilian plants to be organized in a logical and retrievable way, linked to information about the properties of these species and their roles in ecosystems, which will make these more readily accessible to land managers. Practical needs, such as biome-specific manuals of species suitable for use in habitat restoration can be addressed using subsets of the list.

For those megadiverse countries that still lack a comprehensive plant list, concentrated and concerted efforts to develop one are urgently needed if the new and more ambitious GSPC 2020 targets are to be attained (CBD 2010b).

Acknowledgments

The authors would like to acknowledge the Ministério do Meio Ambiente and the Centro Nacional de Conservação da Flora for financial support for the project, the National Council for Scientific and Technological Development for productivity grants, and the Bentham and Moxon Trust for a grant to RCF. Neil Brummitt, Tom Meagher, William Milliken and three anonymous reviewers provided valuable input in various phases of the manuscript.

References cited

Ab'Sáber AN. 1983. O domínio dos cerrados: Introdução ao conhecimento. Revista Servidor Público 3: 41–55.

Ab'Sáber A[N]. 2003. Os Domínios de Natureza no Brasil: Potencialidades Paisagísticas. Ateliê.

Andrade-Lima D. 1981. The caatinga dominium. Revista Brasileira de Botânica 4: 149–153.

Barbosa MRV, Sothers C, Mayo S, Gamarra-Rojas C, Mesquita AC. 2006. Checklist das Plantas do Nordeste Brasileiro: Angiospermas e Gymnospermas. Ministério de Ciência e Tecnologia.

Bernal R. 2009. A elaboração do Catálogo de Plantas da Colômbia. In: Simpósio Metas da Convenção da Biodiversidade para 2010: Construindo a Lista de Espécies do Brasil. Paper presented at the 60th Brazilian Botanical Conference; 28 June–3 July 2009, Feira de Santana, Brazil.

Boldrini II. 2009. A flora dos campos do Rio Grande do Sul. Pages 63–77 in Pillar VDP, Muller SC, Castilhos ZMS, Jacques AVA, eds. Campos Sulinos: Conservação e Uso Sustentável da Biodiversidade. Ministério do Meio Ambiente.

Brummitt N, Nic Lughadha E. 2003. Biodiversity: Where's hot and where's not. Conservation Biology 17: 1442–1448.

Cáceres MES. 2007. Corticolous Crustose and Microfoliose Lichens of Northeastern Brazil, 1st ed. IHW.

[CBD] Convention on Biological Diversity. 2010a. COP 5 Decision V/10: Global strategy for plant conservation. CBD. (1 May 2011; *www.cbd.int/decision/cop/?id=7152*)

———. 2010b. COP 10 Decision X/17: Consolidated update of the Global Strategy for Plant Conservation 2011–2020. CBD. (1 May 2011; *www.cbd.int/decision/cop/?id=12283*)

[CNPq] Conselho Nacional de Desenvolvimento Científico e Tecnológico (National Council for Scientific and Technological Development). 2010. Edital MCT/CNPq/FNDCT/MEC/CAPES/FAP's No. 56/2010—REFLORA. CNPq. (1 May 2010; *www.cnpq.br/editais/ct/2010/056.htm*)

Crouch NR, Smith GF. 2011. Informing and influencing the interface between biodiversity science and biodiversity policy in South Africa. Botanical Journal of the Linnean Society 166: 301–309.

Daly DC, Silveira M. 2009. Primeiro Catálogo da Flora do Acre, Brasil [First Catalogue of the Flora of Acre, Brazil]. EDUFAC.

[DCBio] Office of the National Program for Biodiversity Conservation, Ministry of the Environment, Brazil. 2010. Fourth National Report to the Convention of Biological Diversity, Brazil. Ministry of the Environment.

De Oliveira EC, Horta PA, da Silva BNT. 2007. Algae Maris Brasilis: A Catalogue of Brazilian Marine Algae. (12 March 2009; *www.algaemarisbrasilis.ccb.ufsc.br/algaemarisbrasilis.html*)

Forzza RC, et al. 2010a. Catálogo das Plantas e Fungos do Brasil, 2 vols. Andrea Jakobsson Estúdio and Rio de Janeiro Botanical Garden.

Forzza RC, et al. 2010b. Introdução. Lista de Espécies da Flora do Brasil. Rio de Janeiro Botanical Garden. (30 May 2010; *http://floradobrasil.jbrj.gov.br/2010*)

Giam X, Bradshaw CJA, Tan HTW, Sodhi NS. 2010. Future habitat loss and the conservation of plant biodiversity. Biological Conservation 143: 1594–1602.

Giulietti AM, Pirani JR. 1988. Patterns of geographic distribution of some plant species from the Espinhaço range, Minas Gerais and Bahia. Pages 39–69 in Heyer WR, Vanzolini PE, eds. Proceedings of a Workshop on Neotropical Distribution Patterns. Academia Brasileira de Ciências.

Giulietti AM, Harley RM, Queiroz LP, Wanderley MGL, Van Den Berg C. 2005. Biodiversidade e conservação das plantas no Brasil. Megadiversidade 1: 52–61.

Govaerts R. 2001. How many species of seed plants are there? Taxon 50: 1085–1090.

[GPI] Global Plants Initiative 2011. Global Plants Initiative: Resources for the Digitization of Herbarium Specimens. GPI. (2 November 2011; *http://gpi.myspecies.info*)

Gradstein SR, Costa DP. 2003. The Hepaticae and Anthocerotae of Brazil. Memoirs of the New York Botanical Garden 87. New York Botanical Garden Press.

Hennen JF, Figueiredo MB, de Carvalho AA Jr, Hennen PG. 2005. Catalogue of the Species of Plant Rust Fungi (Uredinales) of Brazil. Rio de Janeiro Botanical Garden. (12 March 2009; *http://www.jbrj.gov.br/publica/uredinales/Brazil_Catalogue1drevisado.pdf*)

[IBGE] Instituto Brasileiro de Geografia e Estatística. 2010. Mapa de biomas. IBGE. (2 November 2011; *ftp://geoftp.ibge.gov.br/mapas/tematicos/mapas_murais/biomas.pdf*)

[IPNI] The International Plant Names Index. 2009. The International Plant Names Index (IPNI). (12 March 2009; *www.ipni.org*)

Kress WJ, et al. 1998. Amazonian biodiversity: Assessing conservation priorities with taxonomic data. Biodiversity and Conservation 7: 1577–1587.

Lewinsohn TL, Prado PI. 2005. Quantas espécies há no Brasil? Megadiversidade 1: 36–42.

Mendonça RC, Felfili JM, Walter BMT, Silva Júnior MC, Rezende AV, Filgueiras TS, Nogueira PE, Fagg CW. 2008. Flora vascular do bioma Cerrado: Checklist com 12.356 espécies. Pages 421–1279 in Sano SM,

Almeida SP, Ribeiro JF, eds. Cerrado: Ecologia e Flora, vol. 2. Embrapa Cerrados, Embrapa Informação Tecnológica.

Milliken W, Zappi D[C], Sasaki D, Hopkins M, Pennington RT. 2011. Amazon vegetation: How much don't we know and how much does it matter? Kew Bulletin 65: 691–709.

Mittermeier RA, Robles Gil P, Mittermeier CG. 1997. Megadiversity: Earth's Biologically Wealthiest Nations. CEMEX and Agrupación Sierra Madre.

———. 1999. Hotspots: Earth's Biologically Richest and Most Endangered Terrestrial Ecoregions. CEMEX, Conservation International, and Agrupación Sierra Madre.

Mittermeier RA, Robles Gil P, Hoffmann M, Pilgrim J, Brooks T, Mittermeier CG, Lamoreux J, da Fonseca GAB. 2004. Hotspots revisited. CEMEX and Agrupación Sierra Madre.

[MMA] Ministério do Meio Ambiente. 1998. Primeiro relatório nacional para a Convenção sobre Diversidade Biológica—Brasil [First National Report for the Convention on Biological Diversity—Brazil]. MMA.

Myers N, Mittermeier RA, Mittermeier CG, da Fonseca GAB, Kent J. 2000. Biodiversity hotpots for conservation priorities. Nature 403: 853–858.

Pott A, Pott VJ. 1997. Plants of Pantanal. Embrapa.

Procopiak LK, Fernandes LF, Moreira-Filho H. 2006. Diatomáceas (Bacillariophyta) marinhas e estuarinas do Paraná, Sul do Brasil: Lista de espécies com ênfase em espécies nocivas. Biota Neotropica 6(3). (12 March 2009; *http://www.biotaneotropica.org.br/v6n3/pt/abstract?inventory+bn02306032006*)

Queiroz LP, Conceição A, Giulietti AM. 2006. Nordeste semi-árido: Caracterização geral e lista das fanerógamas. Pages 15–364 in Giulietti AM, Queiroz LP, eds. Diversidade e caracterização das fanerógamas do semiárido brasileiro, vol. 1. Associação Plantas do Nordeste.

Ribeiro MC, Metzger JP, Martensen AC, Ponzoni FJ, Hirota MM. 2009. The Brazilian Atlantic Forest: How much is left, and how is the remaining forest distributed? Implications for conservation. Biological Conservation 142: 1144–1153.

Schulman L, Toivonen T, Ruokolainen K. 2007. Analysing botanical collecting effort in Amazonia and correcting for it in species range estimation. Journal of Biogeography 34: 1388–1399.

Secretariat of the Convention on Biological Diversity. 2009. The Convention on Biological Diversity Plant Conservation Report: A Review of Progress in Implementing the Global Strategy of Plant Conservation. Secretariat of the Convention on Biological Diversity.

Shepherd GJ. 2005. Plantas terrestres. Pages 145–192 in Lewinsohn TM, ed. Avaliação do Estado do Conhecimento da Biodiversidade Brasileira. Serie Biodiversidade, vol. 2. Ministério do Meio Ambiente.

Sobral M, Stehmann JR. 2009. An analysis of new angiosperm species discoveries in Brazil (1990–2006). Taxon 58: 227–232.

SpeciesLink. 2010. The Project speciesLink. SpeciesLink. (10 May 2010; *http://splink.cria.org.br/index?&setlang=en*)

Stehmann JR, Forzza RC, Salino A, Sobral M, da Costa DP, Kamino LHY. 2009. Plantas da Floresta Atlântica. Rio de Janeiro Botanical Garden.

Ter Steege H, et al. 2003. A spatial model of tree alpha-diversity and density for the Amazon Region. Biodiversity and Conservation 12: 2255–2277.

Urban I. 1906. Index familiarum. Pages 239–268 in von Martius CPF, ed. Pars Prior: Algae, Lichenes, Hepaticae. Flora Brasiliensis 1. Cottae.

Veloso HP, Rangel Filho ALR, Lima JCA. 1991. Classificação da Vegetação Brasileira, Adaptada a um Sistema Universal. Instituto Brasileiro de Geografia e Estatística.

Von Martius CPF, ed. 1833. Pars Prior: Algæ, Lichenes, Hepaticæ. Flora Brasiliensis 1. Cottae.

Von Staden L, Raimondo D, Foden W. 2009. Introduction. Pages 1–5 in Raimondo D, Von Staden L, Foden W, Victor JE, Helme NA, Turner RC, Kamundi DA, Manyama PA, eds. Red List of South African Plants 2009. Strelitzia 25.

Royal Botanic Gardens, Kew. 2009. World Checklist of Selected Plant Families. Royal Botanic Gardens, Kew. (12 March 2009; *http://apps.kew.org/wcsp/prepareChecklist.do?checklist=selected_families%40%40306021120112009952*)

Rafaela C. Forzza (rafaela@jbjr.gov.br), José Fernando A. Baumgratz, Anibal A. de Carvalho Jr., Marcus Antonio N. Coelho, Denise P. da Costa, Paula M. Leitman, Gustavo Martinelli, Marli Pires Morim, and Ariane Luna Peixoto are affiliated with the Rio de Janeiro Botanical Garden, in Rio de Janeiro, Brazil. Carlos Eduardo M. Bicudo and Jefferson Prado are affiliated with the Botanical Institute in São Paulo, Brazil. Dora A. L. Canhos and Sidnei Souza are affiliated with the Centro de Referência em Informação Ambiental in São Paulo, Brazil. Andrea F. Costa, Mariângela Menezes, and Lana S. Sylvestre are affiliated with the Federal University of Rio de Janeiro, in Rio de Janeiro, Brazil. Michael G. Hopkins is affiliated with the National Institute of Amazonian Research, in Manaus, Brazil. Lucia G. Lohmann, José R. Pirani, and Vinicius Castro Souza are affiliated with the University of São Paulo, in São Paulo, Brazil. Eimear Nic Lughadha is affiliated with the Herbarium, Library, Art and Archives Directorate of the Royal Botanic Gardens, Kew, in Richmond, United Kingdom. Leonor Costa Maia is affiliated with the Federal University of Pernambuco, in Pernambuco, Brazil. Luciano P. Queiroz is affiliated with the State University of Feira de Santana, in Feira de Santana, Brazil. João R. Stehmann is affiliated with the Federal University of Minas Gerais, in Belo Horizonte, Brazil. Bruno M. T. Walter is affiliated with Embrapa Recursos Genéticos e Biotecnologia's Centro Nacional de Pesquisas de Recursos Genéticos e Biotecnologia, in Brasília, Brazil. Daniela C. Zappi is affiliated with the Herbarium, Library, Art and Archives Directorate of the Royal Botanic Gardens, Kew, in Richmond, United Kingdom, and with Gardens by the Bay, in Singapore.