ACTA
AMAZONICA

http://dx.doi.org/10.1590/1809-4392201402662

Updated checklist of aquatic macrophytes from Northern Brazil

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ABSTRACT

Field collection and herbaria data did not allow to quantify the diversity of aquatic plants from Northern Brazil, so we could not detect biogeographic patterns. Therefore, our objectives were to identify and quantify the aquatic macrophytes of North Brazilian states, analyzing herbaria data plataforms (SpeciesLink and Flora do Brasil). The checklist was produced by bibliographic search (articles published between 1980 and 2000), herbaria collections of the platforms SpeciesLink and Flora do Brasil and field expeditions, where we utilized asystematic sampling. We also analyzed the floristic similarity of aquatic macrophytes among Northern Brazil, wetlands of distinct Brazilian regions and the Neotropics. We recorded 539 species, of which 48 are endemic to Brazil. The states with highest number of species were Amazonas and Pará, independently on platform. The most represented families were Poaceae (89 species), Podostemaceae (55), Cyperaceae (50) and Fabaceae (47). We highlight the unprecedent richness of Podostemaceae, due to our own field collection efforts on favorable habitats, 25 species being endemic. Emergent and/or amphibious plants (515) were dominant in total species richness and were best represented in lotic habitats. We found significant differences in richness and floristics among states, obtained from the platforms. There is floristic similarity among Northern states and other Brazilian wetlands. In conclusion, we observed a rich aquatic flora in Northern Brazil, in spite of scarcity of records for Acre, Rondonia and Tocantins; we highlight the unprecedent number of endemic species of Podostemaceae (25) and contrasting richness between SpeciesLink and Flora do Brasil.

KEYWORDS: floristics, life forms, Podostemaceae, species richness

Lista atualizada de macrófitas aquáticas da região Norte do Brasil

RESUMO

Os eforços de campo e os dados de herbários não nos permitiam quantificar a diversidade plantas aquáticas no Norte do Brasil e, com isso, nos impediam de traçar padrões biogeográficos sobre essa comunidade. Assim, o presente estudo teve por objetivos identificar e quantificar as macrófitas aquáticas dos estados do Norte do Brasil, analisando duas plataformas de dados de herbarios (SpeciesLink e Flora do Brasil). O *checklist* baseou-se em levantamento bibliográfico (revistas e artigos publicados entre 1980 e 2000) e em coletas de campo, na qual foi utilizada amostragem de "caminhamento". Após a elaboração do *checklist*, verificaram-se os registros das espécies para os estados da região, consultando-se as coleções das plataformas SpeciesLink e Flora do Brasil. Foi analisada a similaridade de especies de macrófitas aquáticas do Neotrópico, Norte do Brasil e ecossistemas aquáticos de distintas regiões do país. Foram registradas 539 espécies, sendo 48 endêmicas do Brasil. As famílias mais representativas foram Poaceae (89 espécies), Podostemaceae (55), Cyperaceae (50) e Fabaceae (47). Ressaltamos a inédita riqueza de Podostemaceae, devida a nossos esforços de coleta em ambientes propícios, 25 espécies sendo endêmicas. Os estados que apresentaram maior número de registros de espécies foram Amazônia e Pará, independentemente da plataforma de dados analisada. As espécies anfíbias e/ou emergentes (505 espécies) foram dominantes na riqueza total dos sete estados analisados. Foram constatadas diferenças significativas quanto aos resultados de riqueza e composição florística dos estados, obtidos pelas plataformas Flora do Brasil e SpeciesLink. A análise de similaridade florística evidenciou a formação de grados entre estados do Norte ou ecossistemas aquáticos brasileiros cujos sistemas climatológicos apresentam semelhanças. Em síntese, observamos uma flora rica de plantas aquáticas no Norte do Brasil, apesar da carência de registros para o Acre, Rondonia e Tocantins. Destacamos o número recorde de espécies endêmicas de Podostemaceae (25 spp.) e as divergências quanto aos resultados de riqueza registradas pelo SpeciesLink e Flora do Brasil.

PALAVRAS-CHAVE: florística, formas de vida, Podostemaceae, riqueza

INTRODUCTION

The water surface of the Northern region represents 70% of the area of Brazil (*ca.* 4 million km²), that includes rivers, streams, waterfalls, floodplains, wet savannas, swamps, lakes and reservoirs (Bicudo *et al.* 2010). This region has the largest hydrographic basin on Earth (Amazonas), which peculiar hydrologic features (white waters, black waters and clear waters) and vegetation types (savannas, floodable forests, white sand savannas or *campinal*/*campinaranas*, flood free forests) make Northern Brazil rich in endemism of aquatic biodiversity (Piedade *et al.* 2010).

Wide latitudinal and longitudinal gradients influence the climatological and limnological systems of micro-basins (Raven *et al.* 2007). So, the distribution of aquatic species and, consequently, the patterns of richness and composition can vary within Northern Brazil and/or between this region and other Brazilian wetlands.

The Northern region of Brazil is still little known considering species richness and life forms of aquatic macrophytes. According to the species list of Flora do Brasil (Lista de espécies da flora do Brasil 2012), the richness of aquatic plants of this region is estimated as 137 species of strictly aquatic habitat, while the Northeast and the Pantanal exhibit, respectively, 412 and 273 species of aquatic macrophytes and amphibious plants (Pott and Pott 2000; Moura-Júnior *et al.* 2013). However, the data of SpeciesLink (SPLink 2012) reveal that the richness of aquatic macrophytes for Northern Brazil is around 250 species, with *ca*. 2500 records in Brazilian herbaria.

According to Moura-Júnior *et al.* (2013), checklists elaborated after compilation of field data, bibliographic survey, herbaria collection and/or platforms of virtual data (*e.g.* Flora do Brasil and the project SpeciesLink) allow to increase knowledge on biodiversity in a given study area as well as to identify efficient tools to obtain data. This way, when utilizing Flora do Brasil and SpeciesLink platforms to compile the checklist, we can test whether patterns of species richness and composition of aquatic plants are influenced by the chosen data set. We used both because they are the main databanks on flora in Brazil.

The objective of this work was to: (i) inventory the aquatic macrophyte flora for Northern Brazil, pointing out the endemic species; (ii) determine richness of macrophytes regarding life forms; (iii) determine species richness and floristic patterns among Northern states and other Brazilian regions; and (iv) compare the data platforms Flora do Brasil and SpeciesLink.

MATERIALS AND METHODS

Description of the study area

The Northern region has seven states: Acre (AC), Amapá (AP), Amazonas (AM), Pará (PA), Rondônia (RO), Roraima (RR) and Tocantins (TO) (IBGE 2011) (Figure 1). The climate exhibits spatial variation, being equatorial (predominant) or tropical, with a relatively dry period in June-November, and a rainy season with heavy rainfall, from December to May (monthly mean of 300 mm) (INMET 2013). The mean annual rainfall of 2,000 mm, reaching over 3,000 mm in some areas, such as the littoral of AP, the mouth of the Amazonas river and parts of Western Amazon (INMET 2013). Above the equatorial line, the seasons become inverted in relation to the southern side.

The Northern region has two main watersheds: of the Amazon River and of the Tocantins River (ANA 2012). The Amazon basin is the largest in the world, covering 3.87 million km² (nearly half Brazil), draining all Northern states (ANA 2012). The Tocantins basin covers 1 million km² in TO, GO, MT, PA and MA, the main rivers being Araguaia, Tocantins and Itacaiúnas (ANA 2012).

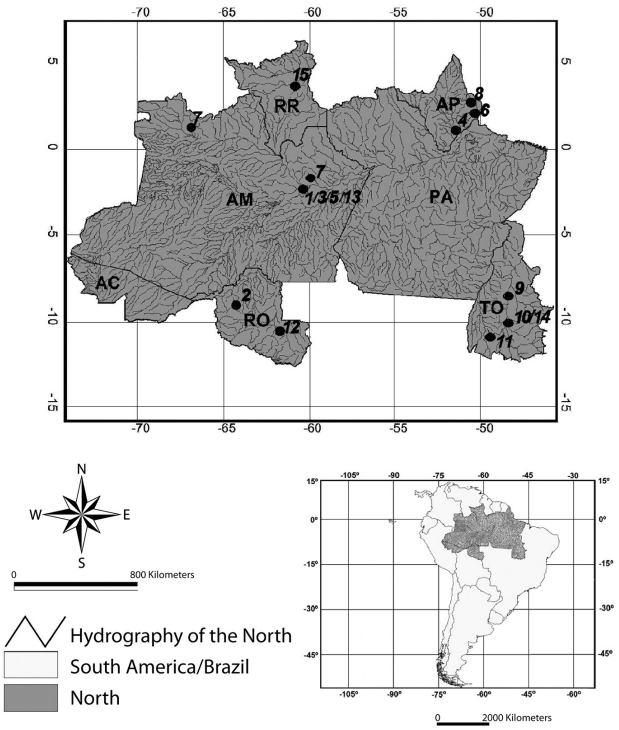

Figure 1. Geographic localization and hydrological map of the Northern region of Brazil. Legend: (1-15) study areas of the consulted sources for compilation of the checklist (Table 1). Northern states: AC = Acre; AM = Amazonas; AP = Amapá; RO = Rondônia; RR = Roraima; PA = Pará; TO = Tocantins.

Data collection

We constructed a list of aquatic macrophytes for Northern Brazil. This checklist was generated by a bibliographic search of studies published between August 1980 and 2013. We consulted floristic and/or taxonomic works such as book

chapters or national and international scientific articles (Table 1). We incorporated many additional species from the author's own field collections to the checklist. Some taxa recorded in the field were identified to the taxonomic level of variety by the specialist author.

The species were collected by authors for over seven years (1994-2001) of field research, in sub-basins of the River Amazonas, Tapajós and Xingu of the different seasons of the hydrological cycle, and specimens are kept in the Herbarium INPA of the Instituto Nacional de Pesquisas da Amazônia, including types of various species. Samplings were performed following the method of fast sampling, similar to the asystematic sampling (Filgueiras *et al.* 1994). Accordig to Ratter *et al.* (2003), the technique is based on surveys called wide patrolling, doing at least three walks in strait line in the vegetation and listing the not yet recorded species observed at regular time intervals (5 to 15 minutes).

After compiling the checklist, we verified the species records for the Northern states, consulting the floristic collections of the system SpeciesLink (SPLink 2014) and the species list of Flora do Brasil (Lista de espécies da Flora do Brasil 2014). Afterwards, the results obtained from these data banks were compared regarding richness and species composition. We point out that some species cited in the consulted bibliography for the checklist were so far unknown for Brazil (14 species) or for the Northern region (60 species) (*sensu* Lista de espécies da Flora do Brasil 2014). The consulted sources did not mention the herbarium record number or collector number of 74 species, impairing their taxonomic checking, therefore they were disregarded.

Table 1. Consulted studies for the compilation of the checklist of aquatic macrophytes of Northern Brazil with information of the states and respective types of studied habitats. Legend: ([1-15]) – geographic localization of the study area on the map of the Northern region (Figure 1); (*) – report which sampling area covers the whole Northern region.

References	Studied region	Type(s) of studied habitats
Junk and Furch (1980)	AM[1]/RO[2]	Rivers and anabranches
Albuquerque (1981)	North*	Rivers, floodplains, lakes, temporary lakes, oxbow lakes, permanent lakes, swamps, reservoirs
Junk and Piedade (1993)	AM[3]	Floodplains
Costa-Neto *et al.* (2003)	AP[4]	Anabranches
Piedade *et al.* (2005)	AM[5]	Rivers, floodplains, lakes, temporary lakes, oxbow, permanent lakes, swamps, reservoirs
Tavares *et al.* (2006)	AP[6]/AM[7]	Rivers
Costa-Neto *et al.* (2007)	AP[8]	Natural lakes
Trevelin *et al.* (2007)	AM[13]	Rivers
Piedade *et al.* (2010)	North*	Rivers, floodplains, lakes, temporary lakes, oxbow lakes, permanent lakes, swamps, reservoirs
Bianchini Jr. *et al.* (2010)	TO[9]	Reservoirs
Lolis and Thomaz (2011)	TO[10]	Reservoirs
Oliveira *et al.* (2011)	TO[11]	Rivers
Souza and Nunes (2011)	RO[12]	Rivers
Pinheiro and Lolis (2012)	TO[14]	Reservoirs
Pinheiro *et al.* (2012)	RR[15]	Natural lakes

The species list followed the classification of families proposed by APG III (2009) for angiosperms, by Smith *et al.* (2006) for pteridophytes, and Buck and Goffinet (2000) for bryophytes. Plant names and respective authors were verified at the data bank of Missouri Botanical Garden (Tropicos 2014), correcting synonyms and invalid names. The concept of aquatic macrophytes followed Fasset (1940): plants visible with the naked eye that occur either permanently or for several months emerse, submerged or floating in fresh water.

Species were classified regarding life forms and types of ecosystems where they were recorded (lentic, lotic or reservoirs). Life forms of macrophytes followed Irgang and Gastal (1996), based on horizontal zoning of species in the ecosystem and on water depth: amphibious – species which colonize the interface between aquatic and terrestrial habitats; epiphytes – plants rooted on organic substrates (emergent and/or floating macrophytes); emergent – plants rooted on the bottom, emerse leaves and flowers, occurring in shallow areas and close to the shore; submerged and floating – species of deep and central zones of the water body occurring under or on top of the water column, respectively.

The species were assorted into life forms following information given by the consulted articles. The species cited in articles without mentioning life forms were classified according to specific literature (Pott and Pott 2000; Moura-Junior *et al.* 2013). Some species show more than one life form, *e.g.* emergent/amphibious or emergent/epiphyte.

The types of habitats were categorized as: lotic – rivers or streams; lentic – lakes and ponds; and intermediate ones – reservoirs or ecosystems with abiotic characteristics similar to either lotic or lentic habitats (Thornton 1990; Esteves 2011). The species were categorized into habitats following information given by the consulted articles.

Analyses of data

For the objectives (i), (ii) and (iii) we used descriptive statistics. We ran cluster analyses to evaluate the floristic similarity of aquatic plants among the Northern states (gathered from Flora do Brasil and SpeciesLink) or between the Northern region and other Brazilan large wetlands. Floristic similarity was considered as percentage of species composition coincident between two environments. The

matrices of flora were submitted to analyses of similarity using Jaccard index (Magurran 2004) and ordinated by WPGMA, applying the software PRIMER pc. 6.0 (Clarke and Gorley 2006). The index of Jaccard (Sj) was utilized to compare the floristic composition of the states from different plataforms of analyzed data, as well as to evaluate the floristic similarity of macrophytes of the North with the Neotropics and other Brazilian wetlands.

$$Sj = a/(a + b + c)$$

where "a" is the number of species found in both sites A and B, "b" is the number of species in site B, but not in A, "c" is the number of species in site A, but not in B.

To test consistency of clusters we utilized the method of Monte Carlo with 1000 replicates and α = 5%, using the program RandMat version 1.0 (Manly 1997). Based on available records we calculated the percentage of species occurrence, according to Mateucci and Colma (1982).

We used the the software StimateS 9.10 (Colwell 2013) for expected richness of aquatic macrophytes of Northern Brazil and their minimum and maximum confidence intervals (95% CI), according to Flora do Brasil and SpeciesLink. The expected richness values and the CIs for each platform were calculated after the floristic matrix of the states (sampling units), that was later rarefacted to 50 samples (stabilization point for expected richness). The rarefaction curve for expected richness was elaborated after the formula established by Sanders (1968) and modified by Simberloff (1972):

$$E(S_n) = \sum_{i=1}^{S} [1 - \frac{N/N_i}{n} / \left(\frac{N}{n}\right)]$$

where E(S) is the expected number of species in a random sampling, S is the total number of recorded species, *N* os the total number of recorded individuals, *Ni* is the number of individuals of species *i*, and *n* is the standardized size of the chosen sample. To test significance of differences between the richness obtained from Flora do Brasil and SpeciesLink, we compared the CIs of these platforms.

RESULTS

Based on bibliographic search and field expeditions we identified 539 species of aquatic macrophytes for Northern Brazil, of which 48 species are endemic to Brazil, standing out 25 Podostemaceae (Table 2).

Data from Flora do Brasil and SpeciesLink evidenced that the states AM and PA had the highest species richness. The results obtained from Flora do Brasil showed respectively 410 and 434 species for AM and PA, while SpeciesLink contemplated 430 and 432 species, respectively (Table 2). The minimum richness CI considering Flora do Brasil was 558 species, and the estimated maximum according to SpeciesLink was 551 species (Figure 2). Upon the estimated CIs, we verified significant differences regarding richness between Flora do Brasil and SpeciesLink (Figure 2).

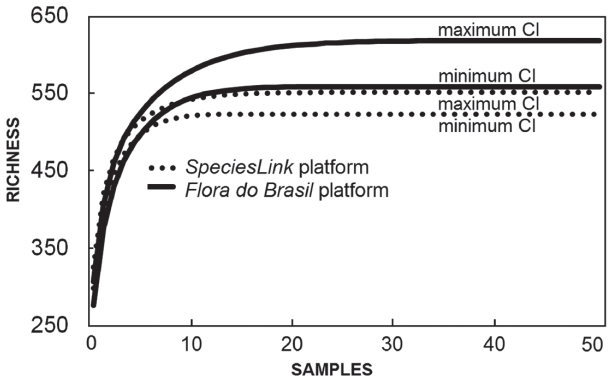

Figure 2. Rarefaction curve for expected richness of aquatic macrophytes of Northern Brazil, based on data of the platforms SpeciesLink and Flora do Brasil. Legend: (Line and dotted) - confidence interval maximum and minimum (CI 95%) of the expected richness, extrapolated for 50 sampling units.

The families which most contributed to total richness of aquatic macrophytes in Northern Brazil were Poaceae (89 species), Podostemaceae (55), Cyperaceae (50) and Fabaceae (47), that added to over 40% of the recorded species in each state (Figure 2). Other families with considerable richness of aquatic macrophytes in this region were Convolvulaceae (16), Malvaceae (16), Asteraceae (15), Polygalaceae (14), Lamiaceae (12), Onagraceae (12), Lentibulariaceae (11) and Rubiaceae (10), that altogether contributed to over 15% of the aquatic flora of the studied states (Table 2).

From the total inventoried macrophytes, 52 species (9.6%) presented records for all Northern states, independently on the platform. Among plants spread over the entire region, *Cyperus haspan* L., *C. luzulae* (L.) Retz. and *Eleocharis interstincta* (Vahl) Roem. & Schult. occurred in all habitats, what explains their presence in the whole study area (Table 2).

According to the Monte Carlo test, the states with similarity of Jaccard scores (J) >0.50 (or 50%) were considered significantly ($p < 0.05$) similar in floristic composition of aquatic macrophytes. Within this significance limit we did not observe differences regarding floristic data of SpeciesLink and Flora do Brasil, except for TO (Figure 3A). After data extraction from the platforms we observed the formation of two grades, following a latitudinal gradient: 1st - states of AP, AM, PA and RR (latitude between 4 and -9°); and 2rd - AC and RO (latitude between -6 and -12°) (Figures 1, 3A). Yet, TO did not show floristic similarity with other Northern states, independently on platform (Figures 1, 3A).

Through analysis of floristic similarity of aquatic macrophytes among the Neotropics, the Northern region and wetlands of distinct Brazilian regions, we also found a latitudinal gradient, with formation of three grades (J = 0.12): the first formed by North and Northeast; the second composed of the Pantanal wetland and the Paraná river floodplain; and the third represented by wetlands of Rio Grande do Sul (Figure 3B). However, the formation of these grades was not confirmed by the Monte Carlo test, which limit of significance was Jaccard J >0.40 (40%) (Figure 3B). The results of cluster analysis also evidenced low floristic similarity (J = 0.04) of aquatic macrophytes between Northern Brazil and the world checklist, considering that out of 539 species recorded for this region, 329 (75%) had not yet been incorporated to the checklist of the Neotropics.

The species with amphibious and/or emergent life forms were dominant in the flora of aquatic macrophytes of Northern Brazil (498 species), together representing over 90% of the species richness. The states AM and PA contemplated 13 categories of life forms each, independently on the platform (Table 2). According to the data extracted from SpeciesLink, AC, AP, RO, RR and TO exhibited 11, 12, 11, 12 and 12 life forms, respectively, while for Flora do Brasil we counted 12 (AC, AP, RR), 11 (TO) and 9 forms (RO).

Lentic habitats of Northern Brazil showed higher richness of aquatic macrophytes (517 species), more representative when compared to lotic (293 species) and transition ecosystems (38 species), the states AP, AM, PA and RR being the most influent in such results (Table 2).

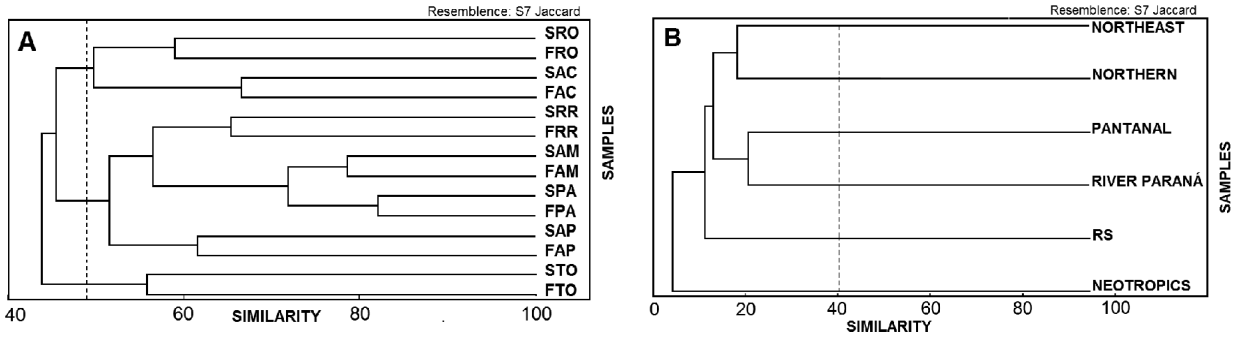

Figure 3. Floristic similarity (index of Jaccard) of aquatic macrophytes of the Northern states of Brazil (A) or of North with the Neotropics and aquatic ecosystems of distinct regions of Brazil (B), and Monte Carlo permutation test (with 1000 replications, $\alpha = 5\%$). Legends: (SAC) SpeciesLink - Acre; (SAP) SpeciesLink - Amapá; (SAM) SpeciesLink - AM; (SPA) SpeciesLink - Pará; (SRO) SpeciesLink - Rondônia; (SRR) SpeciesLink - Roraima; (STO) SpeciesLink - Tocantins; (FAC) Flora do Brasil - Acre; (FAP) Flora do Brasil - Amapá; (FAM) Flora do Brasil - Amazonas; (FPA) Flora do Brasil - Pará; (FRO) Flora do Brasil - Rondônia; (FRR) Flora do Brasil - Roraima; (FTO) Flora do Brasil – Tocantins.

Table 2. List of families, species and life forms (LF) of aquatic macrophytes in the states of Northern Brazil, with information on endemism (END), life form (LF), and type of ecosystem/habitat with record (HAB). Legend: (F) record on platform Flora do Brasil; (S) record on platform SpeciesLink; (A) Amphibious; (EM) Emergent; (FF) Free floating; (RF) Rooted floating; (RS) Rooted submersed; (FS) Free submersed; (EP) Epiphyte; (LEN) Lentic ecosystem; (TRA) Transition ecosystem; (LOT) Lotic ecosystem; (+) presence of information; (-) absence of information; (*) species not in checklist of Neotropics; (#) species recorded in the field; (a) lotic habitats; (b) reservoirs; (c) lentic habitats; (d) species recorded in three types of habitats.

Family/ Species	LF	AC		AP		AM		PA		RO		RR		TO		END	HAB
		F	S	F	S	F	S	F	S	F	S	F	S	F	S		
Acanthaceae																	
**Justicia comata* (L.) Lam.	EM	+	+	-	+	+	+	+	+	+	+	-	-	-	-	-	c
**Justicia laevilinguis* (Nees) Lindau	EM	-	-	-	-	+	+	+	+	+	+	-	-	-	-	-	c
**Justicia pectoralis* Jacq.	A	+	-	-	-	+	+	+	-	+	-	+	-	-	-	-	c
Alismataceae																	
#Echinodorus grisebachii Small	EM	-	-	+	+	+	+	+	-	+	+	-	+	-	-	-	a
Echinodorus longipetalus Micheli	EM	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-	d
Echinodorus macrophyllus (Kunth) Micheli	EM	-	-	-	+	-	-	-	-	+	+	+	+	-	-	-	a,c
Echinodorus paniculatus Micheli	EM	-	-	+	+	-	-	+	+	-	-	-	+	-	-	+	b
Echinodorus scaber Rataj	EM	-	-	-	-	+	+	+	+	-	-	-	-	-	-	-	c
Helanthium tenellum (Mart.) Britton	EM/A	-	-	-	-	-	+	+	+	+	+	+	+	-	+	-	d
Hydrocleys nymphoides (Willd.) Buchenau	RF	-	+	-	-	-	+	+	+	-	-	-	-	-	-	-	a,c

Table 2. (Continuation)

Family/ Species	LF	AC		AP		AM		PA		RO		RR		TO		END	HAB
		F	S	F	S	F	S	F	S	F	S	F	S	F	S		
Limnocharis flava (L.) Buchenau	EM/A	+	+	+	+	+	+	+	+	-	+	+	+	+	+	-	d
Sagittaria guayanensis Kunth	EM/FF	+	+	-	-	+	+	+	+	-	+	+	+	+	+	-	d
Sagittaria rhombifolia Cham.	EM	-	-	-	+	-	-	+	+	-	-	+	+	+	+	-	c
Sagittaria sprucei Micheli	EM	+	+	-	-	+	+	+	+	-	-	-	-	-	-	-	c
Amaranthaceae																	
**Alternanthera brasiliana* (L.) Kuntze	A	-	-	-	-	-	-	+	+	+	+	-	-	+	-	-	c
**Alternanthera paronychioides* A. St.-Hil.	A	-	-	-	-	+	+	+	+	-	-	-	-	-	-	-	a,c
**Alternanthera pilosa* Moq.	A	+	+	-	-	+	+	+	+	-	+	+	+	-	-	-	a,c
Alternanthera tenella Colla	A	+	+	-	-	+	+	+	+	+	+	+	+	-	-	-	c
**Amaranthus spinosus* L.	A	+	+	-	-	+	+	-	+	-	-	-	+	+	+	-	c
**Amaranthus viridis* L.	A	-	-	-	-	+	+	+	+	-	-	-	-	-	-	-	a,c
**Chamissoa altissima* (Jacq.) Kunth	A	+	+	-	-	+	+	-	+	-	+	-	+	-	-	-	c
**Chenopodium ambrosioides* L.	A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	c
Apocynaceae																	
**Allamanda nobilis* T. Moore	EM	-	-	+	-	+	+	-	+	+	-	+	+	-	-	-	c
**Mandevilla hirsuta* (A.Rich.) K. Schum.	EM	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	c
**Odontadenia nitida* (Vahl) Müll. Arg.	A	+	+	+	+	+	+	+	+	+	+	+	+	-	+	-	c
**Rhabdadenia biflora* (Jacq.) Müll. Arg.	A	-	-	+	+	-	+	+	+	-	+	-	+	-	-	-	c
**Rhabdadenia madida* (Vell.) Miers	A	-	-	+	+	+	+	+	+	-	+	-	+	-	+	-	a,c
Araceae																	
**Dracontium longipes* Engl.	A	+	+	-	-	+	+	-	-	-	-	-	-	-	-	+	c
Lemna aequinoctialis Welw.	FF	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	c
Lemna valdiviana Phil.	FF	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	c
Montrichardia arborescens (L.) Schott	A	+	+	-	+	+	+	+	+	+	+	-	+	-	-	-	a,c
Montrichardia linifera (Arruda) Schott	EM	-	-	+	+	+	+	+	+	-	-	+	+	-	-	-	c
Pistia stratiotes L.	FF	+	+	+	+	+	+	+	+	-	-	-	+	-	-	-	d
Spirodela intermedia W. Koch	FF	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-	c
Urospatha sagittifolia (Rudge) Schott	EM/A	+	+	+	+	+	+	+	+	-	+	-	-	+	+	-	b,c
**Xanthosoma striatipes* (Kunth & Bouché) Madison	EM	+	+	-	-	+	+	+	+	-	+	-	+	+	+	-	b
Arecaceae																	
**Bactris maraja* Mart.	A	+	+	-	+	+	+	+	+	+	+	+	+	-	+	-	a,c
**Mauritia flexuosa* L.f.	A	+	+	-	-	+	+	+	+	+	+	-	+	+	+	-	c
**Mauritiella armata* (Mart.) Burret	A	+	-	-	-	+	+	+	+	+	+	+	+	+	+	-	c
Asteraceae																	
**Ambrosia artemisiaefolia* L.	A	+	+	+	+	+	+	+	+	+	+	-	-	-	-	-	c
**Conyza bonariensis* (L.) Cronquist	A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	c
**Conyza sumatrensis* (Retz.) E.Walker	A	-	-	-	-	-	+	-	-	+	+	-	-	-	-	-	c
#*Eclipta prostrata* (L.) L.	EM	+	+	-	-	-	+	-	-	-	-	-	-	-	-	-	d
**Egletes viscosa* (L.) Less.	EM/A	+	+	-	-	+	+	+	+	+	+	-	-	+	+	-	a,c
**Emilia sonchifolia* (L.) DC. ex Wight	A	-	-	-	+	+	+	+	+	-	+	-	+	-	+	-	c
**Erechtites hieracifolius* (L.) Raf. ex DC.	A	+	+	-	-	+	+	+	+	-	+	-	-	-	+	-	c
Gymnocoronis spilanthoides DC.	A	-	-	-	-	-	+	+	+	-	-	-	-	-	-	-	c
**Mikania congesta* DC.	A	-	-	-	+	+	+	+	+	+	+	+	+	-	-	-	c
**Mikania cordifolia* (L. f.) Willd.	A	-	+	-	+	+	+	-	+	-	+	-	+	-	+	-	c
Pacourina edulis Aubl.	A	+	-	+	+	+	+	+	+	-	-	-	-	-	-	-	c
**Sphagneticola trilobata* (L.) Pruski	A	+	+	+	+	+	+	+	+	+	+	+	-	+	-	-	c

Table 2. (Continuation)

Family/ Species	LF	AC		AP		AM		PA		RO		RR		TO		END	HAB
		F	S	F	S	F	S	F	S	F	S	F	S	F	S		
**Tilesia baccata* (L.f.) Pruski	A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	c
**Trichospira verticillata* (L.) S.F.Blake	A	-	-	+	-	+	+	+	+	-	-	+	+	-	-	-	c
**Wedelia calycina* Rich.	A	+	-	-	-	+	-	+	+	+	-	+	-	-	-	-	c
Bignoniaceae																	
**Pleonotoma clematis* (Kunth) Miers	A	+	-	+	+	+	+	+	+	+	+	+	+	-	-	-	c
**Tanaecium pyramidatum* (Rich.) L.G.Lohmann	A	+	+	+	+	+	+	+	+	+	-	+	+	+	-	-	c
#Tynanthus polyanthus (Bureau) Sandwith	A	+	+	-	-	+	+	+	+	+	+	-	-	-	-	-	c
Blechnaceae																	
**Blechnum serrulatum* Rich.	EM/A	-	-	+	+	+	+	+	+	+	+	+	+	-	+	-	c
Boraginaceae																	
**Cordia tetrandra* Aubl.	A	+	+	+	+	+	+	+	+	+	+	+	+	+	-	-	c
#Euploca procumbens (Mill.) Diane & Hilger	A	+	+	-	-	-	+	+	+	+	+	+	-	+	-	-	c
Heliotropium indicum L.	A	+	+	+	+	+	+	-	+	+	+	-	+	-	+	-	a,c
Cabombaceae																	
Cabomba aquatica Aubl.	RS	-	-	+	-	+	+	+	+	-	-	+	+	-	-	-	a,c
Cabomba furcata Schult. & Schult. f.	RS	-	-	-	-	+	+	+	+	-	-	+	+	-	+	-	d
Cannaceae																	
Canna glauca L.	EM	-	-	-	-	-	+	+	+	-	-	+	+	-	+	-	c
Cleomaceae																	
**Tarenaya spinosa* (Jacq.) Raf.	A	+	-	-	-	+	-	+	+	+	-	+	+	+	-	-	a,c
Commelinaceae																	
**Aneilema umbrosum* (Vahl) Kunth	A	+	-	-	-	+	+	+	+	-	-	-	-	-	-	-	c
**Commelina erecta* L.	A	-	-	-	-	+	+	+	+	+	+	-	-	+	+	-	a,c
**Dichorisandra hexandra* (Aubl.) Kuntze ex Hand.-Mazz.	A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	c
Convolvulaceae																	
**Aniseia martinicensis*(Jacq.) Choisy	A/EP	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	a,c
**Evolvulus nummularius* (L.) L.	A	-	-	+	+	+	+	+	+	-	-	-	-	+	+	-	c
**Ipomoea alba* L.	A	+	+	+	+	+	+	+	+	+	+	+	-	+	+	-	c
Ipomoea aquatica Forssk.	A	-	-	-	-	+	+	+	-	-	-	-	-	-	-	-	c
Ipomoea asarifolia (Desr.) Roem. & Schult.	EM/A	+	+	+	+	+	+	+	+	+	+	+	+	-	+	-	a,c
#Ipomoea batatas (L.) Poir.	A/EP	+	-	+	+	+	+	+	+	-	-	+	+	+	-	-	c
Ipomoea carnea Jacq.	EM/A	+	+	+	-	+	+	+	+	-	+	+	-	+	+	-	a,c
**Ipomoea cynanchifolia* Meisn.	A	-	-	-	-	+	+	+	+	+	-	+	-	-	-	-	c
#Ipomoea philomega (Vell.) House	A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	c
**Ipomoea quamoclit* L.	A	+	+	-	-	+	+	+	+	+	+	-	-	-	+	-	c
**Ipomoea setifera* Poir.	A	-	+	-	+	+	+	+	+	-	-	-	+	+	+	-	c
**Ipomoea squamosa* Choisy	A	-	-	+	+	+	+	+	+	+	+	+	+	+	+	-	c
#Iseia luxurians (Moric.) O'Donell	A	-	+	-	+	+	+	+	-	+	+	+	+	-	-	-	c
**Merremia umbellata* (L.) Hallier f.	A	+	+	-	+	+	+	+	+	+	+	+	+	+	+	-	c
**Operculina hamiltonii* (G.Don) D.F.Austin & Staples	A	+	+	+	-	+	+	+	+	+	+	+	-	+	+	-	c
**Tetralocularia pennellii* O'Donell	A	+	-	-	-	+	+	+	+	-	-	-	-	-	-	-	c
Costaceae																	
**Costus arabicus* L.	A	+	+	+	+	+	+	+	+	+	+	+	+	-	+	-	c
Cucurbitaceae																	
**Elaterium amazonicum* Mart.	EM/A	-	-	-	+	+	-	+	+	-	-	-	-	-	-	-	c
**Gurania bignoniacea* (Poepp. & Endl.) C.Jeffrey	A	+	+	+	+	+	+	+	+	+	+	+	+	-	-	-	c

Table 2. (Continuation)

Family/ Species	LF	AC		AP		AM		PA		RO		RR		TO		END	HAB
		F	S	F	S	F	S	F	S	F	S	F	S	F	S		
**Gurania tricuspidata* Cogn.	A	-	-	-	-	+	+	-	-	+	+	-	-	-	-	-	c
**Luffa operculata* (L.) Cogn.	A	-	-	-	-	+	+	-	+	-	-	-	-	-	-	-	c
**Momordica charantia* L.	A	+	+	+	+	-	+	-	+	-	+	-	+	+	+	-	c
Cyperaceae																	
**Abildgaardia ovata* (Burm. f.) Kral	A	+	-	-	-	+	-	+	+	+	-	+	+	-	-	-	c
**Becquerelia cymosa* Brongn.	A	+	+	+	-	+	+	+	+	+	+	+	+	+	-	-	c
**Bulbostylis capillaris* (L.) C.B. Clarke	A	+	-	+	+	+	+	+	+	+	-	+	+	+	-	-	c
**Bulbostylis juncoides* (Vahl) Kük.	A	+	-	+	-	+	+	+	+	+	-	+	-	+	+	-	c
**Bulbostylis truncata* (Nees) M.T. Strong	A	-	-	+	-	+	+	+	+	-	-	+	-	+	+	-	c
Cyperus aggregatus (Willd.) Endl.	A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	a,c
Cyperus articulatus L.	A	-	-	-	+	+	+	+	+	-	-	-	-	-	-	+	a,c
Cyperus chalaranthus J.Presl & C.Presl	A	+	+	-	-	-	+	-	-	-	-	-	-	-	+	-	c
**Cyperus compressus* L.	A	+	-	+	+	+	+	+	+	+	-	+	+	+	+	-	a,c
Cyperus distans L.	A	+	-	+	+	+	+	+	+	+	-	+	+	+	-	-	a,c
**Cyperus esculentus* L.	A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	a,c
Cyperus giganteus Vahl	A	+	-	+	+	+	+	+	+	+	+	+	+	+	+	-	a,b
**Cyperus haspan* L.	A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	d
Cyperus ligularis L.	A	-	+	+	+	+	+	+	+	-	-	+	+	+	-	-	c
Cyperus luzulae (L.) Retz.	A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	d
Cyperus odoratus L.	A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	a,c
**Cyperus rigens* C.Presl	A	-	-	-	-	-	+	-	+	-	-	-	-	+	-	-	a,c
**Cyperus rotundus* L.	A	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+	c
Cyperus surinamensis Rottb.	EM/A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	b
#Eleocharis capillacea Kunth	EM/A	-	-	-	-	-	+	-	-	-	+	-	+	-	+	-	c
Eleocharis filiculmis Kunth	EM/A	-	+	+	+	+	+	-	+	-	+	-	+	+	+	-	b
**Eleocharis geniculata* (L.) Roem. & Schult.	EM/A	-	-	-	+	-	+	+	+	-	-	+	-	+	+	-	c
Eleocharis interstincta (Vahl) Roem. & Schult.	EM	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	d
Eleocharis minima Kunth	EM/A	-	-	+	+	+	+	+	+	-	-	+	+	+	+	-	d
Eleocharis mutata (L.) Roem. & Schult.	EM/A	-	-	-	+	-	+	+	+	-	-	-	+	-	+	-	c
#Eleocharis nana Kunth	EM/A	-	-	-	-	-	+	-	+	-	-	-	+	-	+	-	c
#Eleocharis retroflexa (Poir.) Urb.	EM/A	-	-	+	+	-	+	+	+	-	-	-	-	-	-	-	c
Eleocharis sellowiana Kunth	EM/A	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-	d
#Fimbristylis aestivalis (Retz.) Vahl	EM/A	-	-	-	-	+	+	+	+	-	-	+	+	+	-	-	c
**Fimbristylis cymosa* R. Br.	A	-	-	+	-	-	+	+	+	-	-	-	-	-	-	-	c
Fimbristylis dichotoma (L.) Vahl	EM/A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	c
**Fimbristylis miliacea* (L.) Vahl	EM/A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	c
Fimbristylis spadicea (L.) Vahl	EM/A	-	-	+	+	+	+	+	+	+	-	+	-	+	-	-	c
Fuirena umbellata Rottb.	EM/A	-	+	+	-	+	+	+	+	-	+	+	+	+	+	-	b,c
**Kyllinga odorata* Vahl	A	+	-	+	+	+	+	+	+	+	+	+	+	+	+	-	c
Lipocarpha humboldtiana Nees	A	+	-	+	-	+	-	+	-	+	-	+	+	+	+	-	c
**Lipocarpha salzmanniana* Steud.	A	-	-	-	-	+	-	+	-	-	-	+	+	+	-	-	c
Oxycaryum cubense (Poepp. & Kunth) Lye	EM/EP	+	+	+	+	+	+	+	+	+	-	+	+	+	+	-	d
**Pycreus polystachyos* (Rottb.) P. Beauv.	EM/A	-	-	-	-	+	+	+	+	+	-	+	+	+	-	-	a,c
**Rhynchospora barbata* (Vahl) Kunth	EM	-	+	+	+	+	+	+	+	+	+	+	+	+	+	-	c
Rhynchospora corymbosa (L.) Britton	EM	-	-	-	-	-	+	-	+	-	+	-	-	-	+	+	d
**Rhynchospora emaciata* (Nees) Boeckeler	EM	+	-	+	-	+	+	+	+	+	-	+	+	+	+	-	a,c

Table 2. (Continuation)

Family/ Species	LF	AC		AP		AM		PA		RO		RR		TO		END	HAB
		F	S	F	S	F	S	F	S	F	S	F	S	F	S		
**Rhynchospora globosa* (Kunth) Roem & Schult.	EM/A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	a,c
Rhynchospora holoschoenoides (Rich.) Herter	EM/A	+	-	+	+	+	+	+	+	+	+	+	+	+	+	-	a,c
**Rhynchospora nervosa* (Vahl) Boeckeler	EM	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	c
**Rhynchospora schomburgkiana* (Boeckeler) T. Koyama	EM	+	-	+	-	+	+	+	-	+	+	+	-	+	-	-	c
**Rhynchospora subplumosa* C.B. Clarke	EM	+	-	+	-	+	-	+	+	+	-	+	+	+	+	-	c
Rhynchospora velutina (Kunth) Boeckeler	EM	+	-	+	+	+	+	+	-	+	-	+	+	+	+	-	c
**Scleria microcarpa* Nees ex Kunth	A	+	+	+	+	+	+	+	+	+	-	+	+	+	+	-	c
**Scleria secans* (L.) Urb.	EM	+	-	+	+	+	+	+	+	+	-	+	+	+	+	-	c
Dioscoreaceae																	
**Dioscorea marginata* Griseb.	A	-	-	-	+	+	+	+	+	-	+	-	-	+	+	-	c
Eriocaulaceae																	
Eriocaulon humboldtii Kunth	A	-	-	+	+	+	-	-	-	-	-	+	+	+	+	-	a
#Paepalanthus bifidus (Schrad.) Kunth	A	-	-	-	-	-	+	+	+	+	-	+	-	-	-	-	c
#Paepalanthus lamarckii Kunth	A	+	+	+	+	-	+	+	+	-	+	-	+	+	+	-	c
**Syngonanthus anomalus* Ruhland	EM/RS	-	-	+	-	+	+	+	+	-	-	+	+	-	-	-	c
**Syngonanthus caulescens* (Poir.) Ruhland	EM	-	+	-	+	+	+	+	+	-	+	+	+	+	+	-	c
#Syngonanthus gracilis (Bong.) Ruhland	EM	-	-	-	-	+	+	+	+	+	+	+	+	-	+	-	c
#Syngonanthus oblongus (Körn.) Ruhland	EM	-	-	-	-	+	+	+	+	-	-	-	-	-	+	-	c
Tonina fluviatilis Aubl.	RS	+	+	-	+	-	+	-	+	-	+	-	+	-	+	-	c
Euphorbiaceae																	
**Acalypha arvensis* Poepp.	A	+	+	-	-	-	+	+	+	+	+	-	-	-	+	-	c
**Acalypha poiretii* Spreng.	A	-	-	-	-	-	+	+	+	-	-	-	-	-	-	-	a,c
**Astraea lobata* (L.) Klotzsch	A	+	-	+	+	+	+	+	+	+	+	+	+	+	+	-	a,c
Caperonia castaneifolia (L.) A. St.-Hil.	A	-	-	+	-	+	+	+	+	+	-	+	+	+	+	-	c
Croton trinitatis Millsp.	A	+	+	+	+	+	+	+	+	+	+	-	+	+	+	-	c
**Dalechampia scandens* L.	A	-	+	-	-	+	+	+	+	+	-	-	+	-	-	-	c
**Dalechampia tiliifolia* Lam.	A	+	+	+	+	-	+	+	+	+	+	+	+	-	+	-	c
**Euphorbia hyssopifolia* L.	A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	c
**Euphorbia hirta* L.	A	+	+	-	+	+	+	+	+	+	+	+	-	+	+	-	c
**Euphorbia thymifolia* L.	A	-	-	+	-	+	+	+	+	-	-	-	+	-	-	-	c
Fabaceae																	
Aeschynomene americana L.	A	+	+	-	-	+	+	+	+	+	+	+	-	+	+	-	a,c
Aeschynomene fluminensis Vell.	A	+	-	-	+	-	-	+	+	+	-	+	+	+	+	-	a,c
Aeschynomene paniculata Willd. ex Vogel	A	+	-	+	+	+	+	+	+	+	+	+	+	+	+	-	a,c
Aeschynomene rudis Benth.	A	-	-	+	+	+	+	+	+	-	-	-	+	-	-	-	a,c
Aeschynomene sensitiva Sw.	A	-	+	-	+	+	+	+	+	+	+	+	+	-	+	-	c
**Calopogonium mucunoides* Desv.	A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	c
**Centrosema brasilianum* (L.) Benth.	A	-	-	-	-	+	-	+	-	-	-	+	-	-	-	-	c
**Chamaecrista calycioides* (DC. ex Collad.) Greene	A	-	-	-	-	+	-	+	+	-	-	+	+	-	-	-	c
**Chamaecrista diphylla* (L.) Greene	A	-	+	+	+	+	+	+	+	+	+	+	+	+	+	-	c
**Chamaecrista hispidula* (Vahl) H.S.Irwin & Barneby	A	-	-	-	+	+	+	+	+	-	-	+	+	-	-	-	c
Chamaecrista nictitans (L.) Moench	A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	c
**Clitoria falcata* Lam.	A/EP	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	c
**Clitoria guianensis* (Aubl.) Benth.	A/EP	-	-	+	+	+	+	+	+	-	-	+	+	+	+	-	c
**Clitoria laurifolia* Poir.	A/EP	-	+	-	+	+	+	+	+	-	-	+	+	-	-	-	c
**Crotalaria micans* Link	A	+	+	+	+	+	+	+	+	-	+	+	+	-	+	-	c

Table 2. (Continuation)

Family/ Species	LF	AC		AP		AM		PA		RO		RR		TO		END	HAB
		F	S	F	S	F	S	F	S	F	S	F	S	F	S		
**Crotalaria nitens* Kunth	A	-	-	-	-	+	+	+	+	-	-	-	-	-	+	-	c
**Crotalaria pallida* Aiton	A	+	+	-	+	+	+	+	+	-	+	+	+	-	+	-	c
**Crotalaria pilosa* Mill.	A	-	-	+	+	-	-	+	+	-	-	+	+	+	+	-	c
**Crotalaria sagittalis* L.	A	-	-	-	-	+	+	-	-	+	-	+	+	-	-	-	c
**Cymbosema roseum* Benth.	A	+	+	+	+	+	+	+	+	-	-	+	+	-	-	-	c
**Desmodium barbatum* (L.) Benth.	A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	c
**Dioclea guianensis* Benth.	A	+	+	+	+	+	+	+	+	-	+	+	+	-	+	-	c
**Eriosema simplicifolium* (DC.) G. Don	A	-	-	+	+	+	+	+	+	-	-	+	+	+	+	-	c
**Indigofera lespedezioides* Kunth	A	-	-	-	-	+	+	+	+	+	+	+	+	+	+	-	c
**Macrolobium multijugum* (DC.) Benth.	A	-	+	+	+	+	+	+	+	-	+	-	+	-	+	-	a
**Macroptilium gracile* (Poepp. ex Benth.) Urb.	A	-	-	+	-	+	+	+	+	-	-	+	+	-	-	+	c
**Mimosa debilis* Humb. & Bonpl. ex Willd.	A	-	-	-	-	+	+	+	+	+	+	+	+	+	+	-	a,c
**Mimosa dormiens* Humb. & Bonpl. ex Willd.	A	-	-	-	-	+	+	+	+	-	-	-	-	-	-	-	a,c
**Mimosa invisa* Mart. ex Colla	A	+	-	-	-	+	+	-	-	-	-	+	+	-	-	-	a,c
**Mimosa pellita* Humb. & Bonpl. ex Willd.	A	+	-	+	+	+	+	+	+	+	+	+	+	+	+	-	a,c
**Mimosa pigra* L.	A	+	+	-	+	+	+	-	+	-	+	-	+	-	+	-	a,c
**Mimosa pudica* L.	A	-	+	-	+	+	+	+	+	+	+	+	+	-	-	-	a,c
Mimosa setosa Benth.	A	+	+	-	-	-	-	-	+	-	+	-	+	-	+	-	a,c
Neptunia oleracea Lour.	A	-	-	-	-	+	+	+	+	-	-	-	-	-	-	-	a,c
**Neptunia plena* (L.) Benth.	A	+	-	-	-	+	+	+	+	-	-	-	-	-	-	-	a,c
**Rhynchosia minima* (L.) DC.	A	-	+	-	-	+	+	+	+	-	-	-	+	-	+	-	c
Senna obtusifolia (L.) H.S.Irwin & Barneby	A	+	+	-	-	+	+	+	+	+	+	+	+	+	+	-	c
**Senna occidentalis* (L.) Link	A	+	+	+	+	+	+	+	+	+	+	+	+	+	-	-	c
**Senna reticulata* (Willd.) H.S. Irwin & Barneby	A	+	+	+	+	+	+	+	+	+	+	-	+	-	+	-	c
**Sesbania exasperata* Kunth	A	+	+	+	+	+	+	+	+	-	+	+	+	-	+	-	c
**Stylosanthes guianensis* (Aubl.) Sw.	A	-	-	-	+	+	+	+	+	-	+	+	+	+	+	-	c
**Teramnus volubilis* Sw.	A	-	-	-	-	+	+	+	+	-	-	-	-	-	-	-	c
**Vigna juruana* (Harms) Verdc.	A	-	-	-	-	-	+	+	+	-	-	-	+	-	-	-	c
Vigna lasiocarpa (Mart.ex Benth.) Verdc.	A	-	-	+	-	+	+	+	+	-	+	+	+	-	-	-	c
**Vigna longifolia* (Benth.) Verdc.	A	-	-	-	-	+	+	+	+	-	+	-	-	-	+	-	c
**Zornia guanipensis* Pittier	A	-	-	-	+	-	-	+	+	-	-	-	+	-	-	-	c
**Zornia latifolia* Sm.	A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	a,c
Gentianaceae																	
**Coutoubea ramosa* Aubl.	A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	a,c
**Coutoubea spicata* Aubl.	A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	c
**Schultesia benthamiana* Klotzsch	A	-	-	-	-	+	+	+	+	-	-	+	+	-	+	-	c
**Schultesia brachyptera* Cham.	A	-	-	+	-	+	+	+	+	+	+	+	+	+	+	-	c
**Schultesia guianensis* (Aubl.) Malme	A	+	+	-	-	+	+	+	+	-	-	+	+	-	+	-	c
Gesneriaceae																	
#*Drymonia coccinea* (Aubl.) Wiehler	A	+	+	+	+	+	+	+	+	+	+	+	+	-	-	-	c
Haemodoraceae																	
Schiekia orinocensis (Kunth) Meisn.	A	-	-	-	-	+	+	+	+	+	+	+	+	+	+	-	a,c
Heliconiaceae																	
**Heliconia marginata* (Griggs) Pittier	EM/A	+	+	-	+	-	+	-	+	-	-	-	+	-	+	-	a,c
**Heliconia psittacorum* L. f.	EM/A	-	+	+	+	+	+	+	+	+	+	+	+	+	+	-	c
Hydrocharitaceae																	

Table 2. (Continuation)

Family/ Species	LF	AC		AP		AM		PA		RO		RR		TO		END	HAB
		F	S	F	S	F	S	F	S	F	S	F	S	F	S		
**Apalanthe granatensis* (Bonpl.) Planch.	RS	-	-	-	-	+	-	+	+	-	-	+	+	+	-	-	b,c
Najas guadalupensis (Spreng.) Magnus	RS	-	-	+	-	+	-	-	-	-	-	-	-	-	-	-	a,b
**Najas microcarpa* (A. Braun) Bolle ex Christ	RS	-	-	-	-	+	-	-	-	-	-	-	-	+	+	-	a,b
Hydroleaceae																	
Hydrolea elatior Schott	A	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	c
Hydrolea spinosa L.	A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	c
Hypericaceae																	
**Vismia cayennensis* (Jacq.) Pers.	A	+	+	+	+	+	+	+	+	-	+	+	+	-	-	-	a,c
Hypoxidaceae																	
**Curculigo scorzonerifolia* (Lam.) Baker	A	-	-	-	+	+	-	+	+	+	+	+	+	-	+	-	c
Iridaceae																	
**Cipura paludosa* Aubl.	A	+	+	+	+	+	+	+	+	-	+	+	+	-	+	-	c
Lamiaceae																	
**Hyptis atrorubens* Poit.	A	+	+	+	+	+	+	+	+	-	+	+	+	+	+	-	c
**Hyptis brevipes* Poit.	A	+	+	-	+	+	+	+	+	+	+	-	+	-	+	-	a,c
**Hyptis dilatata* Benth.	A	-	-	+	-	+	-	+	-	+	+	+	+	-	+	-	a,c
**Hyptis lantaniifolia* Poit.	A	-	-	-	+	-	+	-	+	-	-	-	+	-	-	-	a,c
**Hyptis lorentziana* O. Hoffm.	A	-	+	+	-	+	+	+	+	+	+	-	-	-	-	-	a,c
**Hyptis mutabilis* (Rich.) Briq.	A	+	+	+	+	+	+	+	+	-	+	-	-	+	-	-	a,c
**Hyptis parkeri* Benth.	A	-	-	+	-	+	+	+	+	+	+	+	+	-	-	-	c
**Hyptis recurvata* Poit.	A	+	+	+	+	+	+	+	+	-	-	+	+	-	+	-	a,c
**Hyptis spicigera* Lam.	A	-	-	-	-	-	+	-	+	-	+	-	+	-	+	-	c
**Marsypianthes chamaedrys* (Vahl) Kuntze	A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	a,c
**Ocimum campechianum* Mill.	A	+	+	-	-	+	+	+	+	-	-	+	+	-	-	-	c
**Vitex cymosa* Bertero ex Spreng.	A	-	+	-	-	+	+	+	+	+	+	-	-	-	+	-	c
Lauraceae																	
**Cassytha filiformis* L.	A	-	-	-	+	+	+	+	+	+	+	+	+	+	+	-	c
Lentibulariaceae																	
Utricularia breviscapa C. Wright ex Griseb.	FS	+	-	-	+	+	+	+	+	-	-	+	+	+	+	-	d
**Utricularia erectiflora* A. St.-Hil. & Girard	A	-	-	-	-	-	-	-	-	-	-	+	+	-	+	-	a,c
**Utricularia fimbriata* Kunth	FS	-	+	-	+	+	+	+	+	-	-	+	+	-	+	-	a,c
Utricularia foliosa L.	FS	-	+	+	+	+	+	+	+	-	-	+	+	-	-	-	d
Utricularia gibba L.	FS	-	+	-	+	+	+	+	+	-	-	-	+	-	-	-	d
**Utricularia guyanensis* A. DC.	FS	-	-	-	-	-	-	+	-	-	-	-	+	+	-	-	a,c
**Utricularia myriocista* A. St.-Hil. & Girard	FS	-	-	+	+	+	+	+	+	-	-	+	+	-	-	-	c
**Utricularia pusilla* Vahl	A	-	+	-	-	+	+	+	+	-	-	+	+	-	+	-	c
**Utricularia simulans* Pilg.	EM/A	-	-	-	-	+	+	+	+	-	-	+	+	-	+	-	c
**Utricularia subulata* L.	EM/A	-	-	+	+	+	+	+	+	-	+	+	+	+	+	-	c
**Utricularia triloba* Benj.	EM/A	-	-	+	+	+	+	+	+	-	-	+	+	+	-	-	a,c
Linderniaceae																	
Lindernia crustacea (L.) F. Muell.	A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	a,c
Lindernia diffusa (L.) Wettst.	A	+	+	-	-	+	+	+	+	-	+	+	+	-	-	-	a,c
#Torenia thouarsii (Cham. & Schltdl.) Kuntze	A	+	+	-	-	+	+	+	-	+	+	-	-	-	-	-	c
Loganiaceae																	
**Spigelia anthelmia* L.	A	+	-	-	+	+	+	+	+	+	+	+	+	+	+	-	c
Lythraceae																	

Table 2. (Continuation)

Family/ Species	LF	AC		AP		AM		PA		RO		RR		TO		END	HAB
		F	S	F	S	F	S	F	S	F	S	F	S	F	S		
Cuphea antisyphilitica Kunth	A	-	-	+	+	+	+	+	+	+	+	+	+	+	+	-	a,c
Cuphea melvilla Lindl.	A	+	+	+	+	+	+	+	+	+	+	-	+	+	+	-	a,c
Malvaceae																	
**Byttneria genistella* Triana & Planch.	A	+	+	+	+	+	+	+	+	+	+	-	+	-	+	-	c
**Byttneria scabra* L.	A	+	-	+	+	-	+	+	+	-	-	-	+	-	-	-	c
**Helicteres guazumifolia* Kunth	A	-	+	-	-	-	+	-	-	+	+	+	+	-	+	-	c
**Hibiscus bifurcatus* Cav.	A	+	+	+	+	-	-	+	+	-	+	-	+	-	-	-	c
**Hibiscus dimidiatus* Schrank	A	-	-	-	-	-	+	+	+	-	-	-	-	-	-	-	a,c
**Hibiscus furcellatus* Ders.	A	-	-	+	+	+	+	+	+	+	-	-	+	+	-	-	c
**Hibiscus sororius* L.	A	+	+	-	-	+	+	-	+	-	-	-	-	-	+	-	c
**Melochia arenosa* Benth.	A	+	-	+	-	+	+	+	+	-	+	-	+	-	+	-	a,c
**Melochia graminifolia* A. St.-Hil.	A	+	-	-	-	+	-	+	-	+	+	-	+	+	+	-	a,c
Melochia spicata (L.) Fryxell	A	-	-	-	-	-	+	-	-	-	+	-	+	-	+	-	a,c
**Pavonia angustifolia* Benth.	A	-	-	-	-	-	-	-	-	-	-	+	+	-	+	-	c
**Pavonia grandiflora* A. St.-Hil.	A	-	-	-	-	-	+	-	-	-	-	+	+	-	+	+	c
**Sida acuta* Burm. f.	A	-	+	-	-	-	+	+	+	-	+	-	+	+	+	-	c
**Sida rhombifolia* L.	A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	c
**Sida setosa* Mart.	A	-	+	-	+	+	+	+	+	-	-	-	+	-	-	-	c
**Urena lobata* L.	A	+	+	-	+	+	+	+	+	-	+	-	+	+	+	-	c
Marantaceae																	
**Calathea capitata* (Ruiz & Pav.) Lindl.	A	+	+	-	+	+	+	-	+	-	+	-	-	-	+	-	c
**Calathea comosa* (L. f.) Lindl.	A	+	+	-	-	+	+	-	+	-	-	-	-	-	-	-	c
**Calathea lanata* Petersen	A	+	+	-	+	+	+	-	+	-	-	-	-	-	-	-	c
**Calathea loeseneri* J.F. Macbr.	A	+	+	-	-	+	+	-	+	-	-	-	-	-	-	-	c
**Calathea micans* (L. Mathieu) Körn.	A	+	+	+	+	+	+	-	+	+	+	-	+	-	-	-	c
**Ischnosiphon polyphyllus* (Poepp. & Endl.) Körn.	A	-	-	-	-	+	+	+	+	-	-	-	-	-	-	-	c
Thalia geniculata L.	A	+	+	+	+	+	+	+	+	-	+	-	+	-	+	-	c
Marsileaceae																	
Marsilea crotophora D.M. Johnson	RF	-	-	-	-	+	+	-	+	-	-	-	-	-	-	-	a,c
Marsilea polycarpa Hook. & Grev.	FF	-	+	-	-	-	+	+	+	-	-	+	-	-	-	-	a,c
Mayacaceae																	
Mayaca fluviatilis Aubl.	RS	+	+	+	+	+	+	-	+	+	+	-	-	-	-	-	a
**Mayaca kunthii* Seub.	RS	-	-	-	-	+	-	+	-	-	+	-	-	-	-	-	a,c
Mayaca longipes Mart. ex Seub.	RS	-	-	+	+	+	+	+	+	-	-	-	-	-	-	-	a,c
Melastomataceae																	
**Aciotis acuminifolia* (Mart. ex DC.) Triana	A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	c
#*Aciotis ornata* (Miq.) Gleason	A	-	-	+	-	+	+	+	-	-	-	+	-	-	-	-	c
**Acisanthera limnobios* (DC.) Triana	A	-	-	-	-	-	-	+	+	-	+	+	+	+	+	-	a,c
**Clidemia capitellata* (Bonpl.) D. Don	A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	c
**Comolia villosa* (Aubl.) Triana	A	-	-	+	+	+	+	+	+	+	+	+	+	-	-	-	c
**Rhynchanthera grandiflora* (Aubl.) DC.	A	-	+	+	+	+	+	+	+	+	+	+	+	-	-	-	a,c
**Rhynchanthera serrulata* (L.C.Rich.) DC.	A	-	+	-	+	+	-	+	+	-	-	+	+	-	+	-	a,c
**Tibouchina aspera* Aubl.	A	+	+	+	+	+	+	+	+	+	+	-	+	-	-	-	c
**Tibouchina gracilis* (Bonpl.) Cogn.	A	-	-	-	-	-	-	-	+	-	-	-	+	+	+	-	c
Menispermaceae																	
**Cissampelos andromorpha* DC.	A/EP	+	+	-	-	+	+	+	+	+	+	+	+	+	+	-	a

Table 2. (Continuation)

Family/ Species	LF	AC		AP		AM		PA		RO		RR		TO		END	HAB
		F	S	F	S	F	S	F	S	F	S	F	S	F	S		
**Cissampelos glaberrima* A. St.-Hil.	A/EP	+	+	-	-	-	+	-	-	-	-	-	+	-	+	-	a,c
**Odontocarya arifolia* Barneby	A	-	-	-	-	+	+	-	-	-	+	-	-	-	-	-	a,c
**Odontocarya tamoides* (DC.) Miers	A	-	+	-	-	-	+	-	+	-	-	-	+	+	+	-	a,c
Menyanthaceae																	
Nymphoides indica (L.) Kuntze	RF	-	-	+	+	+	+	+	+	+	-	+	+	+	+	-	d
Molluginaceae																	
**Mollugo verticillata* L.	EM	-	-	-	+	+	+	+	+	-	+	-	+	-	+	-	c
Myrtaceae																	
**Psidium acutangulum* DC.	A	+	+	-	+	+	+	+	+	+	+	+	-	+	+	-	c
Nymphaeaceae																	
Nymphaea gardneriana Planch.	RF	+	+	-	-	-	-	+	+	-	-	-	+	-	+	-	a,c
Nymphaea rudgeana G. Mey.	RF	-	-	+	+	+	+	+	+	-	-	-	+	-	-	-	a,c
Victoria amazonica (Poepp.) J.E. Sowerby	RF	+	+	-	-	+	+	+	+	-	-	-	-	-	-	-	a,c
Ochnaceae																	
**Sauvagesia erecta* L.	A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	c
**Sauvagesia rubiginosa* A.St.-Hil.	A	-	+	+	-	+	+	+	+	-	-	+	+	-	-	-	c
**Sauvagesia sprengelii* A. St.-Hil.	A	+	+	+	+	+	+	+	+	+	+	+	+	-	+	-	c
Onagraceae																	
**Ludwigia affinis* (DC.) H. Hara	EM	+	+	+	+	+	+	+	+	+	+	+	+	-	+	-	a,c
**Ludwigia decurrens* Walter	EM/A	+	+	+	+	+	+	+	+	+	+	-	-	-	+	-	a,c
**Ludwigia densiflora* (Micheli) H. Hara	EM/A	+	+	-	-	+	+	+	+	+	+	-	+	-	-	-	a,c
Ludwigia helminthorrhiza (Mart.) H. Hara	EM/FF	-	+	-	-	-	+	+	+	-	+	-	-	-	-	-	d
**Ludwigia hyssopifolia* (G. Don) Exell	EM/A	+	+	-	+	+	+	+	+	+	+	+	+	-	+	-	a,c
**Ludwigia leptocarpa* (Nutt.) H. Hara	EM	+	+	-	+	+	+	+	+	-	+	-	+	-	+	-	a,c
**Ludwigia nervosa* (Poir.) H. Hara	EM/A	-	-	+	+	+	+	+	+	+	+	+	+	+	+	-	a,c
Ludwigia octovalvis (Jacq.) P.H. Raven	EM/A	+	+	-	+	+	+	+	+	+	+	-	+	+	+	-	a,c
**Ludwigia rigida* (Miq.) Sandwith	EM/A	-	-	+	+	-	-	+	+	+	-	+	+	-	-	-	a,c
Ludwigia sedoides (Humb. & Bonpl.) H. Hara	FF	+	+	+	-	+	+	+	+	+	+	+	+	-	+	-	d
**Ludwigia tomentosa* (Cambess.) H. Hara	EM/A	-	-	-	-	-	-	-	+	-	-	-	-	+	+	-	a,c
**Ludwigia torulosa* (Arn.) H. Hara	EM/A	-	-	+	+	-	-	+	+	+	+	-	-	-	-	-	a,c
Orchidaceae																	
**Eulophia alta* (L.) Fawc. & Rendle	A	-	+	+	-	+	+	+	+	+	-	-	-	+	+	-	c
Orobanchaceae																	
**Buchnera palustris* (Aubl.) Spreng.	A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	c
**Buchnera rosea* Kunth	A	+	-	-	-	+	+	+	+	+	+	+	+	+	+	-	a,c
Melasma melampyroides (Rich.) Pennell	A	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	c
Oxalidaceae																	
**Oxalis barrelieri* L.	A	+	+	-	-	+	+	+	+	-	+	+	+	-	-	-	a,c
Passifloraceae																	
**Passiflora foetida* L.	EP	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	a,c
**Passiflora vespertilio* L.	A	+	+	+	+	+	+	+	+	+	+	-	+	-	-	-	a,c
**Piriqueta cistoides* (L.) Griseb.	A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	c
**Piriqueta duarteana* (A. St.-Hil., A. Juss. & Cambess.) Urb.	A	-	-	-	-	-	-	+	+	-	-	-	-	+	+	+	c
**Turnera scabra* Millsp.	A	+	+	+	-	+	+	+	-	-	-	+	+	-	-	-	c
Pedaliaceae																	
#Sesamum indicum L.	A	-	+	-	+	-	+	-	+	-	-	-	-	-	-	-	c

Table 2. (Continuation)

Family/ Species	LF	AC		AP		AM		PA		RO		RR		TO		END	HAB
		F	S	F	S	F	S	F	S	F	S	F	S	F	S		
Phyllanthaceae																	
Phyllanthus fluitans Benth. ex Müll. Arg.	FF	-	-	+	+	+	+	+	+	-	-	-	-	-	-	-	a,c
**Phyllanthus niruri* L.	EM	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	a,c
**Phyllanthus stipulatus* (Raf.) G.L.Webster	FF	+	+	-	-	+	+	+	+	+	+	+	+	-	-	-	a,c
Plantaginaceae																	
**Bacopa aquatica* Aubl.	RS	-	-	+	-	+	+	+	+	-	-	-	-	-	-	-	a,c
Bacopa arenaria Loefgr. & Edwall	EM	-	-	-	-	-	+	+	+	-	-	-	-	-	-	+	b
#*Bacopa egensis* (Poepp.) Pennell	EM	-	+	-	-	+	+	+	+	-	-	-	-	-	-	-	c
Bacopa reflexa (Benth.) Edwall	EM	+	-	+	-	+	-	+	+	-	-	+	+	-	+	-	a,c
**Bacopa serpyllifolia* (Benth.) Pennell	RS	+	-	-	-	-	+	-	-	-	-	+	+	-	-	-	a,c
**Conobea aquatica* Aubl.	EM/A	-	-	+	+	-	-	+	+	-	-	+	+	-	-	-	a,c
**Mecardonia procumbens* (Mill.) Small	A	+	+	-	+	+	+	+	-	-	-	-	-	-	-	-	a
**Scoparia dulcis* L.	A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	a,c
Poaceae																	
**Andropogon bicorni*s L.	EM/A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	a,c
**Andropogon selloanus* (Hack.) Hack.	EM/A	-	-	-	-	+	+	+	+	-	-	+	+	+	+	-	a,c
**Andropogon virgatus* Desv.	EM/A	-	-	+	+	+	+	+	+	-	-	-	+	+	+	-	a,c
**Axonopus leptostachyus* (Flüggé) Hitchc.	A	+	-	+	+	+	+	+	+	-	-	+	+	-	-	-	a,c
**Axonopus purpusii* (Mez) Chase	A	+	-	+	+	-	-	+	+	-	+	+	+	-	+	-	a,c
**Cenchrus purpureus* (Schumach.) Morrone	EM/A	-	-	+	-	+	+	-	-	-	-	-	+	-	-	-	c
**Coix lacryma-jobi* L.	A	+	+	-	-	-	+	-	+	-	+	-	-	-	-	-	a,c
**Cynodon dactylon* (L.) Pers.	A	-	-	-	-	+	+	+	+	+	-	-	-	-	-	-	a,c
**Digitaria ciliaris* (Retz.) Koeler	A	-	-	-	-	+	+	+	+	-	-	-	-	-	-	-	a,c
**Digitaria horizontalis* Willd.	A	+	+	+	+	+	+	+	+	-	-	-	-	+	+	-	a,c
**Digitaria violascens* Link	A	-	-	+	-	+	-	+	+	-	-	+	-	-	-	-	a,c
**Dinebra scabra* (Nees) P.M. Peterson & N. Snow	EM/A	-	-	-	-	+	-	+	-	+	-	-	-	-	-	-	a,c
Echinochloa colona (L.) Link	EM	-	-	+	-	+	+	+	+	+	+	-	+	-	+	-	a,c
Echinochloa crusgalli (L.) P. Beauv.	EM	-	-	-	-	+	+	+	-	-	-	+	-	+	-	-	a,c
Echinochloa crus-pavonis (Kunth) Schult.	EM	+	-	-	-	+	-	+	+	-	-	-	+	-	+	-	c
Echinochloa polystachya (Kunth) Hitchc.	EM/RF	-	+	-	-	+	+	+	+	-	-	-	-	-	-	-	a,c
**Eleusine indica* (L.) Gaertn.	A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	c
**Eragrostis acutiflora* (Kunth) Nees	A	-	-	+	+	+	-	+	+	+	-	-	-	-	-	-	a,c
**Eragrostis ciliaris* (L.) R. Br.	A	+	-	+	+	+	+	+	+	+	-	+	+	-	-	-	a,c
**Eragrostis japonica* (Thunb.) Trin.	A	-	-	+	-	+	-	+	+	+	-	+	+	-	-	-	a,c
**Eragrostis hypnoides* (Lam.) Britton, Sterns & Poggenb.	A	+	+	+	+	+	+	+	+	+	+	+	+	-	+	+	c
**Eragrostis pilosa* (L.) P. Beauv.	A	-	-	+	+	-	+	+	+	-	-	+	-	-	-	-	a,c
**Eragrostis tenella* (L.) P. Beauv. ex Roem. & Schult.	A	-	-	+	-	+	+	+	-	-	+	+	-	-	-	-	a,c
**Eriochloa distachya* Kunth	A	-	-	-	-	-	-	+	-	-	+	-	-	-	+	-	c
**Eriochrysis cayennensis* P. Beauv.	A	-	-	+	+	-	+	+	+	-	-	+	+	-	-	-	c
Gynerium sagittatum (Aubl.) P. Beauv.	A	-	-	-	-	+	+	-	+	-	+	-	+	-	-	-	a,c
**Homolepis aturensis* (Kunth) Chase	A	+	+	+	+	+	+	+	+	+	+	+	+	-	-	+	a,c
Hymenachne amplexicaulis (Rudge) Nees	EM/A	-	-	-	+	+	+	+	+	-	+	-	+	-	+	-	a,c
Hymenachne donacifolia (Raddi) Chase	EM/A	+	+	-	-	-	+	-	+	-	+	-	-	-	-	-	a,c
**Isachne polygonoides* (Lam.) Döll	EM/A	+	+	+	-	+	+	+	+	+	-	-	+	+	+	+	c
**Ischaemum guianense* Kunth ex Hack.	EM/A	-	-	+	+	-	-	-	+	+	-	-	-	-	-	-	a,c
**Lasiacis procerrima* (Hack.) Hitchc.	EM/A	-	-	-	-	+	+	-	-	-	-	+	+	-	-	-	a,c

Table 2. (Continuation)

Family/ Species	LF	AC		AP		AM		PA		RO		RR		TO		END	HAB
		F	S	F	S	F	S	F	S	F	S	F	S	F	S		
Leersia hexandra Sw.	EM/A	-	-	+	+	+	+	+	+	-	-	-	-	-	-	-	a
**Leptochloa virgata* (L.) P. Beauv.	EM/A	-	-	+	-	+	+	+	+	-	-	+	-	+	+	-	a,c
Luziola spruceana Benth. ex Döll	EM/A	+	-	+	-	+	+	+	+	-	-	-	-	-	-	-	a,c
Luziola subintegra Swallen	EM/A	-	-	+	-	-	-	+	+	-	-	+	+	-	+	-	a,c
**Megathyrsus maximus* (Jacq.) BK Simon & SWL Jacobs	EM	-	-	-	-	+	+	-	+	-	-	-	-	-	-	-	a,c
**Mesosetum loliiforme* (Hochst. ex Steud.) Chase	A	+	+	+	+	+	+	+	+	+	-	+	+	+	+	-	a,c
**Olyra ecaudata* Döll	A	+	+	-	+	+	-	+	+	-	+	-	+	-	-	-	a,c
**Olyra longifolia* Kunth	A	-	+	+	+	+	+	+	+	-	-	+	+	-	-	-	a,c
Oryza grandiglumis (Döll) Prod.	A	+	+	-	-	+	+	+	+	-	-	-	-	-	+	-	a,c
Oryza latifolia Desv.	A	-	-	+	+	+	+	+	+	-	-	-	-	-	+	-	a,c
Oryza sativa L.	A	+	-	+	-	+	-	+	+	+	-	+	-	+	+	-	a,c
**Otachyrium succisum* (Swallen) Send. & Soderstr.	A	-	+	-	-	-	-	+	+	-	-	-	+	-	-	-	a,c
**Otachyrium versicolor* (Döll) Henrard	A	+	+	-	-	+	+	+	+	-	-	-	+	-	-	-	a
**Panicum aquaticum* Poir.	EM	+	-	-	-	+	-	+	+	-	-	-	-	-	-	-	a,c
**Panicum dichotomiflorum* Michx.	EM	-	-	+	-	+	+	+	+	-	-	+	-	+	+	-	a,c
Panicum elephantipes Nees ex Trin.	EM	-	-	+	+	+	+	+	+	+	-	+	+	-	-	-	a,c
**Panicum grande* Hitchc. & Chase	EM	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-	a,c
Panicum repens L.	EM	-	-	-	-	+	-	+	-	-	-	-	-	-	-	-	a,c
Paratheria prostrata Griseb.	A	-	-	-	-	+	-	+	+	-	-	-	-	-	-	-	c
**Pariana campestris* Aubl.	A	-	-	+	+	-	+	+	+	-	+	-	+	-	+	-	a,c
**Paspalum boscianum* Flüggé	EM	+	+	+	-	+	+	+	+	+	+	+	+	+	-	-	a,c
**Paspalum conjugatum* P.J. Bergius	EM	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	a,c
**Paspalum conspersum* Schrad.	EM	-	-	-	-	-	-	+	+	-	+	-	-	-	+	-	a,c
**Paspalum coryphaeum* Trin.	EM	-	-	-	+	-	+	+	-	-	-	+	+	+	-	-	a,c
**Paspalum densum* Poir.	EM	-	-	-	-	-	-	+	+	-	-	+	+	+	+	-	a,c
**Paspalum denticulatum* Trin.	EM	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	a
Paspalum fasciculatum Willd. ex Flüggé	EM	-	+	+	-	+	+	+	+	-	+	+	-	-	-	-	a,c
**Paspalum ligulare* Nees	EM	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	a,c
**Paspalum melanospermum* Desv. ex Poir.	EM	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	a,c
**Paspalum orbiculatum* Poir.	EM	-	-	+	+	+	+	+	+	-	+	+	-	-	-	-	a,c
**Paspalum plicatulum* Michx.	EM	-	-	-	-	-	+	+	+	-	-	+	+	+	+	-	a,c
**Paspalum pulchellum* Kunth	EM	-	-	+	+	+	-	+	+	-	-	+	+	-	+	-	a,c
Paspalum repens P.J. Bergius	EM/FF	+	+	+	-	+	+	+	+	+	+	+	+	+	+	-	a,c
**Paspalum trichophyllum* Henrard	EM	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	a,c
Paspalum vaginatum Sw.	EM	-	-	-	-	-	+	+	+	-	-	-	-	-	-	-	a,c
Paspalum virgatum L.	EM	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	a,c
**Paspalum wrightii* Hitchc. & Chase	EM	-	-	-	-	-	-	+	-	+	-	-	-	+	-	-	a,c
**Raddiella esenbeckii* (Steud.) Calderón & Soderstr.	A	-	-	-	-	+	+	+	+	-	+	+	+	-	+	-	a,c
**Reimarochloa aberrans* (Döll) Chase	A	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-	a,c
**Reimarochloa acuta* (Flüggé) Hitchc.	A	-	-	-	+	+	+	+	+	-	-	-	-	+	-	-	a,c
**Reimarochloa brasiliensis* (Spreng.) Hitchc.	A	-	-	-	-	+	+	+	-	-	-	-	-	+	-	-	a,c
**Rugoloa hylaeica* (Mez) Zuloaga	EM	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	a,c
**Rugoloa pilosa* (Sw). Zuloaga	EM	+	-	+	-	+	-	+	-	+	-	+	-	+	-	-	a,c
**Rugoloa polygonata* (Schrad.) Zuloaga	EM	+	-	+	-	-	-	+	-	-	-	-	-	-	-	+	a,c
**Sacciolepis myuros* (Lam.) Chase	A	-	-	-	+	+	+	-	+	-	+	-	+	-	+	-	a,c
**Sacciolepis striata* (L.) Nash	A	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-	a,c

Table 2. (Continuation)

Family/ Species	LF	AC		AP		AM		PA		RO		RR		TO		END	HAB
		F	S	F	S	F	S	F	S	F	S	F	S	F	S		
**Setaria parviflora* (Poir.) Kerguélen	EM	+	+	+	+	+	+	+	+	-	+	+	+	+	+	-	a,c
**Sorghastrum setosum* (Griseb.) Hitchc.	EM	-	-	-	-	+	+	+	+	-	-	+	+	-	-	-	a,c
**Sorghum bicolor* subsp. *arundinaceum* (Desv.) de Wet & J.R.Harlan	EM	+	+	-	-	-	-	-	+	-	-	-	-	-	-	-	a,c
**Sporobolus virginicus* (L.) Kunth	EM	-	-	-	+	-	-	+	+	-	-	-	-	-	-	-	a,c
**Steinchisma laxum* (Sw.) Zuloaga	EM	+	+	+	+	+	+	+	+	-	-	-	-	+	+	-	c
**Stephostachys mertensii* (Roth) Zuloaga & Morrone	EM	+	-	-	-	+	-	+	-	-	-	+	-	-	-	-	a
**Trichanthecium cyanescens* (Nees ex Trin.) Zuloaga & Morrone	EM	-	-	+	-	+	+	+	-	+	+	+	+	+	-	-	a,c
Trichanthecium micranthum (Kunth) Zuloaga & Morrone	EM	+	-	-	-	+	-	+	-	+	-	+	-	-	-	-	a,c
**Trichanthecium nervosum* (Lam.) Zuloaga & Morrone	EM	-	-	+	+	+	+	+	-	+	+	+	-	-	-	-	a,c
**Trichanthecium parvifolium* (Lam.) Zuloaga & Morrone	EM	+	+	+	-	+	+	+	-	+	-	+	+	+	-	-	a,c
**Trichanthecium pyrularium* (Hitchc. & Chase) Zuloaga & Morrone	EM	-	-	+	-	+	-	+	+	+	-	-	-	-	-	-	a,c
Podostemaceae																	
#*Apinagia aripecurensis* P. Royen	EM/RS	-	-	-	-	-	-	+	-	-	-	-	-	-	-	+	a,c
#*Apinagia batrachifolia* (Mildbr.) P. Royen var. *batrachifolia*	EM/RS	-	-	+	+	+	+	-	-	-	-	-	-	-	-	+	a,c
#*Apinagia corymbosa* (Engl.) P. Royen var. *capillarifolia* (Engl.) P. Royen	EM/RS	-	-	-	-	-	-	-	-	-	-	+	-	-	+	+	a,c
#*Apinagia corymbosa* (Tul.) Engler var. *corymbosa*	EM/RS	-	-	-	-	-	-	+	-	-	-	-	-	+	+	+	a,c
#*Apinagia exlilis* (Tul.) P. Royen	EM/RS	-	-	-	-	+	-	+	-	-	-	-	-	-	-	-	a,c
#*Apinagia fimbrifolia* P. Royen	EM/RS	-	-	-	-	+	+	-	-	+	-	-	-	+	+	-	a,c
#*Apinagia guyanensis* (Pulle) P. Roeyn	EM/RS	-	-	+	+	+	+	+	+	-	-	-	-	-	-	-	a,c
#*Apinagia kockii* (Engler) P. Royen	EM/RS	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	a,c
#*Apinagia longifolia* (Tul.) P. Royen	EM/RS	-	-	-	+	-	-	+	-	-	-	-	+	-	-	-	a,c
#*Apinagia minor* P. Royen	EM/RS	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	a,c
#*Apinagia platystigma* P. Royen	EM/RS	-	-	+	-	-	+	-	-	-	-	-	-	-	-	-	a,c
#*Apinagia rangiferina* P. Royen	EM/RS	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	a,c
#*Apinagia richardiana* (Tul.) P. Royen	EM/RS	-	-	+	+	+	+	+	+	-	-	+	+	-	+	-	a,c
#*Apinagia secundiflora* (Tul.) Pulle	EM/RS	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	a,c
#*Apinagia spruceana* (Wedd.) Engler	EM/RS	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	a,c
#*Apinagia surumuensis* (Engler) P. Royen	EM/RS	-	-	-	-	-	+	-	-	-	-	+	-	-	-	-	a,c
#*Apinagia tenuifolia* P. Royen	EM/RS	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	a,c
#*Castelnavia fluitans* Tul. & Wedd.	EM/RS	-	-	-	-	-	-	+	+	-	-	-	-	+	+	-	a,c
#*Castelnavia monandra* Tul. & Wedd.	EM/RS	-	-	-	-	-	-	+	+	-	-	-	-	-	+	+	a,c
Castelnavia multipartita Tul. & Wedd.	EM/RS	-	-	-	-	-	-	+	+	-	-	-	-	-	-	+	a,c
#*Castelnavia noveloi* C. Philbrick & C. P. Bove	EM/RS	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	a,c
#*Castelnavia pendulosa* (C. T. Philbrick & C. P. Bove) C. Philbrick & C. P. Bove	EM/RS	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	a,c
#*Castelnavia princeps* Tul. & Wedd.	EM/RS	-	-	-	-	-	-	+	+	-	-	-	-	-	+	+	a,c
#*Ceratolacis erytrolichen* (Tul. & Wedd.) Wedd.	EM/RS	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	a,c
#*Jenmaniella ceratophylla* Engl.	EM/RS	-	-	-	-	-	+	+	+	-	-	-	-	-	-	-	a,c
#*Jenmaniella fimbriata* P. Royen	EM/RS	-	-	-	-	-	+	+	+	-	-	-	-	+	+	+	a,c
#*Jenmaniella tridactylitifolia* (Engler) v. Royen	EM/RS	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-	a,c
#*Marathrum capillaceum* (Pulle) v. Roeyn	EM/RS	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	a,c
#*Marathrum foeniculaceum* Bonpl.	EM/RS	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	a,c
#*Marathrum squamosum* Wedd. var. *phellandrifollium* (Engler) P. Royen	EM/RS	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	a,c
#*Marathrum squamosum* Wedd. var. *squamosum*	EM/RS	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	a,c
#*Monostylis capillacea* Tul.	EM/RS	-	-	-	-	+	+	+	+	+	+	-	-	+	+	-	a,c

Table 2. (Continuation)

Family/ Species	LF	AC		AP		AM		PA		RO		RR		TO		END	HAB
		F	S	F	S	F	S	F	S	F	S	F	S	F	S		
#*Mourera alcicornis* (Tul.) Wedd.	EM/RS	-	-	-	-	-	-	+	+	-	-	-	-	-	-	+	a,c
#*Mourera elegans* (Tul.) Baill.	EM/RS	-	-	-	-	-	-	+	+	-	-	-	-	-	-	+	a,c
#*Mourera fluviatilis* Aublet	EM/RS	-	-	+	+	-	+	+	+	-	-	+	+	-	-	-	a,c
#*Mourera weddelliana* Tul.	EM/RS	-	-	-	-	-	-	+	-	-	-	-	-	+	-	+	a,c
#*Mourera monadelpha* (Bong.) C.T.Philbrick & C.P.Bove	EM/RS	-	-	-	-	+	-	+	+	+	-	-	-	-	-	-	a,c
#*Oserya biceps* Tul. & Wedd.	EM/RS	-	-	-	-	-	-	+	+	-	-	-	-	-	-	+	a,c
#*Oserya flabellifera* Tul. & Wedd	EM/RS	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	a,c
#*Oserya perpusilla* (Went) P. Royen	EM/RS	-	-	-	-	+	+	-	-	-	-	+	+	-	-	-	a,c
#*Oserya sphaerocarpa* Tul. & Wedd.	EM/RS	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	a,c
#*Podostemum flagelliforme* (Tul. & Wedd.) C. Philbrick & Novelo	EM/RS	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-	a,c
#*Rhyncholacis carinata* P. Royen	EM/RS	-	-	+	-	-	+	-	-	-	-	-	-	-	-	+	a,c
#*Rhyncholacis crassipes* Spruce	EM/RS	-	-	-	-	+	+	-	-	-	-	-	-	-	-	+	a,c
#*Rhyncholacis flagellifolia* P. Royen	EM/RS	-	-	+	-	+	+	-	-	-	-	+	+	-	-	+	a,c
#*Rhyncholacis hydrocichorium* Tul.	EM/RS	-	-	-	-	+	+	+	+	-	-	-	-	-	-	-	a,c
#*Rhyncholacis linearis* Tul.	EM/RS	-	-	-	-	-	+	+	-	-	-	-	-	-	-	+	a,c
#*Rhyncholacis minor* P. Royen	EM/RS	-	-	-	-	-	-	+	+	-	-	-	-	-	-	+	a,c
#*Rhyncholacis nitelloides* (Wedd.) P. Royen	EM/RS	-	-	-	-	+	+	-	-	-	-	-	-	-	-	+	a,c
#*Rhyncholacis oligandra* Wedd. var. *oligandra*	EM/RS	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	a,c
#*Rhyncholacis unguifera* P. Royen	EM/RS	-	-	-	-	+	+	-	-	-	-	-	-	-	-	+	a,c
#*Rhyncholacis varians* Spruce var. *tricholoba* Wedd.	EM/RS	-	-	-	-	+	+	-	-	-	-	-	-	-	-	+	a,c
#*Rhyncholacis varians* Spruce var. *varians*	EM/RS	-	-	-	-	+	+	-	-	-	-	-	-	-	-	+	a,c
#*Weddellina squamulosa* Tul. var. *squamulosa*	EM/RS	-	-	-	+	+	+	+	+	+	+	-	-	+	+	-	a,c
#*Weddellina squamulosa* Tul var. *uaupensis* (Benth. & Hooker) P. Royen	EM/RS	-	-	-	-	+	+	-	-	-	-	-	-	-	-	+	a,c
Polygalaceae																	
**Asemeia monticola* (Kunth) J.F.B.Pastore & J.R.Abbott	A	-	+	+	+	+	+	+	+	-	-	+	+	-	-	-	a,c
**Polygala adenophora* DC.	A	-	-	+	+	+	+	+	+	+	+	-	+	+	+	-	c
**Polygala appendiculata* Vell.	A	-	-	-	-	+	-	+	+	-	-	+	-	-	-	+	a,c
**Polygala appressa* Benth.	A	-	-	+	+	+	+	+	+	-	-	+	+	+	+	-	a,c
**Polygala hygrophila* Kunth	A	+	+	+	+	+	+	+	+	-	-	+	+	+	+	+	a
**Polygala longicaulis* Kunth	A	-	-	+	+	+	+	+	+	-	-	+	+	+	+	+	a,c
**Polygala mollis* Kunth	A	+	-	+	+	+	+	+	+	-	-	+	-	+	-	-	a,c
**Polygala paniculata* L.	A	-	-	-	-	+	+	+	+	-	-	+	+	-	-	-	a
**Polygala subtilis* Kunth	A	-	-	-	-	+	+	+	+	-	-	+	+	-	+	-	c
**Polygala timoutou* Aubl.	A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	a,c
**Polygala trichosperma* Jacq.	A	-	-	+	-	+	+	+	+	+	-	+	+	+	+	-	c
**Securidaca diversifolia* (L.) S.F. Blake	A	-	-	+	+	+	+	+	+	+	+	+	+	+	+	-	a,c
**Securidaca lateralis* A.W. Benn.	A	-	-	+	-	+	+	+	+	+	+	-	+	-	-	-	a,c
#*Securidaca prancei* Wurdack	A	-	-	-	-	+	+	+	+	+	+	-	-	-	-	-	c
Polygonaceae																	
Polygonum acuminatum Kunth	EM/A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	b,c
Polygonum ferrugineum Wedd.	EM/A	-	-	-	-	+	-	+	+	+	+	-	-	+	+	-	a,b
Polygonum punctatum Elliott	EM/A	+	+	-	-	+	+	+	+	-	-	+	-	-	-	-	b
Pontederiaceae																	
Eichhornia azurea (Sw.) Kunth	EM/FF	-	-	+	+	+	+	+	+	+	+	+	+	+	+	-	d
Eichhornia crassipes (Mart.) Solms	EM/FF	-	+	-	-	+	+	-	+	-	+	-	+	-	+	-	d

Table 2. (Continuation)

Family/ Species	LF	AC		AP		AM		PA		RO		RR		TO		END	HAB
		F	S	F	S	F	S	F	S	F	S	F	S	F	S		
Eichhornia diversifolia (Vahl) Urb.	EM/FF	+	+	-	-	-	+	+	+	-	+	-	+	+	+	-	b,c
Pontederia rotundifolia L. f.	EM	-	-	-	-	-	+	+	+	+	-	-	-	-	+	-	a,c
Pteridaceae																	
Ceratopteris pteridoides (Hook.)	EM/FF	-	+	-	+	+	+	+	+	-	-	-	+	-	-	-	a,c
Rubiaceae																	
**Alibertia latifolia* (Benth.) K. Schum.	A	+	+	+	-	+	+	+	+	+	-	+	-	+	+	-	c
#**Borreria ocymoides* (Burm.f.) DC.	A	-	-	-	-	+	+	-	+	-	-	-	+	-	+	-	c
#**Borreria verticillata* (L.) G. Mey.	A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	c
#**Isertia parviflora* Vahl	A	-	-	-	-	+	+	+	+	-	-	+	+	-	-	-	c
#**Oldenlandia lancifolia* (K. Schum.) DC.	A	+	+	-	-	+	+	+	+	+	+	-	+	-	+	-	c
**Oldenlandia tenuis* K. Schum.	A	-	-	-	-	+	+	+	+	-	+	+	-	-	-	-	c
#**Palicourea corymbifera* (Müll. Arg.) Standl.	A	+	+	-	+	+	+	+	+	+	+	+	+	-	+	-	c
**Psychotria poeppigiana* Müll. Arg.	A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	a,c
**Rosenbergiodendron densiflorum* (K.Schum.) Fagerl.	A	-	-	-	-	+	+	+	+	+	+	-	-	-	-	-	c
**Sipanea pratensis* Aubl.	A	-	-	+	+	+	+	-	+	-	+	+	+	-	-	+	a,c
Salviniaceae																	
Azolla microphylla Kaulf.	FF	-	+	-	-	+	+	-	+	-	-	-	-	-	-	-	a,c
Salvinia auriculata Aubl.	FF	-	-	+	+	+	+	+	+	-	-	+	+	+	+	-	d
Santalaceae																	
**Phoradendron platycaulon* Eichler	A	-	-	-	-	+	+	+	+	+	+	-	+	-	-	-	c
Sapindaceae																	
Cardiospermum halicacabum L.	A	+	+	+	+	+	+	+	+	-	-	+	+	-	-	-	a,c
#*Cupania cinerea* Poepp.	A	+	+	+	+	+	+	+	+	+	+	+	+	-	-	-	c
#**Paullinia stipularis* Benth.	A	-	-	-	-	+	+	+	+	+	-	-	-	-	-	+	a,c
Scrophulariaceae																	
#*Capraria biflora* L.	A	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	c
Solanaceae																	
**Physalis angulata* L.	A	+	+	+	-	+	+	+	+	+	+	-	-	-	-	-	c
**Solanum anceps* Ruiz & Pav.	A	+	+	+	-	+	+	-	-	+	+	-	-	-	-	-	c
**Solanum crinitum* Lam.	A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	c
**Solanum jamaicense* Mill.	A	+	+	+	+	+	+	+	+	+	+	-	-	-	-	-	c
**Solanum sisymbriifolium* Lam.	A	+	+	-	-	-	+	-	-	+	+	-	-	-	+	-	c
**Solanum thelopodium* Sendtn.	A	+	+	-	-	+	+	-	-	+	+	-	-	-	-	-	c
Sphenocleaceae																	
Sphenoclea zeylanica Gaertn.	EM/A	+	+	+	+	+	+	+	+	+	+	-	-	-	-	-	c
Thelypteridaceae																	
#*Cyclosorus interruptus* (Willd.) H. Itô	EM	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	a,c
**Thelypteris serrata* (Cav.) Alston	EM	+	+	+	+	+	+	+	+	+	+	+	-	-	+	-	a,c
Typhaceae																	
Typha domingensis Pers.	EM	-	-	-	-	-	-	+	+	-	-	-	-	+	+	-	a,c
Verbenaceae																	
**Lantana camara* L.	A	+	+	+	+	+	+	-	+	+	+	+	+	+	+	-	c
**Lantana canescens* Kunth	A	-	-	-	-	+	+	-	+	-	-	-	-	-	+	-	c
**Stachytarpheta angustifolia* (Mill.) Vahl	A	-	-	+	+	-	+	+	+	-	-	-	+	-	-	-	c
Vitaceae																	
**Cissus erosa* Rich.	A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	c

Table 2. (Continuation)

Family/ Species	LF	AC		AP		AM		PA		RO		RR		TO		END	HAB
		F	S	F	S	F	S	F	S	F	S	F	S	F	S		
**Cissus gongylodes* (Baker) Planch.	A	+	+	-	-	-	-	+	+	-	+	-	-	-	+	-	c
Xyridaceae																	
**Xyris jupicai* Rich.	EM/A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	a,c
**Xyris macrocephala* Vahl	EM/A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	a,c
**Xyris paraensis* Poepp. ex Kunth	EM/A	-	-	-	-	+	+	+	+	-	-	+	+	-	-	-	a,c
**Xyris savanensis* Miq.	EM/A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	a,c

DISCUSSION

The Neotropics have the highest number of species (984) of aquatic plants of the world (Chambers *et al.* 2008). Regarding the high representation of aquatic plants of the region within the Neotropics and the strong endemism, Northern Brazil can be considered a priority area for conservation of the world aquatic vegetation.

Floristic studies on aquatic macrophytes have pointed that species richness is related to area, among other factors (Thomaz *et al.* 2003; Ferreira *et al*. 2011; Moura-Júnior *et al.* 2013). So, the high richness of aquatic macrophytes of Northern Brazil can be explained by the wetland size (138.000 km^2).

In addition, there are evidences of the relation between increase in plant species richness with decrease of latitudinal gradient (Signor 1990; Cox and Moore 2010). This relationship is widely accepted, based on various theories: temporal, spatial, competitive, predictive, climate stability and biological production (Blackburn and Gaston 1996; Buzas *et al.* 2002; Raven *et al.* 2007). Therefore, the bioclimatic features related to the low latitude of Northern Brazil can also explain the high richness of aquatic macrophytes in this region.

It is known that sampling effort can influence results in assessment of richness and/or floristics. Therefore, the highest richness of aquatic macrophytes recorded in lentic habitats is because they have been more surveyed in Northern Brazil. According to Moura-Junior *et al.* (2011a), some of the hydrological characteristics of lentic environments (*e.g.* reduced turbidity and high transparency) favor the heterogeneity of aquatic plants, which may also explain the high richness of these environments for Northern Brazil. This fact shows the need for widening studies in lotic habitats, *e.g.* rivers and waterfalls. Moreover, the large and quite unaccessible wetlands of Araguaia, Guaporé and River Negro remain largely undersampled for aquatic macrophytes.

The states of AP, AM, RR and PA presented higher richness than large wetlands in Brazil, such as the Pantanal – 138,000 km^2 (Pott and Pott 2000) and the Paraná river floodplain – 2,500 km^2 (Ferreira *et al.* 2011), what reinforces the importance of the Northern region of Brazil as a priority for conservation of diversity the world aquatic plants.

Poaceae and Cyperaceae are also among the richest families for other Brazilian wetlands, such as the Pantanal (Pott *et al.* 2011) and the floodplains of the upper Paraná river (Thomaz *et al.* 2003) and São Francisco river (Moura-Júnior *et al.* 2011a; Campelo *et al.* 2012). Souza and Lorenzi (2008) estimate *ca*. 1500 species of Poaceae and 700 Cyperaceae for Brazil, widely distributed over a range of aquatic and/or terrestrial habitats. It is believed that Cyperaceae and Poaceae adapt to ecotonal areas due to efficient vegetative propagation (rhizomes and/or stolons), what justifies the presence of *C. haspan*, *C. luzulae* and *E. interstincta* in all states and analyzed habitats. These are species of wide distribution (MOBOT 2011).

The species richness of Fabaceae in our study converged with the checklist of aquatic macrophytes of Northeast of Brazil (Moura-Júnior *et al.* 2013), wherein this family is one of the five richest. Morphological, ecophysiological and reproductive plasticity could explain the richness of Fabaceae in ecotonal areas (between terrestrial and aquatic zones), justifying the high number of legumes in Northern Brazil (Moura-Júnior *et al.* 2013). *E.g. Mimosa* spp. produce numerous long-living seeds. The richness of Malvaceae is because many of the listed species (*e.g. Sida* spp. and *Urena lobata* L.) are rather weedy and colonize gaps left after flood.

We call attention to the yet unreported high richness (55 species) of Podostemaceae in our study, considering the scarcity of this family in reports on aquatic macrophytes for tropical regions. Furthermore, 25 species are endemic to Brazil. We point out that all the cited species of this family were recorded in field expeditions and collected by two of the authors. We believe that the gap of records of Podostemaceae in studies on macrophytes of Northern Brazil may be related to lack of specialists and/or sampling difficulties regarding such rheophytes, which occur in habitats of very difficult and dangerous access, such as rapids and waterfalls.

It is noteworthy that *Podostemum flagelliformis* (Tul. & Wedd.) C. Philbrick & Novelo has been collected only once (1840s) in Brazil. This species occurs only attached to rocks in river-rapids. The only known location for the species (Tocantins River, near Porto Nacional) is now flooded by the reservoir of a hydroelectric dam in the Tocantins River, near the town of Lajeado. Thus, the unique appropriate habitat

does not longer exist. We conducted field studies in the region over two seasons (2005, 2006) and this species was not reencountered. Therefore, it is listed as critically endangered (possibly extinct).

Climate is considered the main biogeographic predictor of flora and fauna, and the most determinant factors in characterization of the system are solar radiation, temperature, moisture and atmospheric pressure (Briggs 1995; Cox and Moore 2010). The latitudinal variation of these factors (mainly temperature) can cause differences in terrestrial and/or aquatic vegetation (Raven *et al.* 2007). In this context, floristic similarity of aquatic plants between the regions North and Northeast of Brazil, as well as their dissimilarity in relation to other Brazilian wetlands can be explained by the latitudinal variation of the climate system.

It is also known that micro-climatic differences within the region can influence sedimentological, hydrological and limnological characteristics of the hydrographic basins, changing patterns of geographic distribution of species and, consequently, the floristic composition of aquatic macrophytes (Murphy *et al.* 2003; Jacobs and Macisaac 2009). Therefore, the differences in richness and floristic composition of aquatic macrophytes among states of Northern Brazil can also be attributed to sedimentological, hydrological and limnological features of the micro-watersheds.

Sampling effort may have also influenced the floristic variation among states. This can be verified by results of floristic similarity, which showed similar patterns to the platforms, such as AM and PA (states with highest diversity of aquatic macrophytes), and the blurring of floristic similarity of TO (lowest richness) compared to other states of northern Brazil.

The assemblages of amphibious and/or emergent plants exhibit high species richness within the community of aquatic macrophytes of tropical regions (Moura-Júnior *et al.* 2013), regarding the wide range of adaptation and resilience of these plants under environmental pressures exerted by different types of ecosystems (lotic, lentic and transitional). We attribute the high participation of amphibious and emergent plants to their morphophysiology, which allow them to survive in the aquatic-terrestrial interface (Henry-Silva *et al*. 2010; Ribeiro *et al.* 2011; Moura-Júnior *et al.* 2011a). Other probable causes of the high number of amphibious and/or emergent aquatic macrophytes are the strategies of dispersal and seed dormancy of such plants and the shallow waters of the studied ecosystems in Northern Brazil.

The range of adaptation of amphibious and/or emergent species to ecotonal habitats allows that records may have arisen from research on both aquatic and non aquatic habitats (Moura-Júnior *et al.* 2011b), what can also partly explain the high species richness in Northern Brazil. Quite numerous plants are rather terrestrial elsewhere, generally considered ruderal, *e.g.* some Amaranthaceae, Fabaceae, Poaceae, Solanaceae and Malvaceae, whereas they are able to grow in running water along flooded riversides and sediments. Within this perspective, the taxonomic records of assemblages strictly related to aquatic habitats (floating and submerged) are considered little representative in studies focused on communities of aquatic macrophytes, what we corroborated. Nevertheless, the high number of aquatic species recorded in our study evidenced that Northern Brazil can be considered rich in life forms.

SpeciesLink is a repository updated by Brazilian herbaria. So, some negative biases could happen due to delayed update of herbarium databanks, and underestimate richness. In counterpart, Flora do Brasil is a list of species revised by specialists, hence, it is considered a reliable database for inventories of plant species in Brazil. Nevertheless, in our study nine species recorded in the field and confirmed by specialists were not listed in Flora do Brasil. This suggests that the data of Flora do Brasil may also be underestimated. Even so, we suggest that in studies of richness or diversity the Flora do Brasil platform can be priorized, while the choice of platform is not important for floristic composition.

CONCLUSIONS

There is a rich and diversified flora of aquatic plants in Northern Brazil, evidenced by the number of recorded taxa and variety of life forms. We highlight the unreported high number of species (48) of Podostemaceae, of which 25 are endemic. The contrasting results obtained from the platforms SpeciesLink and Flora do Brasil for richness may partially arise from delay in updating herbaria data or finding of new records of species. In this context, we suggest to amplify floristic and taxonomic efforts in Northern Brazil, particularly in AC, RO and TO, short of information upon aquatic plants. In the future, probably more aquatic species shall be added to this first checklist.

ACKNOWLEDGEMENTS

To Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES, Ministry of Education, Brazil) for a Visiting Professor grant to A. Pott and a post-doc grant to F. A. Ferreira. To the researchers Liliane Lima and Tassia Pinheiro, from Universidade Federal Rural de Pernambuco.

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Recebido em 11/06/2014
Aceito em 27/10/2014