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CLASSIFICATION AND BIOGEOGRAPHY OF PANICOIDEAE (POACEAE) IN THE NEW WORLD

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ABSTRACT

Panicoideae (Poaceae) in the New World comprise 107 genera (86 native) and 1357 species (1248 native). As circumscribed herein, Panicoideae include eight tribes: Andropogoneae, Arundinelleae, Centothecae, Gynerieae, Isachneae, Paniceae, Steyermarkochloaeae, and Thysanolaeneae. The two major tribes are Andropogoneae with 230 species (16.95% of all New World panicoids), and Paniceae with 1082 species (79.73%). Andropogoneae are divided into nine subtribes (Andropogoninae, Anthistiriinae, Coicinae, Germainiinae, Ischaeminae, Rottboelliinae, Saccharinae, Sorghinae, and Trip-sacinae), while Paniceae are divided into seven subtribes (Arthropogoninae, Cenchrinae, Digitariinae, Melinidinae, Panicinae, Paspalinae, and Setariinae). Brazil is the center of diversity of New World panicoids with 741 species (54.6% of all species). The distributions of endemic and restricted taxa were analyzed in terms of biogeographical regions and Kranz syndrome. Amphitropical disjuncts and widespread species are also discussed.

Key words: Andropogoneae, biogeography, classification, endemism, Paniceae, Panicoideae, Poaceae, taxonomy.

INTRODUCTION

Subfamily Panicoideae (Poaceae) includes ca. 3270 species grouped in 206 genera (Grass Phylogeny Working Group [GPWG] 2001). The subfamily is distributed world-wide, and is present on all continents except Antarctica. However, its members are dominant in tropical and subtropical areas, but are less conspicuous in temperate or cold-temperate habitats.

The subfamily was described by Link (1827) and has been recognized as a monophyletic group because of its paired florets, the lower of which is staminate or sterile (Brown 1810, 1814), and its distinctive simple starch grains (Tateoka 1962; Kellogg and Campbell 1987; GPWG 2001).

In the past century several tribes were included in Panicoideae on the basis of morphological characters. Pilger (1940) distinguished three tribes: Paniceae, with six subtribes (Anthephorinae; Boivinellinae; Lecomtellinae; Melinidinae; Panicinae, which included *Coelachne* R. Br., *Heteranthoecia* Stapf, and *Isachne*; and Trachyinae); Andropogoneae, with six subtribes (Andropogoninae; Dimeriinae; Ischaeminae; Rottboelliinae; Saccharinae; and Sorghinae); and Maydeae. Later, Pilger (1954) raised some of the subtribes to the tribal level, recognizing, along with Paniceae: Anthephorae, with a single genus, *Anthephora*; Arthropogoneae, with *Achlaena*, *Arthropogon*, *Reynaudia*, and *Snowdenia* C. E. Hubb.; Boivinelleae, with *Boivinella* A. Camus, *Cyphochlaena* Hack., and *Perulifera* A. Camus; Isachneae, with *Coelachne*, *Heteranthoecia*, *Isachne*, and *Limnopoia* C. E. Hubb.; Lecomtelleae, with *Lecomtella* A. Camus; Melinideae, with *Melinis*, *Rhynchelytrum* Nees, and *Tricholaena* Schult.; and Trachyae, with *Trachys* Pers. Pilger (1954) also recognized tribes Andropogoneae and Maydeae within subfamily Andropogonoideae.

Clayton and Renvoize (1986) followed Pilger (1940, 1954) in part, recognizing seven tribes in Panicoideae. The two largest tribes were Paniceae (with six subtribes, including Panicinae [= Setariinae]) and Andropogoneae (with 11 subtribes), and the remaining tribes were small: Arundinelleae, Eriachneae, Hubbardieae, Isachneae, and Steyermarkochloaeae. Clayton and Renvoize (1986) recognized Centothecoidae as an independent subfamily.

Watson and Dallwitz (1992) accepted six tribes in the subfamily: Andropogoneae, Arundinelleae, Isachneae, Maydeae, Neurachneae, and Paniceae. These authors placed Centothecae in Bambusoideae, Steyermarkochloaeae and Eriachneae in Arundinoideae, and Hubbardieae in Isachneae.

Six tribes were recognized by the GPWG (2001): Andropogoneae, Arundinelleae, Hubbardieae, Isachneae, Paniceae, and Steyermarkochloaeae. They summarized the most important characters for the subfamily, including the presence of proximal female-sterile florets and the transformation to the classical NADP-ME C₄ subtype. Other characters include the presence of one female-fertile floret per spikelet, the gain of a germination flap, and the loss of disarticulation above the glumes, a synapomorphy for Panicoideae excluding *Danthoniopsis* Stapf. The subfamily was characterized by the GPWG (2001) as follows: plants primarily herbaceous, mainly occurring in the tropics and subtropics, but also diverse in temperate areas; spikelets bisexual or unisexual (if the latter, plants dioecious or monoecious), frequently paired, usually dorsally compressed and disarticulating below the glumes; lodicules two; stigmas two; caryopsis with the hilum usually short; endosperm hard, containing simple or less commonly compound starch grains; embryo usually without an epiblast, with a scutellar cleft present and with the mesocotyl internode elongated. The basic chromosome number

varies: $x = 5-9, 10 (12, 14)$. The photosynthetic pathway varies from C_3 to C_4 , the latter including PEP-CK, NAD-ME and NADP-ME subtypes; there are also some C_3/C_4 intermediates in *Steinchisma*. The Kranz syndrome is constant in some tribes, such as Andropogoneae, but is variable in others, e.g., Arundinelleae and Paniceae (Soreng and Davis 1998), which suggests that this character has evolved more than once in Panicoideae (Clayton and Renvoize 1986; Giussani et al. 2001).

The monophyly of the subfamily has been supported by every molecular phylogenetic study to date, including phylogenies of both chloroplast and nuclear genes (Soreng and Davis 1998; Giussani et al. 2001; GPWG 2001). These results suggest that the subfamily should include, within the PACCAD clade, all genera previously included within Centothecoideae, and *Gynerium* (formerly in Arundinoideae). Soreng and Davis (1998) suggested that Centothecoideae should be assigned to Panicoideae, along with isolated genera previously classified in Arundinoideae. These authors indicated that their conclusions are supported by previous molecular studies (Barker et al. 1995, using *rbcL* sequences; Clark et al. 1995, using *ndhF* sequences), in which Centothecoideae and *Thysanolaena* (Arundinoideae) are embedded within Panicoideae.

Duvall et al. (2007) have proposed that *Isachne* and *Eriachne* R. Br. should be excluded from Panicoideae, because they are closely related to *Micraira* F. Muell. Also, Sánchez-Ken and Clark (2007) have provided new insights into relationships in the Panicoideae–Centothecoideae clade, using three data sets that also showed *Gynerium* as sister to Panicoideae.

The purpose of this work is to present a tentative classification for Panicoideae, on the basis of New World taxa, to discuss morphological characters, and to present biogeographical trends for genera and species within the subfamily.

METHODS

As part of the ongoing Catalogue of New World Grasses project (Judziewicz et al. 2000; Soreng et al. 2000 onwards; Peterson et al. 2001; Soreng et al. 2003; Zuloaga et al. 2003), the geographic distributions of all accepted taxa (native and introduced) were recorded at the level of country with the Caribbean nations treated as a single unit. This paper represents a summary of distribution patterns of the native species. All of the original data are available online at <http://mobot.mobot.org/W3T/Search/nwgc.html> (Jun 2005).

To analyze the distributions of endemic taxa, we followed the classification of floristic regions of the world proposed by Takhtajan (1986).

CLASSIFICATION

In our classification of Panicoideae in the New World (Table 1; <http://mobot.mobot.org/W3T/Search/nwgclass.html>) we recognize eight tribes (Andropogoneae, Arundinelleae, Centothecoideae, Gynerieae, Isachneae, Paniceae, Steyermarkochloaeae, and Thysanolaeneae), with nine subtribes in Andropogoneae (Andropogoninae, Anthistiriinae, Coicinae, Germainiinae, Ischaeminae, Rottboelliinae, Saccharinae, Sorghinae, and Tripsacinae) and seven subtribes in Paniceae (Arthropogoninae, Cenchrinae, Digitariinae, Melinidinae,

Panicinae, Paspalinae, and Setariinae). This realignment is based on previous morphological and molecular work (Clayton and Renvoize 1986; Watson and Dallwitz 1992; Gómez-Martínez and Culham 2000; Zuloaga et al. 2000; Giussani et al. 2001; GPWG 2001; Sánchez-Ken and Clark 2001; Barber et al. 2002; Aliscioni et al. 2003).

New World Panicoideae include a total of 107 genera and 1357 species (with 21 genera and 109 species introduced) distributed in eight tribes, six (Arundinelleae, Centothecoideae, Gynerieae, Isachneae, Steyermarkochloaeae, and Thysanolaeneae) comprising a small number of genera and species, while Andropogoneae and Paniceae hold the majority of native and introduced genera and species (Table 2).

Axonopus, *Digitaria*, *Panicum*, *Paspalum*, and *Setaria* are the five largest genera of Panicoideae in the New World (Table 3), and together they account for 51.44% of all native New World panicoids.

Andropogoneae

Recent phylogenetic studies have questioned the monophyly and subtribal classification of Andropogoneae (Mason-Gamer et al. 1998; Spangler et al. 1999; Kellogg 2000). Kellogg (2000) indicated that none of the accepted subtribes are monophyletic, and that further studies are necessary to obtain a more confident understanding of the phylogeny of the group. For current classification purposes, and acknowledging the necessity of future studies in the group, we follow Filgueiras (2003), who adopted the classification of Clayton and Renvoize (1986) for the Catalogue of New World Grasses.

The tribe, the second largest in Panicoideae, includes taxa with spikelets paired, usually with one spikelet sessile and the other pedicelled, alike or dissimilar, the sessile spikelet being bisexual and the pedicelled spikelet male or barren. The basic chromosome number is commonly $x = 5$, occasionally 9 (Clayton and Renvoize 1986), and all taxa are C_4 , XyMS-. Clayton and Renvoize (1986) included 85 genera and ca. 960 species in the tribe, which has a broad distribution throughout the tropics. Andropogoneae include 35 genera and 230 species in the New World, grouped in nine subtribes. Subtribes Andropogoninae (4 gen./81 spp.), Sorghinae (6/54), and Saccharinae (7/30) have the greatest number of genera and species in the tribe (Table 2). Endemic genera are present in Anthistiriinae and Tripsacinae (Table 1).

Andropogon, *Bothriochloa*, and *Schizachyrium* have 49, 25, and 23 species, respectively, while the remaining genera each have 1–14 species. It is notable that 15 genera are introduced: *Apluda*, *Arthraxon*, *Chrysopogon*, *Coix*, *Cymbopogon*, *Dichanthium*, *Eremochloa*, *Euclasta*, *Hyperthelia*, *Microstegium*, *Miscanthus*, *Pogonatherum*, *Polytrias*, *Rottboellia*, and *Themeda*. This accounts for the majority of introduced genera in Panicoideae. Three genera are endemic: *Agenium* (South America), *Tripsacum* (North America, Mesoamerica, and northern South America), and *Zea* (Mexico and Central America).

Arundinelleae

Arundinelleae have a worldwide distribution, but most members occur in the Old World tropics. The tribe includes four genera in America usually found in savanna woodlands

Table 1. Classification of New World Panicoideae. Numbers in parentheses are the number of accepted species in the New World. * = all species introduced. ** = endemic.

Tribe Andropogoneae	<i>Loudetiopsis</i> Conert (1)	<i>Sacciolepis</i> Nash (6)
Subtribe Andropogoninae	<i>Tristachya</i> Nees (6)	Subtribe Paspalinae
<i>Andropogon</i> L. (49)	Tribe Centothecae	<i>Acostia</i> Swallen (1)**
<i>Arthraxon</i> P. Beauv. (2)*	<i>Calderonella</i> Soderstr. & H. F. Decker	<i>Alloteropsis</i> J. Presl (1)*
<i>Cymbopogon</i> Spreng. (7)*	(1)**	<i>Amphicarpum</i> Kunth (2)**
<i>Schizachyrium</i> Nees (23)	<i>Chasmanthium</i> Link (5)**	<i>Anthraenania</i> P. Beauv. (4)**
Subtribe Anthistirinae	<i>Orthoclada</i> P. Beauv. (1)	<i>Anthraenantiopsis</i> Mez ex Pilg. (4)**
<i>Agenium</i> Nees (3)**	<i>Pohlidium</i> Davidse, Soderstr. & R. P.	<i>Axonopus</i> P. Beauv. (83)
<i>Elymandra</i> Stapf (1)	Ellis (1)**	<i>Canastra</i> Morrone, Zuloaga, Davidse &
<i>Heteropogon</i> Pers. (2)	<i>Zeugites</i> P. Browne (10)**	Filg. (1)**
<i>Hyparrhenia</i> Andersson ex E. Fourn. (4)	Tribe Gynerieae	<i>Centrochloa</i> Swallen (1)**
<i>Hyperthelia</i> Clayton (1)*	<i>Gynerium</i> Willd. ex P. Beauv. (1)**	<i>Echinolaena</i> Desv. (6)**
<i>Themeda</i> Forssk. (2)*	Tribe Isachneae	<i>Gerritea</i> Zuloaga, Morrone & Killeen
Subtribe Coicinae	<i>Isachne</i> R. Br. (12)	(1)**
<i>Coix</i> L. (1)*	Tribe Paniceae	<i>Homolepis</i> Chase (5)**
Subtribe Germainiinae	Subtribe Arthropogoninae	<i>Hymenachne</i> P. Beauv. (4)
<i>Trachypogon</i> Nees (3)	<i>Altoparadisium</i> Filg., Davidse, Zuloaga	<i>Ichnanthus</i> P. Beauv. (31)
Subtribe Ischaeminae	& Morrone (2)**	<i>Mesosetum</i> Steud. (26)**
<i>Apluda</i> L. (1)*	<i>Achlaena</i> Griseb. (1)**	<i>Ophiochloa</i> Filg., Davidse & Zuloaga
<i>Ischaemum</i> L. (6)	<i>Arthropogon</i> Nees (3)**	(1)**
Subtribe Rottboelliinae	<i>Reynaudia</i> Kunth (1)**	<i>Oplismenopsis</i> Parodi (1)**
<i>Elionurus</i> Humb. & Bonpl. ex Willd. (4)	Subtribe Cenchrinae	<i>Otachyrium</i> Nees (8)**
<i>Eremochloa</i> Buse (1)*	<i>Anthephora</i> Schreb. (1)	<i>Panicum</i> incertae sedis (64)
<i>Hemarthria</i> R. Br. (1)	<i>Cenchrus</i> L. (15)	<i>Paspalum</i> L. (285)
<i>Mnesithea</i> Kunth (12)	<i>Paratheria</i> Griseb. (1)	<i>Phanopyrum</i> (Raf.) Nash (1)**
<i>Rhytachne</i> Desv. ex Ham. (3)	<i>Pennisetum</i> Rich. (36)	<i>Plagiantha</i> Renvoize (1)**
<i>Rottboellia</i> L. f. (1)*	Subtribe Digitariinae	<i>Reimarochloa</i> Hitchc. (3)**
Subtribe Saccharinae	<i>Digitaria</i> Haller (89)	<i>Spheneria</i> Kuhlm. (1)**
<i>Eriochrysis</i> P. Beauv. (5)	Subtribe Melinidinae	<i>Steinchisma</i> Raf. (7)**
<i>Imperata</i> Cirillo (8)	<i>Chaetium</i> Nees (3)**	<i>Streptostachys</i> Desv. (4)**
<i>Microstegium</i> Nees (1)*	<i>Eriochloa</i> Kunth (25)	<i>Tatianyx</i> Zuloaga & Soderstr. (1)**
<i>Miscanthus</i> Andersson (1)*	<i>Megathyrsus</i> (Pilg.) B. K. Simon &	<i>Thrasya</i> Kunth (22)**
<i>Pogonatherum</i> P. Beauv. (1)*	S. W. L. Jacobs (1)*	<i>Thrasypopsis</i> Parodi (2)**
<i>Polytrias</i> Hack. (1)*	<i>Melinis</i> P. Beauv. (2)*	<i>Triscenia</i> Griseb. (1)**
<i>Saccharum</i> L. (13)	<i>Moorochloa</i> Veldkamp (1)*	Subtribe Setariinae
Subtribe Sorghinae	<i>Scutachne</i> Hitchc. & Chase (2)**	<i>Ixophorus</i> Schtdl. (1)**
<i>Bothriochloa</i> Kuntze (25)	<i>Urochloa</i> P. Beauv. (35)	<i>Panicum</i> incertae sedis (3)
<i>Chrysopogon</i> Trin. (3)*	Subtribe Panicinae	<i>Paspalidium</i> Stapf (6)
<i>Dichanthium</i> Willemet (4)*	<i>Acroceras</i> Stapf (5)	<i>Setaria</i> P. Beauv. (60)
<i>Euclasta</i> Franch. (1)*	<i>Cyrtococcum</i> Stapf (1)*	<i>Setariopsis</i> Scribn. (2)**
<i>Sorghastrum</i> Nash (14)	<i>Dichantherium</i> (Hitchc. & Chase)	<i>Stenotaphrum</i> Trin. (1)
<i>Sorghum</i> Moench (7)	Gould (58)	Tribe Steyermarkochloae
Subtribe Tripsacinae	<i>Echinochloa</i> P. Beauv. (20)	<i>Arundoclaytonia</i> Davidse & R. P.
<i>Tripsacum</i> L. (14)**	<i>Lasiacis</i> (Griseb.) Hitchc. (15)**	Ellis (1)**
<i>Zea</i> L. (5)**	<i>Oplismenus</i> P. Beauv. (3)	<i>Steyermarkochloa</i> Davidse & R. P.
Tribe Arundinelleae	<i>Panicum</i> incertae sedis (50)	Ellis (1)**
<i>Arundinella</i> Raddi (3)	<i>Panicum</i> L. (60)	Tribe Thysanolaeneae
<i>Loudetia</i> Hochst. ex Steud. (1)	<i>Pseudechinolaena</i> Stapf (1)	<i>Thysanolaena</i> Nees (1)*

or flood plains: *Arundinella*, with three species from Mexico and the Caribbean to Argentina; *Tristachya*, with six species from Mexico to southern Brazil and Paraguay; and two genera, *Loudetia* and *Loudetiopsis*, represented by single species in cerrados and open grasslands of Bolivia, Brazil, and Paraguay. The tribe is characterized by spikelets often in triads, slightly laterally compressed, and the upper lemma awned, the awn often deciduous. The four New World genera have a basic chromosome number of $x = 6, 7, 10, 12,$ and $14,$ and all species are $C_4, XyMS-$.

Arundinelleae were placed in Panicoideae by several au-

thors, including Conert (1957), Clayton (1971), Renvoize (1982), Clayton and Renvoize (1986), and Watson and Dallwitz (1992). Clayton and Renvoize (1986) and Kellogg and Watson (1993) considered Arundinelleae to be phylogenetically basal to Andropogoneae. However, recent molecular evidence (Mason-Gamer et al. 1998; Spangler et al. 1999; Kellogg 2000) indicates the tribe is polyphyletic, and that *Arundinella* should be included in Andropogoneae. Also, Barker et al.'s (1995) *rbcL* data placed *Tristachya* sister to *Hyparrhenia* within the Andropogoneae clade. In the present treatment Arundinelleae are still treated as a separate tribe

Table 2. Numerical summary of New World Panicoideae.

Tribe/subtribe	Genera	Native species	Introduced species	Total species	% of all species
Andropogoneae	35	183	47	230	16.95
Andropogoninae	4	70	11	81	5.96
Anthistiriinae	6	8	5	13	1.96
Coicinae	1	0	1	1	0.07
Germiniinae	1	3	0	3	0.22
Ischaeminae	2	3	4	7	0.52
Rottboelliinae	6	20	2	22	1.62
Saccharinae	7	21	9	30	2.21
Sorghinae	6	39	15	54	3.98
Tripsacinae	2	19	0	19	1.40
Arundinelleae	4	11	0	11	0.81
Centothecaeae	5	18	0	18	1.33
Gynerieae	1	1	0	1	0.07
Isachneae	1	12	0	12	0.88
Paniceae	58	1021	61	1082	79.73
Arthropogoninae	4	7	0	7	0.52
Cenchrinae	4	46	7	53	3.90
Digitariinae	1	86	3	89	6.56
Melinidinae	7	47	22	69	5.08
Panicinae	9	205	14	219	16.14
Paspalinae	28	570	2	572	42.15
Setariinae	5	60	13	73	5.38
Steyrmarkochloaeae	2	2	0	2	0.15
Thysanolaeneae	1	0	1	1	0.07
Total	107	1248	109	1357	100

in its traditional circumscription until molecular phylogenetic studies that include all genera of the tribe can be conducted.

Centothecaeae

The position of Centothecaeae has been unstable in classifications over the past four decades. The tribe was raised to subfamily level by Soderstrom (1981), a decision followed by Clayton and Renvoize (1986), emphasizing the centothecoid embryo and leaf anatomical characters, mainly the palisade arrangement in the mesophyll. As previously mentioned, Soderstrom (1981), Watson et al. (1985), and Watson and Dallwitz (1992) included the tribe within Bambusoideae, while Barker et al. (1995), Clark et al. (1995), Soreng and Davis (1998), Gómez-Martínez and Culham (2000), and Sánchez-Ken and Clark (2003) pointed out, based on molecular characters, the relationship of Centothecaeae with Panicoideae.

Centothecaeae, as treated here, include five genera: *Chasmanthium*, with five North American species; *Orthoclada*, with one tropical American and one tropical African species; *Zeugites*, with ten species distributed from Mexico and the West Indies to Bolivia; and *Calderonella* and *Pohlidium*, both monotypic, the former in Panama and Colombia and the latter restricted to Panama. Centothecaeae are distinguished by spikelets one- to many-flowered, often compressed laterally; embryo with an epiblast, scutellar cleft, and mesocotyl internode present; mesophyll nonradiate, often with an adaxial palisade layer; and a basic chromosome number of $x = 12$. All species are C_3 .

Table 3. Numbers of species in the five largest genera occurring in the five New World countries most diverse in Panicoideae (see Table 5).

Genus	USA	Mexico	Venezuela	Brazil	Bolivia
<i>Axonopus</i>	3	11	27	53	20
<i>Digitaria</i>	29	29	16	43	23
<i>Panicum</i> s.l.	35	67	67	116	36
<i>Paspalum</i>	40	79	83	167	74
<i>Setaria</i>	23	26	16	28	19
Total	130	212	209	407	172
Total native species	351	464	396	741	359
% of native species	37.04	45.69	52.78	54.93	47.91

Gynerieae

Tribe Gynerieae includes one Neotropical genus, *Gynerium*, known as “caña brava” or “giant reed,” and is distinguished by distichous leaves, leathery blades with wide midribs, dioecy, and plumose pistillate inflorescences. It has a basic chromosome number of $x = 11$ and is C_3 . The monotypic genus is distributed from Mexico and the West Indies to northwestern Argentina, and it is found along river margins or in swampy places. On the basis of morphology the genus has been placed, together with other reedlike grasses (e.g., *Arundo* L., *Phragmites* Adans.), in Arundineae (Renvoize 1981; Clayton and Renvoize 1986; Conert 1987; Nicora and Rúgolo de Agrasar 1987). Hitchcock (1914) placed the genus in Festuceae, Caro (1982) in Cortaderieae, and Watson and Dallwitz (1992) in Danthonieae. More recently, based on molecular studies, Hsiao et al. (1998, 1999) classified *Gynerium* in Arundinoideae. On the contrary, Barker (1997), based on *rbcL* sequences, assigned the genus to the Panicoideae + Centothecoideae clade, as sister to Panicoideae or sister to *Thysanolaena* within Centothecoideae. The GPWG (2001), in their combined study of morphological and molecular data, confirmed that *Gynerium* is located within the Panicoideae + Centothecoideae clade. Finally, Sánchez-Ken and Clark (2001) proposed the new tribe Gynerieae in the Panicoideae + Centothecoideae clade.

Isachneae

Isachneae are represented by a single genus, *Isachne*, and 12 species in America, and there are several genera and nearly 110 species in the Old World tropics. The tribe has long been considered part of Panicoideae (Brown 1810; Hackel 1887; Pilger 1954; Clayton and Renvoize 1986; Watson and Dallwitz 1992; GPWG 2001). It is characterized by biflowered spikelets, the lower floret bisexual and the upper floret bisexual or pistillate. Species of the tribe occur only in the tropics in forest interiors, forest edges, or open aquatic habitats. All species are nonKranz and have a basic chromosome number of $x = 10$.

Recent molecular studies (Duvall et al. 2007; Sánchez-Ken and Clark 2007) suggest that *Isachne* is closely related to the Australian genus *Micraira*, and that both genera, plus others, should be reassigned to a new subfamily in the PAC-CAD clade.

Paniceae

Classification of tribe Paniceae, the largest in Panicoideae, has been extensively discussed. Many classifications have been proposed. Pilger (1940), Hsu (1965), Butzin (1970), Brown (1977), and Clayton and Renvoize (1986) used different morphological characters (e.g., spikelets arranged in open and lax panicles, the spikelets borne on long or short pedicels, vs. disposed in unilateral inflorescences branches), together with anatomical and karyological characters, for their classifications. Spikelet compression is usually dorsiventral, while the upper floret is indurate. Two main anatomical and physiological types are found, nonKranz and Kranz. The most common basic chromosome numbers are $x = 9$ and 10.

However, recent morphological and molecular studies have questioned the monophyly of the tribe and also its subtribal classification; consequently we are still searching for a natural grouping of Paniceae (Gómez-Martínez and Culham 2000; Zuloaga et al. 2000; Duvall et al. 2001; Giussani et al. 2001; Aliscioni et al. 2003). Molecular studies (Gómez-Martínez and Culham 2000; Giussani et al. 2001; Aliscioni et al. 2003) have shown that the genera are initially grouped according to basic chromosome number, one clade $x = 10$ and the other $x = 9$, the former linked to Andropogoneae. A morphological analysis (Zuloaga et al. 2000), in which neither Andropogoneae nor the basic chromosome number as a character were included, gave similar results for several groupings of genera in the tribe. These results suggest that Paniceae could even be split into two tribes.

Also, *Panicum*, one of the most controversial genera in the tribe, has been scrutinized (Giussani et al. 2001; Aliscioni et al. 2003), showing that the genus is not monophyletic and recircumscription is needed. As a result, we treat *Panicum* in a strict sense, with species having open inflorescences, a basic chromosome number of $x = 9$, C_4 photosynthesis of the NAD-ME subtype, and an indurated upper anthercium. Some of the other taxa previously positioned in *Panicum* have been placed in other genera, while other *Panicum* species or sections are in need of further study before nomenclatural changes can be entertained. The latter are identified as *Panicum* incertae sedis in Table 1. Several subtribes are here recognized. All genera of the $x = 10$ clade are grouped in subtribes Arthropogoninae and Paspalinae. The other subtribes of Paniceae are within the $x = 9$ clade (Giussani et al. 2001) and include Cenchrinae, Digitariinae, Melinidinae, Panicinae, and Setariinae.

Arthropogoninae.—This subtribe is represented by four genera, each with one or a few species: *Achlaena*, *Altoparadisium*, *Arthropogon*, and *Reynaudia*. *Achlaena* and *Reynaudia* are monotypic and restricted to Cuba. *Altoparadisium* and *Arthropogon* have two and three species, respectively, in cerros of Bolivia and Brazil. The subtribe is characterized by spikelets laterally or dorsiventrally compressed, glumes awned, upper anthercium hyaline, and the lower palea reduced or absent. There is a trend towards reduction of the number of spikelet bracts, from species of *Arthropogon* that possess both glumes and both florets to the extreme condition in *Altoparadisium* where only the upper glume and lower lemma may be present (*A. chapadense*). All species have Kranz anatomy of the MS, NADP-ME subtype. Based on

morphological characters, genera of the subtribe form a clade, although one species of *Melinis* is also included (Filgueiras et al. 2001). Recent molecular analyses (Giussani et al. 2001) grouped *Altoparadisium* and *Arthropogon* in a strongly supported clade within the $x = 10$ clade, while *Melinis* appeared related to *Moorochloa* in the $x = 9$ clade.

Cenchrinae.—Giussani et al. (2001), in a phylogenetic study of Panicoideae based on the *ndhF* gene, found that *Cenchrus*, *Paspalidium*, *Pennisetum*, *Setaria*, and *Stenotaphrum* form a robust clade. These genera are characterized by the occurrence of bristles (sometimes highly modified, as in *Cenchrus*) in the inflorescences. The bristles may have very different positions in the inflorescence. In some cases they are in a terminal position on the inflorescence or inflorescence branches or they subtend individual spikelets. Clayton and Renvoize (1986) stated that bristles are not homologous within members of this group. However, molecular studies (Gómez-Martínez and Culham 2000; Giussani et al. 2001) suggest that the bristles have a common evolutionary history. Also, morphological studies (Zuloaga et al. 2000) indicate that *Cenchrus* and related genera constitute a clade, and they share the presence of a point of articulation at the base of first-order branches. Recently, the developmental studies of Doust and Kellogg (2002) provided strong evidence for a “bristle clade” and showed that small changes in the differentiation of primordial and axis ramification and elongation are responsible for most of the large differences seen in mature inflorescences. Consequently, although we here follow the circumscriptions of Cenchrinae and Setariinae of Clayton and Renvoize (1986), it now seems very likely that these subtribes should be merged into a single subtribe (Kellogg et al. 2003).

Cenchrinae include four genera, none endemic, in the Americas. Three genera have an involucre of bristles falling with each spikelet: *Anthephora*, with one species; *Cenchrus*, with 15 species; and *Pennisetum* with 36 species, some introduced. The monotypic *Paratheria* has a single bristle falling with each spikelet. All genera are Kranz, of the MS subtype (= NADP-ME).

Digitariinae.—Digitariinae contain a single genus, *Digitaria*, with 89 species (three introduced from the Old World) that occur in tropical and warm-temperate regions from the USA to Argentina and Chile. Common in open places, roadsides, and streamsides, several species are weeds and others are cultivated in pastures. The genus is distinguished by spikelets with a reduced lower glume, upper anthercium cartilaginous, and upper lemma margin thin and not inrolled. All species are C_4 , of the NADP-ME subtype.

Melinidinae.—All genera in this subtribe are Kranz, of the PEP-CK subtype. Most of the genera have an indurate and transversely rugose upper anthercium, and spikelets arranged in unilateral branches and with short pedicels. Melinidinae include seven genera in America: *Eriochloa* (25 spp.) and *Urochloa* (35 spp.) mostly occur in tropical and subtropical regions; *Brachiaria* (Trin.) Griseb. (= *Moorochloa*) (1 sp.), *Megathyrsus* (1 sp.), and *Melinis* (2 spp.) are introduced; and *Chaetium* and *Scutachne* are endemic. *Chaetium* has three species ranging from Mesoamerica and Cuba to South America, while *Scutachne* has two species in Cuba.

Panicinae.—This subtribe is characterized by inflorescences lax and open, spikelets with or without a lower flower, the lower palea always developed, and the upper antherium indurate. Widespread genera (number of New World species in parentheses) within the subtribe are: *Acroceras* (5), *Dichantherium* (58), *Echinochloa* (20), *Oplismenus* (3), *Panicum* s.s. (60), *Pseudechinolaena* (1), and *Sacciolepis* (6). *Lasiacis* is an endemic genus with 15 species, while the monotypic *Cyrtococcum* is introduced. There are also several incertae sedis sections of *Panicum*, and two ungrouped incertae sedis species of the genus, in *Panicinae*, including sect. *Monticolae* Stapf with three widespread species; sect. *Parvifolia* Hitchc. & Chase ex Pilg. with ca. 32 species from Mesoamerica to Argentina; sect. *Verrucosa* Hitchc. & Chase ex C. C. Hsu with two North American species; and sects. *Cordovensia* Parodi and *Parviglumia* Hitchc. & Chase ex Pilg., occurring from Mexico to Argentina, with five and six species, respectively. Section *Cordovensia*, previously included in *Dichantherium*, is actually related to *Acroceras*, *Lasiacis*, and *Pseudechinolaena* (Aliscioni et al. 2003). Two photosynthetic pathways are present in the subtribe: non-Kranz (in *Acroceras*, *Cyrtococcum*, *Dichantherium*, *Lasiacis*, *Oplismenus*, *Pseudechinolaena*, and incertae sedis species of *Panicum*) and Kranz (*Echinochloa*, of the NADP-ME subtype, and *Panicum* s.s., of the NAD-ME subtype).

Paspalinae.—As in *Arthropogoninae*, in this subtribe there is also a trend towards reduction of the number of bracts in the spikelet, with some genera (e.g., *Axonopus* and *Paspalum*) having species whose spikelets have only a lower lemma and an upper floret. Also, taxa of *Paspalinae* have spikelets usually arranged in unilateral inflorescence branches and are either nonKranz or Kranz of the MS, NADP-ME subtype. It is worth emphasizing that 23 genera, of 28 total, are endemic in the New World and only one genus, *Alloteropsis*, is introduced in the Americas from the Old World. *Paspalum* and *Axonopus* are the largest genera, with 285 and 83 total species, respectively, the New World representatives of which are distributed from the USA to Argentina, Uruguay, and Chile; these genera have only a few native species in the Old World. *Mesosetum* includes 26 species from Mesoamerica to Brazil and Argentina. *Thrasya* has 22 species (see discussion of the status of this genus in Denham and Zuloaga 2007), and *Ichnanthus* has 31 species in the New World tropics, with one species, *I. pallens* (Sw.) Munro ex Benth., having a pantropical distribution. A total of 11 endemic genera are monotypic. Of these, nine occur in South America (*Acostia*, *Canastra*, *Centrochloa*, *Gerritea*, *Ophiochloa*, *Oplismenopsis*, *Plagiantha*, *Spheneria*, and *Tatianyax*); *Triscenia* is found in Cuba; and *Phanopyrum* occurs in the southeastern USA. Genera confined to South America and having 2–4 species are: *Anthaenantiopsis* (4 spp.), *Streptostachys* (4 spp.), and *Thrasyopsis* (2 spp. restricted to cerrados of central Brazil). All other genera have 2–8 species: *Amphicarpum* (2 North American spp.), *Anthaenantiopsis* (4 spp.), *Echinolaena* (6 spp.), *Homolepis* (5 spp.), *Hymenachne* (4 spp.), *Otachyrium* (8 spp., one widespread and all confined to South America), *Reimarochloa* (3 spp.), and *Steinichisma* (7 spp.—two widespread, one in Cuba, one in Mexico, and three in South America).

Several sections of *Panicum* also are included in this sub-

tribe as incertae sedis. Their definite placement at the generic level awaits further phylogenetic and morphological study. These sections include sect. *Laxa* Hitchc. & Chase ex Pilg., excluding the type species (*P. laxum* Sw.), with nine American species related to *Hymenachne*, *Plagiantha*, and *Steinichisma*; sect. *Lorea* Zuloaga, with 27 South American species found in the Guiana Highlands and in the Brazilian plateau; sect. *Obtusa* Pilg., with a single North American species related to *Paspalum*; sect. *Prionitina* Zuloaga, with one Cuban and another South American species; sect. *Stolonifera* Hitchc. & Chase ex Pilg., with 13 species distributed from Mexico to Argentina and linked to *Echinolaena* and *Ichnanthus*; sect. *Tuerckheimiana* (Hitchc.) Zuloaga, with a single species in Guatemala and Mexico; as well as sects. *Agrostoides* Hitchc. & Chase ex C. C. Hsu and *Tenera* (Hitchc. & Chase) Pilg., with two and four species, respectively, distributed from North America and the West Indies to South America; and sects. *Megista* Pilg. and *Valida* Zuloaga & Morrone, both monotypic, *Megista* with a widespread species and *Valida* with *P. validum*, confined to southeastern South America.

Setariinae.—This subtribe, represented by five genera in the New World, is characterized by the presence of bristles that persist at the spikelet base after the spikelets have fallen. *Setaria* has nearly 140 species worldwide, mostly in the tropics and subtropics of Africa, Asia, and the New World (60 spp.). *Paspalidium*, as circumscribed in this treatment, has six species with unilateral, distant branches on the inflorescences; Veldkamp (1994) and Webster (1995) transferred species of this genus to *Setaria*. *Setariopsis*, with two species, and the monotypic *Ixophorus*, are endemic to the New World, while *Stenotaphrum* is pantropical. The subtribe has Kranz anatomy, of the MS (= NADP-ME) subtype.

Steyermarkochloae

Davidse and Ellis (1984), when describing the new genus *Steyermarkochloa*, created the new tribe *Steyermarkochloae* for it, and largely on the basis of anatomical characters placed it within subfamily *Arundinoideae*. They compared it with *Arundo*, *Gynerium*, *Phragmites*, and *Thysanolaena*, all genera with anomalous anatomical characters, but because of numerous morphological differences considered the genus to be a peripheral and best placed in its own specialized tribe. Later, Davidse and Ellis (1987) placed the newly described genus *Arundoclaytonia* in *Steyermarkochloae*, still included in *Arundinoideae*. Watson and Dallwitz (1992) followed Davidse and Ellis (1984), but expressed doubt regarding the position of *Steyermarkochloae*, indicating a possible relationship with *Bambusoideae*. Clayton and Renvoize (1986) classified *Steyermarkochloae* in subfamily *Panicoideae*, pointing out “an obvious resemblance of *Steyermarkochloa* to *Hymenachne*,” which was clearly only a very superficial one. Sánchez-Ken and Clark (2007) have indicated, based in part on a partial *ndhF* sequence, that the position of *Arundoclaytonia* is unstable in the PACCAD clade. We retain, for the time being, *Steyermarkochloae* within *Panicoideae* by virtue of their unisexual, dorsally compressed spikelets that disarticulate below the glumes and fall as a unit. Both genera are nonKranz, while chromosome numbers are unknown.

Steyermarkochloae include two endemic and monotypic South American genera which share similar unisexual spikelets, multiflowered male spikelets, two stamens per flower, and lack lodicules. *Arundoclaytonia* is found in white sand savannas of the Amazon region. The genus is characterized by its caespitose habit; basal culm internodes numerous, proliferating, and lignified; cauline leaves with spiral phyllotaxy; inflorescences compact, aggregated into a false panicle; spikelets mostly unisexual; male spikelets 3–13-flowered, bearing two stamens per flower; female spikelets three-flowered, with only the middle floret fertile, the palea convolute and many-nerved; lodicules absent; stigmas and stamens terminally exerted; and the caryopsis fusiform with an elliptic-punctate hilum. *Steyermarkochloa*, the other genus, grows in the Amazonian llanos of Colombia, Venezuela, and adjacent Brazil, in seasonally flooded savannas. The genus has dimorphic culms and leaves, with solid sheaths and cylindrical and flattened blades, a unique foliar morphology within grasses (Davidse and Ellis 1984). Spikelets are mostly unisexual, three-flowered, and the terminal floret is always rudimentary. Male and the few bisexual spikelets usually have two fully developed florets.

Thysanolaeneae

Tribe Thysanolaeneae has one monotypic, introduced, and ornamental Asiatic genus, *Thysanolaena*, present in the Caribbean, USA, and El Salvador and possessing dimorphic flowers and spikelets with a rachilla extension, the spikelet falling as a single unit with the attached pedicel. The biflowered spikelets falling entire at maturity are characters linking this tribe to Panicoideae. The genus has a basic chromosome number of $x = 11$ or 12 (Watson and Dallwitz 1992) and is C_3 . Hilu and Wright (1982) noted that *Thysanolaena* has been included in five different tribes, Arundineae, Arundinelleae, Paniceae, Thysanolaeneae, and Tristegineae. However, their phenetic analysis provided strong evidence for the independence of the tribe and they mentioned that it is related to Centothecoideae, a hypothesis confirmed in the subsequent molecular studies of Barker et al. (1995), Barker (1997), and Clark et al. (1995). Clayton and Renvoize (1986) also recognized the tribe but placed it in Arundinoideae.

BIOGEOGRAPHY

Subfamily Panicoideae is best represented in tropical and subtropical regions of the world. Hartley (1958a, b) pointed out that Paniceae and Andropogoneae may have originated in tropical areas of the Old World, most likely in eastern Africa and Madagascar. Centers of diversity in eastern Africa, India/China, and Australia have been discussed by Hartley (1958a, b) and Cross (1980).

Of the 206 genera and 3270 species included in Panicoideae (GPWG 2001), 44 of the 86 native genera and 1248 species are restricted to the New World (Tables 1, 2), with a total of 911 species confined to one or two of the subregions here considered (Appendix 1). Nearly endemic to the New World are the very species-rich genera *Axonopus* (with one Old World vs. 83 New World spp.) and *Paspalum* (with six Old World vs. 285 New World spp.). Of the restricted genera and near-endemics *Axonopus* and *Paspalum*, the following are more or less widespread: *Anthanantia*, *Axono-*

Table 4. Number of endemic species and genera per continent/region and percentage of total native Panicoideae.

	Species	%	Genera	%
North America	165	12.16	3	2.8
Mesoamerica + Caribbean	115	8.50	6	5.7
South America	577	42.52	18	17.0

pus, *Chaetium*, *Echinolaena*, *Gynerium*, *Homolepis*, *Ixophorus*, *Lasiacis*, *Mesosetum*, *Paspalum*, *Reimarochloa*, *Setariopsis*, *Steinchisma*, *Thrasya*, *Tripsacum*, and *Zeugites*; 22.55% of the restricted species are widespread from North to South America. Nevertheless, many of the genera are not equally distributed throughout the American continents. They tend to be more concentrated in one or more of the biogeographical areas discussed below.

Distribution in Relation to Continents and Political Units

For this comparison the New World was divided into North America, South America, Mesoamerica, and the Caribbean, the last two categories combined in Table 4. Three genera are confined to North America: *Chasmanthium* (Centothecoae), with four species in the eastern and southeastern USA and one species in northern Mexico, and two genera of Paniceae, *Amphicarpum* and *Phanopyrum*, with two and one species, respectively, in the southeastern USA. A total of 165 species of Panicoideae are endemic to North America. It is noteworthy that most of the endemic genera of Andropogoneae and Centothecoae are limited in their distribution to North America and Mesoamerica, with only a few species reaching northern South America (e.g., species of *Calderonella*, *Tripsacum*, and *Zeugites*). Two genera are endemic in Mesoamerica, *Pohlidium* (Centothecoae) in Panama and *Zea* (Andropogoneae), while four genera are confined to the Caribbean, specifically Cuba (*Achlaena*, *Reynaudia*, *Scutachne*, and *Triscenia*). A total of 115 species are endemic in Mesoamerica and the Caribbean.

A total of 18 genera are present only in South America: *Agenium* (Andropogoneae); *Arundoclaytonia* and *Steyermarkochloa* (Steyermarkochloae); and *Acostia*, *Altoparadisium*, *Anthanantia*, *Arthropogon*, *Canastra*, *Centrochloa*, *Gerritea*, *Ophiochloa*, *Oplismenopsis*, *Otachyrium*, *Plagiantha*, *Spheneria*, *Streptostachys*, *Tatianyx*, and *Thrasypopsis* (Paniceae). Some genera of Paniceae are primarily South American, but have one or a few species in Mesoamerica (e.g., *Chaetium*, *Echinolaena*, and *Thrasya*).

As can be observed in Table 5, Brazil, Mexico, Venezuela, the Caribbean region, and Bolivia have the greatest number of species in Panicoideae, with more than 50% of the species in Brazil and 26–34% in the other countries. Also, Brazil, Mexico, USA, the Caribbean, and Venezuela account for the greatest number of endemic species. The distributions of the five largest genera in the subfamily are provided in Table 3.

Distribution in Relation to Biogeographical Areas

For this analysis we used 15 of the subdivisions (regions and provinces) of Takhtajan's (1986) biogeographical classification of the world (Appendix 1). Species designated as endemic are those limited in their distribution to one of the

Table 5. Numerical summary of New World Panicoideae species for 23 countries and the Caribbean region.

	Total	% of all species	Endemic	Native	Native (%)	Intro- duced	Intro- duced (%)
Canada	43	3.2	0	35	2.8	8	18.6
USA	351	25.9	62	281	22.5	70	19.9
Mexico	464	34.2	66	423	33.9	41	8.8
Caribbean	370	27.3	56	316	25.3	54	14.6
Belize	194	14.3	0	179	14.3	15	7.7
Guatemala	274	20.2	2	256	20.5	18	6.6
El Salvador	175	12.9	0	158	12.7	17	9.7
Honduras	289	21.3	1	258	20.7	31	10.7
Nicaragua	227	16.7	1	203	16.3	24	10.6
Costa Rica	266	19.6	2	231	18.5	35	13.2
Panama	238	17.5	2	208	16.7	30	12.6
Colombia	327	24.1	9	308	24.7	19	5.8
Venezuela	396	29.2	34	373	29.9	23	5.8
Guyana	236	17.4	2	210	16.8	26	11.0
Suriname	194	14.3	1	171	13.7	23	11.9
French Guiana	197	14.5	1	176	14.1	21	10.7
Ecuador	231	17.0	12	206	16.5	25	10.8
Peru	251	18.5	7	228	18.3	23	9.2
Brazil	741	54.6	213	688	55.1	53	7.2
Bolivia	359	26.5	11	331	26.5	28	7.8
Chile	40	2.9	3	31	2.5	9	22.5
Paraguay	303	22.3	3	290	23.2	13	4.3
Argentina	346	25.5	8	311	24.9	35	10.1
Uruguay	172	12.7	1	158	12.7	14	8.1
Total	1357	100	497	1248	100	109	8.0

major American continental masses: Caribbean, Mesoamerica, North America, or South America. Restricted species are those that occur in only two of the continental masses.

Holarctic Kingdom

North American Atlantic Region (NAAR).—A total of 72 species are endemic to this region, which stretches across North America from the Atlantic Ocean to the Rocky Mountains, and from the Gulf of Mexico to southern Canada, and is characterized by deciduous forests in the east and grasslands in the west. Endemic genera include *Amphicarpum* (2 spp.) and *Phanopyrum* (1 sp.) in the southeastern USA. In addition, there are 31 and 21 endemic species, respectively, of subtribes Panicinae and Paspalinae. This region shares 17 restricted species in 13 genera with the West Indian Province of the Caribbean Region.

Madrean Region (MR).—This area includes most of the southwestern USA (Arizona, California, Nevada, New Mexico, Utah, and parts of adjacent states) and northern and central Mexico, and is predominantly associated with dry habitats. There are 93 endemic species in the region (which accounts for 10% of all endemic species) and no endemic genera. This is the center of diversification of genera in Centothecaceae (e.g., *Zeugites*), *Zea* (Tripsacinae), and the isolated genus *Ixophorus* (Setariinae).

Neotropical Kingdom

Caribbean Region (CAR).—This region includes tropical lowland plains in southern North America (tropical Florida),

southern Mexico, almost all of Central America, the islands in the Caribbean Sea, and the Galapagos Islands. There are six endemic genera and 120 endemic species among Panicoideae. These are analyzed below within each province.

Central American Province (CAP).—A total of 61 species are confined to this province, which extends from southern Mexico to Panama and neighboring areas of Colombia. Topographically diverse, various kinds of forests dominate this region. Endemic genera are found in Centothecaceae: *Calderonella* and *Pohlidium*, each with a single species in Panama, the former extending to Colombia. Other noteworthy endemic taxa found in this province belong to Tripsacinae (*Tripsacum* spp.) and Centothecaceae (*Zeugites* spp.). Sixteen restricted species are in common with the adjacent Madrean Region.

West Indian Province (WIP).—This province includes tropical areas of southern Florida, and the Greater and Lesser Antilles. Four genera are limited to Cuba: *Achlaena* and *Reynaudia* (Arthropogoninae), *Scutachne* (Melinidinae), and *Triscenia* (Paspalinae). Fifty-six Cuban species are endemic, nearly 50% belonging to *Isachne* and *Paspalum*. The province has 17 restricted species in common with the North American Atlantic Region. In contrast, there are very few species in common with the Central American Province and other biogeographical regions of northern South America.

Galapageian Province (GP).—Five species are endemic to the Galapagos Islands, two in *Paspalum*, and one each in *Cenchrus*, *Pennisetum*, and *Urochloa*. No genera are endemic.

Andean Region (AR).—This region extends along the Andean backbone of South America from Venezuela to northern Chile and Argentina. Highlands dominate, with mountain summits of ca. 5000–6000 m. A total of 65 endemic species are present at medium or high altitudes. Two are in monotypic genera (both Paspalinae) and have very limited, local distributions: *Acostia gracilis* in Ecuador and *Gerritea pseudopetiolata* near La Paz, Bolivia. *Paspalum* and *Pennisetum* account for more than 56% of the endemic species in the region, with 26 and 10, respectively.

Region of the Guiana Highlands (GUR).—This region occupies the Guiana Highlands of northern South America, including southern Venezuela, western Guyana, western Colombia, and portions of northern Brazil. The vegetation comprises tropical forests and savannas. A total of 55 species are endemic, most of them representatives of *Axonopus*, *Panicum*, and *Paspalum*. There are no endemic genera. Only seven restricted species are in common with the Amazonian Region and 15 with cerrado areas of the Brazilian Region.

Amazonian Region (AMR).—This region includes the lowlands of the Amazon Basin, the coasts of Venezuela and its adjacent islands, Trinidad and Tobago, the greater part of Guyana, all of Suriname, all of French Guiana, and parts of northeastern Brazil. Tropical forests are characteristic. The two genera in Steyermarkochloae, *Arundoclaytonia* and *Steyermarkochloa*, are endemic, along with 36 species in 11 other genera. Only four species are shared with the West Indian Province, while 13 are in common with central areas of the Brazilian Region, including the species in the monotypic genus *Spheneria*.

Brazilian Region (BR).—This region includes the Brazilian Highlands and the Caatinga, Paranaense, Atlantic, and Gran Chaco provinces, embracing most of Brazil, eastern Paraguay, Bolivia, and northern Argentina. Dominant vegetation types are savannas with xerophytic shrubs and woodlands (cerrados; Eiten 1972), and tropical or subtropical forests. The region has the greatest number of endemic species (376) and genera (11). The endemic genera are *Agenium* in Andropogoneae, and *Altoparadisium*, *Anthaenantiopsis*, *Arthropogon*, *Canastra*, *Centrochloa*, *Ophiochloa*, *Oplismenopsis*, *Plagiantha*, *Tatianyx*, and *Thrasyopsis* in Paniceae. *Otacyrium*, *Spheneria*, and *Streptostachys* are best represented in the region, but *O. versicolor* (Döll) Henrard is a widespread species and *Spheneria kegelii*, and *Streptostachys asperifolia* extend into the Amazonian Region. Subtribes Panicinae and Paspalinae are dominant in the region, with 50 and 223 species, respectively.

Caatinga Province (CP).—The typical vegetation of this province includes thorny shrubs, cactus parklands, and different types of savannas. Five total species in *Axonopus*, *Dichantherium*, *Panicum*, and *Paspalum* are endemic. No endemic or restricted genera are present.

Uplands of Central Brazil Province (UPL).—The flora of this province, in which the predominant vegetation consists of open savannas with a dry season, is characterized by high levels of endemism. Within Panicoideae there are 196 endemic species (or 21% of the total number of endemic species) and seven endemic genera in Paniceae: *Altoparadisium*, *Arthropogon*, *Canastra*, *Centrochloa*, *Ophiochloa*, *Plagiantha*, and *Tatianyx*. Subtribe Arthropogoninae is well represented with two genera and five species, but it is curious that the other two (monotypic) genera of the subtribe are restricted to Cuba in the West Indian Province.

Chacoan Province (CHA).—This province includes the Gran Chaco and Yungas. It is predominantly characterized by arid tropical forests and woodlands. There are 23 endemic species and another 31 restricted species only shared with the Paraná Province. Subtribe Setariinae is well represented in the province. No endemic or restricted genera are present.

Atlantic Province (ATLP).—This province includes the southeastern coast of Brazil and its islands, and is characterized by evergreen tropical rain forests. A total of 19 species, belonging to seven genera (*Acroceras*, *Dichantherium*, *Digitaria*, *Ichnanthus*, *Isachne*, *Panicum*, and *Paspalum*), are endemic. Three restricted species are shared with the Paraná Province and six with the Uplands of Central Brazil Province. No genera are endemic to the province.

Paraná Province (PAR).—Fifty species and *Oplismenopsis* (Paniceae) are endemic to this province. The province covers areas of southern Brazil, eastern Paraguay, and northeastern Argentina, in which the characteristic vegetation consists of subtropical forests dominated by the genus *Araucaria* Juss., together with tall-grass grasslands. A total of 22 restricted species are in common with cerrados of central Brazil, as well as *Anthaenantiopsis* and *Thrasyopsis*.

Amphitropical Disjuncts

A total of 31 species are disjunct between the Madrean Region or the Caribbean Region and different regions of

South America. Seventeen species occur both in the Madrean Region and in South America in the Chacoan Province or Andean Region. Another 14 species are present in the Central American Province and also in several areas of South America (i.e., the Andean, Brazilian, and Amazonian regions). *Bothriochloa*, *Digitaria*, *Panicum*, and *Paspalum* are the genera with the majority of such amphitropical disjunct species.

Distribution of Endemic Species in Relation to the Kranz Syndrome

There are several interesting geographic patterns of Kranz (C_4) and nonKranz (C_3) taxa. The North American Atlantic Region has 28 nonKranz species (38.89% of the total number of endemic species) and 42 Kranz species (58.33%), of which just two are of the PS subtype. Many of the nonKranz species belong to *Dichantherium*, which is best represented in more temperate areas. On the other hand, the Madrean Region has more than 90% Kranz species. Of these, it is noteworthy that 27% are of the PS subtype, a subtype uncommon elsewhere in the New World. Possessing this subtype are 12 *Panicum* species, seven *Urochloa* species, and three *Eriochloa* species.

The percentage of Kranz species is also high in the Caribbean Region, with 97 species (79.5%). The Galapageian Province has five Kranz species and no endemic C_3 species. The West Indies Province has 48 Kranz species (44 MS, 4 PS). The Central American Province has 44 Kranz species, with just one species of the PS subtype. Only seven nonKranz species and one C_3/C_4 intermediate species occur in the West Indies Province, while there are 17 nonKranz species in the Central American Province. A similar pattern is present in the Amazonian Region, where there are 27 Kranz species (26 MS, 1 PS) and seven nonKranz species. The proportion of Kranz to nonKranz species is more balanced in the Guiana Highlands, with 20 nonKranz species and 35 Kranz species, all of the MS subtype.

The distribution of Kranz species traditionally has been thought to be correlated with warm climates and low altitudes. However, in the Andean Region we found 61 species (92%) to be C_4 , 54 of the MS subtype and just seven of the PS subtype. Kranz species in genera such as *Paspalum* reach 4500 m elevation in this region.

Curiously, the percentage of C_4 species is lower than expected in the warm, low elevations of the Brazilian Region, with 284 Kranz species (76%). However, when considering the photosynthetic pathway by province within the region, 16 species (84%) are nonKranz in the Atlantic Province, where tropical rainforests dominate. The number of Kranz species increases in the Caatinga and Paraná provinces, with more than 80% Kranz species. In the Chacoan Province all endemics are C_4 , with several representatives of the Kranz genus *Setaria*. Finally, all species shared by the Paraná and Chacoan provinces, 31, are Kranz, while of the restricted species shared by the Uplands, Chacoan, and Paraná provinces, 39 (88%) are Kranz and three nonKranz. The Uplands Province of Central Brazil has 71% C_4 species, with *Paspalum* (56 spp.), *Axonopus* (16 spp.), and *Mesosetum* (13 spp.) most diverse. Within this province, *Panicum* is the

richest among the genera possessing C_3 species, with 33 C_3 species and just two C_4 species.

This study indicates that there are at least three centers of richness of C_4 taxa—the southeastern USA and Mexico, the Andean Region, and southern South America within the Chacoan and Paraná provinces. Our results for South America disagree with previous studies of the distribution of C_3 and C_4 grasses (Ellis et al. 1980; Hattersley 1983; Cabido et al. 1997) for other parts of the world. These authors all indicated that the number of C_4 grasses is greater as temperature and rainfall increase, which is correlated with relatively low elevations. In our analysis the percentage of nonKranz species increases from west to east and decreases from north to south, with lower values in the Andean Region and the southern portion of the Brazilian Region.

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Appendix 1. Endemic and restricted species of New World Panicoideae in relation to Kranz syndrome. Endemics in this analysis are those species that occur in only one of the following four continental masses: Caribbean (CB), Mesoamerica (MA), North America (NA), and South America (SA). Restricted species are those that occur in two adjoining continental masses. Floristic regions (Takhatajan 1986): AMR = Amazonian Region, AR = Andean Region, ATLP = Atlantic Province, BR = Brazilian Region, CAP = Central American Province, CAR = Caribbean Region, CHA = Chacoan Province, CP = Caatinga Province, GP = Galapageian Province, GUR = Guiana Highlands Region, MR = Madrean Region, NAAR = North American Atlantic Region, PAR = Paraná Province, UPL = Uplands of Central Brazil Province, WIP = West Indian Province.

Taxon	Continent	Country	Floristic region/province	Kranz syndrome
Tribe Andropogoneae				
Subtribe Andropogoninae				
<i>Andropogon aequatoriensis</i> Hitchc.	SA	Ecuador	AR	C ₄ -MS
<i>A. arctatus</i> Chapm.	NA	USA	NAAR	C ₄ -MS
<i>A. arenarius</i> Hack.	SA		BR-CHA + PAR	C ₄ -MS
<i>A. bourgeaei</i> Hack.	MA		CAR-CAP	C ₄ -MS
<i>A. brachystachys</i> Chapm.	NA	USA	NAAR	C ₄ -MS
<i>A. cabanisi</i> Hack.	NA	USA	NAAR	C ₄ -MS
<i>A. campestris</i> Trin.	SA	Brazil	BR-UPL	C ₄ -MS
<i>A. coloratus</i> Hack.	SA	Argentina	BR-CHA + PAR	C ₄ -MS
<i>A. cordatus</i> Swallen	SA	Bolivia	BR-CHA + PAR	C ₄ -MS
<i>A. crassus</i> Sohns	SA	Venezuela	GUR	C ₄ -MS
<i>A. crispifolius</i> Guala & Filg.	SA	Brazil	BR-UPL	C ₄ -MS
<i>A. crucianus</i> Renvoize	SA		BR-UPL	C ₄ -MS
<i>A. diuturnus</i> Sohns	SA	Venezuela	GUR	C ₄ -MS
<i>A. durifolius</i> Rendle	SA	Brazil	BR-UPL	C ₄ -MS
<i>A. exaratus</i> R. Br.	SA		BR-CHA + PAR	C ₄ -MS
<i>A. floridanus</i> Scribn.	NA	USA	NAAR	C ₄ -MS
<i>A. gerardii</i> Vitman	NA/MA		NAAR + CAR-CAP	C ₄ -MS
<i>A. glaucescens</i> Kunth	SA		AR	C ₄ -MS
<i>A. glaucophyllus</i> Roseng., B. R. Arrill. & Izag.	SA		BR-CHA + PAR	C ₄ -MS
<i>A. glaziovii</i> Hack.	SA		BR-UPL	C ₄ -MS
<i>A. indetonsus</i> Sohns	SA	Brazil	AMR	C ₄ -MS
<i>A. ingrates</i> Hack.	SA	Brazil	BR-UPL	C ₄ -MS
<i>A. insolitus</i> Sohns	SA		AMR	C ₄ -MS
<i>A. lehmannii</i> Pilg.	SA	Colombia	AR	C ₄ -MS
<i>A. liebmannii</i> Hack.	NA	Mexico	MR	C ₄ -MS
<i>A. lindmanii</i> Hack.	SA		BR-CHA + PAR	C ₄ -MS
<i>A. longiberbis</i> Hack.	CB/NA		NAAR + CAR-WIP	C ₄ -MS
<i>A. macrothrix</i> Trin.	SA		BR-UPL + CHA + PAR	C ₄ -MS
<i>A. multiflorus</i> Renvoize	SA	Bolivia	BR-UPL	C ₄ -MS
<i>A. perdignus</i> Sohns	SA	Venezuela	AMR	C ₄ -MS
<i>A. pohlianus</i> Hack.	SA	Brazil	BR-UPL	C ₄ -MS
<i>A. pringlei</i> Scribn. & Merr.	NA	Mexico	MR	C ₄ -MS
<i>A. scabriglumis</i> Swallen	SA	Ecuador	AR	C ₄ -MS
<i>A. ternaries</i> Michx.	NA/MA		NAAR + MR	C ₄ -MS
<i>A. tracyi</i> Nash	NA	USA	NAAR	C ₄ -MS
<i>A. urbanianus</i> Hitchc.	CB		CAR-WIP	C ₄ -MS
<i>A. vetus</i> Sohns	SA	Venezuela	AMR	C ₄ -MS
<i>Schizachyrium beckii</i> Killeen	SA	Bolivia	BR-UPL	C ₄ -MS
<i>S. cubense</i> (Hack.) Nash	CB		CAR-WIP	C ₄ -MS
<i>S. gaumeri</i> Nash	NA	Mexico	MR	C ₄ -MS
<i>S. gracile</i> (Spreng.) Nash	CB/NA		NAAR + CAR-WIP	C ₄ -MS
<i>S. gracilipes</i> (Hack.) A. Camus	SA		BR-UPL + CHA + PAR	C ₄ -MS
<i>S. maritimum</i> (Chapm.) Nash	NA	USA	NAAR	C ₄ -MS
<i>S. mexicanum</i> (Hitchc.) A. Camus	NA	Mexico	MR	C ₄ -MS
<i>S. muelleri</i> Nash	NA	Mexico	MR	C ₄ -MS
<i>S. multinervosum</i> Nash	CB		CAR-WIP	C ₄ -MS
<i>S. niveum</i> (Swallen) Gould	NA	USA	NAAR	C ₄ -MS
<i>S. parvifolium</i> (Hitchc.) Borhidi & Catasús	CB		CAR-WIP	C ₄ -MS
<i>S. praematurum</i> (Fernald) C. F. Reed	NA	USA	NAAR	C ₄ -MS
<i>S. reedii</i> (Hitchc. & Ekman) Borhidi & Catasús	CB		CAR-WIP	C ₄ -MS
<i>S. rhizomatum</i> (Swallen) Gould	NA	USA	NAAR	C ₄ -MS
<i>S. scabriflorum</i> (Rupr. ex Hack.) A. Camus	SA		BR-CHA + PAR	C ₄ -MS
<i>S. scoparium</i> (Michx.) Nash	NA		MR	C ₄ -MS

Appendix 1. Continued.

Taxon	Continent	Country	Floristic region/province	Kranz syndrome
<i>S. sericatum</i> (Swallen) Gould	NA	USA	NAAR	C ₄ -MS
<i>S. spicatum</i> (Spreng.) Herter	SA		BR-CHA + PAR	C ₄ -MS
Subtribe Anthistiriinae				
<i>Agenium leptocladum</i> (Hack.) Clayton	SA		BR-UPL + CHA + PAR	C ₄ -MS
<i>A. majus</i> Pilg.	SA		BR-UPL + CHA + PAR	C ₄ -MS
<i>A. villosum</i> (Nees) Pilg.	SA		BR-UPL + CHA + PAR	C ₄ -MS
<i>Elymandra lithophila</i> (Trin.) Clayton	SA	Brazil	BR-UPL	C ₄ -MS
Subtribe Germaniniinae				
<i>Trachypogon macroglossus</i> Trin.	SA	Brazil	BR-UPL	C ₄ -MS
<i>T. vestitus</i> Andersson	MA/SA		CAR-CAP + AMR	C ₄ -MS
Subtribe Ischaeminae				
<i>Ischaemum arenosum</i> Sohns	SA	Venezuela	GUR	C ₄ -MS
<i>I. guianense</i> Kunth ex Hack.	SA		AMR + GUR	C ₄ -MS
<i>I. minus</i> J. Presl	SA		BR-CHA + PAR	C ₄ -MS
Subtribe Rottboelliinae				
<i>Mnesithea balansae</i> (Hack.) de Koning & Sosef	SA		BR-CHA + PAR	C ₄ -MS
<i>M. cylindrica</i> (Michx.) de Koning & Sosef	NA	USA	NAAR	C ₄ -MS
<i>M. impressa</i> (Griseb.) de Koning & Sosef	CB		CAR-WIP	C ₄ -MS
<i>M. parodiana</i> (Henrard) de Koning & Sosef	SA		BR-CHA + PAR	C ₄ -MS
<i>M. rugosa</i> (Nutt.) de Koning & Sosef	CB/NA		NAAR + CAR-WIP	C ₄ -MS
<i>M. selloana</i> (Hack.) de Koning & Sosef	SA		BR-CHA + PAR	C ₄ -MS
<i>M. tessellata</i> (Steud.) de Koning & Sosef	NA	USA	NAAR	C ₄ -MS
<i>M. tuberculosa</i> (Nash) de Koning & Sosef	CB/NA		NAAR	C ₄ -MS
<i>Rhytachne gonzalezii</i> Davidse	SA		AMR	C ₄ -MS
<i>R. guianensis</i> (Hitc.) Clayton	SA		AMR + BR-UPL	C ₄ -MS
Subtribe Saccharinae				
<i>Imperata brevifolia</i> Vasey	NA		MR	C ₄ -MS
<i>I. condensata</i> Steud.	SA		AR	C ₄ -MS
<i>I. parodii</i> Acevedo	SA	Chile	AR	C ₄ -MS
<i>I. tenuis</i> Hack.	SA		BR-UPL + CHA + PAR	C ₄ -MS
<i>Saccharum alopecuroides</i> (L.) Nutt.	NA	USA	NAAR	C ₄ -MS
<i>S. angustifolium</i> (Nees) Trin.	SA		BR-CHA + PAR	C ₄ -MS
<i>S. baldwinii</i> Spreng.	NA	USA	NAAR	C ₄ -MS
<i>S. brevibarbe</i> (Michx.) Pes.	NA	USA	NAAR	C ₄ -MS
<i>S. coarctatum</i> (Fernald) R. D. Webster	NA	USA	NAAR	C ₄ -MS
<i>S. giganteum</i> (Walter) Pers.	NA		NAAR	C ₄ -MS
Subtribe Sorghinae				
<i>Bothriochloa eurylemma</i> M. Marchi & Longhi-Wagner	SA		BR-CHA + PAR	C ₄ -MS
<i>B. hirtifolia</i> (J. Presl) Henrard	NA/MA		MR + CAR-CAP	C ₄ -MS
<i>B. hybrida</i> (Gould) Gould	NA		MR	C ₄ -MS
<i>B. imperatoides</i> (Hack.) Herter	SA		BR-CHA + PAR	C ₄ -MS
<i>B. meridionalis</i> M. Marchi & Longhi-Wagner	SA		BR-CHA + PAR	C ₄ -MS
<i>B. palmeri</i> (Hack.) Pilg.	NA		MR	C ₄ -MS
<i>B. reevesii</i> (Gould) Gould	NA		MR	C ₄ -MS
<i>B. velutina</i> M. Marchi & Longhi-Wagner	SA	Brazil	BR-CHA + PAR	C ₄ -MS
<i>B. wrightii</i> (Hack.) Henrard	NA		MR	C ₄ -MS
<i>Chrysopogon pauciflorus</i> (Champ.) Benth. ex Vasey	CB/NA		NAAR + CAR-WIP	C ₄ -MS
<i>Sorghastrum balansae</i> (Hack.) Dávila	SA	Paraguay	BR-CHA + PAR	C ₄ -MS
<i>S. brunneum</i> Swallen	NA/MA		MR + CAR-CAP	C ₄ -MS
<i>S. chasae</i> Swallen	SA	Brazil	BR-UPL	C ₄ -MS
<i>S. contractum</i> (Hack.) Kuhl. & A. Kuhn	SA	Brazil	BR-UPL	C ₄ -MS
<i>S. ellioti</i> (C. Mohr) Nash	NA	USA	NAAR	C ₄ -MS
<i>S. minarum</i> (Nees) Hitchc.	SA		BR-UPL + CHA + PAR	C ₄ -MS
<i>S. nudipes</i> Nash	NA	Mexico	MR	C ₄ -MS
<i>S. pohlianum</i> Dávila	NA	Mexico	MR	C ₄ -MS
<i>S. scaberrimum</i> (Nees) Herter	SA	Brazil	BR-UPL	C ₄ -MS
<i>S. secundum</i> (Elliott) Nash	NA	USA	NAAR	C ₄ -MS
<i>S. viride</i> Swallen	SA		BR-UPL + CHA + PAR	C ₄ -MS
<i>Sorghum trichocladum</i> (Rupr. ex Hack.) Kuntze	MA		CAR-CAP	C ₄ -MS

Appendix 1. Continued.

Taxon	Continent	Country	Floristic region/province	Kranz syndrome
Subtribe Tripsacinae				
<i>Tripsacum australe</i> H. C. Cutler & E. S. Anderson	SA		AR	C ₄ -MS
<i>T. bravum</i> J. R. Gray	NA	Mexico	MR	C ₄ -MS
<i>T. cundinamarcae</i> de Wet & Timothy	SA	Colombia	AR	C ₄ -MS
<i>T. intermedium</i> de Wet & J. R. Harlan	MA		CAR-CAP	C ₄ -MS
<i>T. jalapense</i> de Wet & Brink	MA		CAR-CAP	C ₄ -MS
<i>T. lanceolatum</i> Rupr. ex E. Fourn.	NA/MA		MR + CAR-CAP	C ₄ -MS
<i>T. maizar</i> Hern.-Xol. & Randolph	MA		CAR-CAP	C ₄ -MS
<i>T. manisuroides</i> de Wet & J. R. Harlan	MA		CAR-CAP	C ₄ -MS
<i>T. peruvianum</i> de Wet & Timothy	SA		AR	C ₄ -MS
<i>T. pilosum</i> Scribn. & Merr.	MA		CAR-CAP	C ₄ -MS
<i>T. zopilotense</i> Hern.-Xol. & Randolph	MA		CAR-CAP	C ₄ -MS
<i>Zea diploperennis</i> H. H. Iltis, Doebley & R. Guzmán	NA	Mexico	MR	C ₄ -MS
<i>Z. nicaraguensis</i> H. H. Iltis & B. F. Benz	MA	Nicaragua	CAR-CAP	C ₄ -MS
<i>Z. perennis</i> (Hitcch.) Reeves & Mangelsd.	NA	Mexico	MR	C ₄ -MS
Tribe Arundinelleae				
<i>Loudetia flammida</i> (Trin.) C. E. Hubb	SA		BR-UPL	C ₄ -MS
<i>Loudetiopsis chrysothrix</i> (Nees) Conert	SA		BR-UPL	C ₄ -MS
<i>Tristachya angustifolia</i> Hitchc.	NA	Mexico	MR	C ₄ -MS
<i>T. avenacea</i> (J. Presl) Scribn. & Merr.	CA		CAR-CAP	C ₄ -MS
<i>T. contrerasii</i> R. Guzmán	NA	Mexico	MR	C ₄ -MS
<i>T. laxa</i> Scribn. & Merr.	NA	Mexico	MR	C ₄ -MS
<i>T. leiostachya</i> Nees	SA		BR-UPL	C ₄ -MS
<i>T. papilosa</i> R. Guzmán	NA	Mexico	MR	C ₄ -MS
Tribe Centotheceae				
<i>Calderonella sylvatica</i> Soderstr. & H. F. Decker	MA/SA		CAR-CAP + AMR	C ₃
<i>Chasmanthium curvifolium</i> (Valdés-Reyna, Morden & S. L. Hatch) Wipff & S. D. Jones	NA	Mexico	MR	C ₃
<i>C. latifolium</i> (Michx.) H. O. Yates	NA	USA	NAAR	C ₃
<i>C. laxum</i> (L.) H. O. Yates	NA	USA	NAAR	C ₃
<i>C. nitidum</i> (Baldwin) H. O. Yates	NA	USA	NAAR	C ₃
<i>C. ornithorhynchum</i> Nees	NA	USA	NAAR	C ₃
<i>Pohlidium petiolatum</i> Davidse, Soderstr. & R. P. Ellis	MA	Panama	CAR-CAP	C ₃
<i>Zeugites capillaris</i> (Hitcch.) Swallen	NA	Mexico	MR	C ₃
<i>Z. hackelii</i> Swallen	NA	Mexico	MR	C ₃
<i>Z. hintonii</i> Hartley	NA	Mexico	MR	C ₃
<i>Z. latifolia</i> (E. Fourn.) Hemsl.	NA	Mexico	MR	C ₃
<i>Z. munroana</i> Hemsl.	MA		CAR-CAP	C ₃
<i>Z. panamensis</i> Swallen	MA	Panama	CAR-CAP	C ₃
<i>Z. pittieri</i> Hack.	MA		CAR-CAP	C ₃
<i>Z. sagittata</i> Hartley	NA	Mexico	MR	C ₃
<i>Z. smilacifolia</i> Scribn.	NA	Mexico	MR	C ₃
Tribe Isachneae				
<i>Isachne angustifolia</i> Nash	CB		CAR-WIP	C ₃
<i>I. disperma</i> (Lam.) Döll	CB		CAR-WIP	C ₃
<i>I. goiasensis</i> Renvoize	SA	Brazil	BR-UPL	C ₃
<i>I. leersioides</i> Griseb.	CB		CAR-WIP	C ₃
<i>I. ligulata</i> Swallen	SA		CAR + AMR	C ₃
<i>I. pubescens</i> Swallen	MA		CAR-CAP	C ₃
<i>I. pygmaea</i> Griseb.	CB		CAR-WIP	C ₃
<i>I. rigidifolia</i> (Sw.) Trin.	CB		CAR-WIP	C ₃
<i>I. salzmännii</i> (Trin. ex Steud.) Renvoize	SA	Brazil	BR-ATLP	C ₃
Tribe Paniceae				
Subtribe Arthropogoninae				
<i>Achlaena piptostachya</i> Griseb.	CB		CAR-WIP	C ₄ -MS
<i>Altoparadisium chapadense</i> Filg., Davidse, Zuloaga & Morrone	SA	Brazil	BR-UPL	C ₄ -MS
<i>A. scabrum</i> (Pilg. & Kuhlm.) Filg., Davidse, Zuloaga & Morrone	SA		BR-UPL	C ₄ -MS

Appendix 1. Continued.

Taxon	Continent	Country	Floristic region/province	Kranz syndrome
<i>Arthropogon filifolius</i> Filg.	SA	Brazil	BR-UPL	C ₄ -MS
<i>A. villosus</i> Nees	SA		BR-UPL	C ₄ -MS
<i>A. xerachne</i> Ekman	SA	Brazil	BR-UPL	C ₄ -MS
<i>Reynaudia filiformis</i> (Spreng. ex Schult.) Kunth	CB		CAR-WIP	C ₄ -MS
Subtribe Cenchrinae				
<i>Cenchrus distichophyllus</i> Griseb.	CB		CAR-WIP	C ₄ -MS
<i>C. gracillimus</i> Nash	CB/NA		NAAR + CAR-WIP	C ₄ -MS
<i>C. multiflorus</i> J. Presl	MA		CAR-CAP	C ₄ -MS
<i>C. palmeri</i> Vasey	NA	Mexico	MR	C ₄ -MS
<i>C. platyacanthus</i> Andersson	SA	Ecuador	CAR-GP	C ₄ -MS
<i>Pennisetum advena</i> Wipff & Veldkamp	NA	USA	NAAR	C ₄ -MS
<i>P. annuum</i> Mez	SA	Peru	AR	C ₄ -MS
<i>P. chilense</i> (E. Desv.) B. D. Jackson ex R. E. Fr.	SA		AR	C ₄ -MS
<i>P. complanatum</i> (Nees) Hemsl.	MA		CAR-CAP	C ₄ -MS
<i>P. crinitum</i> (Kunth) Spreng.	NA	Mexico	MR	C ₄ -MS
<i>P. distachyon</i> (E. Fourn.) Rupr. ex Chase	MA		CAR-CAP	C ₄ -MS
<i>P. dominguense</i> (Spreng. ex Schult.) Spreng.	CB		CAR-WIP	C ₄ -MS
<i>P. durum</i> Beal	NA	Mexico	MR	C ₄ -MS
<i>P. frutescens</i> Leeke	SA		BR-CHA + PAR	C ₄ -MS
<i>P. intectum</i> Chase	SA		AR	C ₄ -MS
<i>P. montanum</i> (Griseb.) Hack.	SA		AR	C ₄ -MS
<i>P. occidentale</i> Chase	SA		AR	C ₄ -MS
<i>P. pauperum</i> Nees ex Steud.	SA	Ecuador	CAR-GP	C ₄ -MS
<i>P. peruvianum</i> Trin.	SA		AR	C ₄ -MS
<i>P. prolificum</i> Chase	NA	Mexico	MR	C ₄ -MS
<i>P. rigidum</i> (Griseb.) Hack.	SA	Argentina	AR	C ₄ -MS
<i>P. rupestre</i> Chase	SA		AR	C ₄ -MS
<i>P. sagittatum</i> Henrard	SA		AR	C ₄ -MS
<i>P. tempisqueense</i> R. W. Pohl	MA	Costa Rica	CAR-CAP	C ₄ -MS
<i>P. tristachyum</i> (Kunth) Spreng.	SA		AR + BR-UPL	C ₄ -MS
<i>P. weberbaueri</i> Mez	SA		AR	C ₄ -MS
Subtribe Digitariinae				
<i>Digitaria aequatoriensis</i> (Hitchc.) Henrard	SA		AR	C ₄ -MS
<i>D. aequiglumis</i> (Hack. & Arechav.) Parodi	SA		BR-CHA + PAR	C ₄ -MS
<i>D. arenicola</i> (Swallen) Beetle	NA	USA	NAAR	C ₄ -MS
<i>D. atra</i> Luces	SA	Venezuela	AMR	C ₄ -MS
<i>D. badia</i> (Scribn. & Merr.) Fernald	NA/MA		MR + CAR-CAP	C ₄ -MS
<i>D. balansae</i> Henrard	SA		BR-CHA + PAR	C ₄ -MS
<i>D. bonplandii</i> Henrard	SA		BR-UPL	C ₄ -MS
<i>D. breedlovei</i> R. W. Pohl & Davidse	MA	Mexico	CAR-CAP	C ₄ -MS
<i>D. catamarcensis</i> Rúgolo	SA		AR	C ₄ -MS
<i>D. cayoensis</i> Swallen	MA	Mexico	CAR-CAP	C ₄ -MS
<i>D. chacoensis</i> (Parodi) Henrard	SA	Argentina	BR-CHA	C ₄ -MS
<i>D. chaseae</i> Henrard	SA	Brazil	BR-UPL	C ₄ -MS
<i>D. clavitricha</i> R. W. Pohl	MA	Panama	CAR-CAP	C ₄ -MS
<i>D. cognata</i> (Schult.) Pilg.	NA	USA	NAAR + MR	C ₄ -MS
<i>D. connivens</i> (Trin.) Henrard	SA	Brazil	BR-CHA + PAR	C ₄ -MS
<i>D. corynotricha</i> (Hack.) Henrard	SA	Brazil	BR-UPL	C ₄ -MS
<i>D. costaricensis</i> R. W. Pohl	MA		CAR-CAP	C ₄ -MS
<i>D. curtigluma</i> Hitchc.	NA/MA		MR + CAR-CAP	C ₄ -MS
<i>D. dioica</i> Killeen & Rúgolo	SA		AMR + BR-UPL	C ₄ -MS
<i>D. distans</i> (Chase) Fernald	NA	Mexico	MR	C ₄ -MS
<i>D. eggersii</i> (Hack.) Henrard	CB		CAR-WIP	C ₄ -MS
<i>D. ekmanii</i> Hitchc.	CB		CAR-WIP	C ₄ -MS
<i>D. enodis</i> (Hack. ex Arechav.) Parodi	SA	Uruguay	BR-CHA + PAR	C ₄ -MS
<i>D. eriostachya</i> Nees	SA		BR-CHA + PAR	C ₄ -MS
<i>D. floridana</i> Hitchc.	NA	USA	NAAR	C ₄ -MS
<i>D. fragilis</i> (Steud.) Luces	SA		AMR + BR-UPL	C ₄ -MS
<i>D. gardnerii</i> Henrard	SA	Brazil	BR-UPL	C ₄ -MS
<i>D. gracillima</i> (Scribn.) Fernald	NA	USA	NAAR	C ₄ -MS
<i>D. hitchcockii</i> (Chase) Stuck.	NA	USA	MR	C ₄ -MS
<i>D. hololeuca</i> Henrard	SA	Brazil	BR-UPL	C ₄ -MS

Appendix 1. Continued.

Taxon	Continent	Country	Floristic region/province	Kranz syndrome
<i>D. induta</i> Swallen	SA	Brazil	BR-UPL	C ₄ -MS
<i>D. lanuginosa</i> (Nees) Henrard	SA		BR-UPL + CHA + PAR	C ₄ -MS
<i>D. leiantha</i> (Hack.) Parodi	SA		BR-UPL + CHA + PAR	C ₄ -MS
<i>D. leucites</i> (Trin.) Henrard	MA		CAR-CAP	C ₄ -MS
<i>D. matogrossensis</i> (Pilg.) Henrard	SA		BR-UPL + CHA + PAR	C ₄ -MS
<i>D. multiflora</i> Swallen	MA		CAR-CAP	C ₄ -MS
<i>D. myriostachya</i> (Hack.) Henrard	SA	Brazil	BR-CHA + PAR	C ₄ -MS
<i>D. neesiana</i> Henrard	SA	Brazil	BR-UPL	C ₄ -MS
<i>D. pampinosa</i> Henrard	SA	Brazil	BR-UPL	C ₄ -MS
<i>D. panicea</i> (Sw.) Urb.	CB		CAR-WIP	C ₄ -MS
<i>D. paniculata</i> Soderstr. ex McVaugh	NA	Mexico	MR	C ₄ -MS
<i>D. paraguayensis</i> Henrard	SA		BR-UPL + CHA + PAR	C ₄ -MS
<i>D. parva</i> Swallen	SA	Brazil	AMR	C ₄ -MS
<i>D. patens</i> (Swallen) Henrard	NA		MR	C ₄ -MS
<i>D. pauciflora</i> Hitchc.	NA	USA	NAAR	C ₄ -MS
<i>D. phaeothrix</i> (Trin.) Parodi	SA		BR-UPL + CHA + PAR	C ₄ -MS
<i>D. pinetorum</i> Hitchc.	CB		CAR-WIP	C ₄ -MS
<i>D. pittieri</i> (Hack.) Henrard	MA		CAR-CAP	C ₄ -MS
<i>D. pubiflora</i> (Vasey) Wipff	NA		MR	C ₄ -MS
<i>D. purpurea</i> Swallen	SA	Brazil	BR-CHA + PAR	C ₄ -MS
<i>D. sabulicola</i> Henrard	SA	Brazil	BR-ATLP	C ₄ -MS
<i>D. sejuncta</i> (Hack. ex Pilg.) Henrard	SA	Brazil	BR-UPL	C ₄ -MS
<i>D. serotina</i> (Walter) Michx.	CB/NA		NAAR + CAR-WIP	C ₄ -MS
<i>D. simpsonii</i> (Vasey) Fernald	CB/NA		NAAR + CAR-WIP	C ₄ -MS
<i>D. singularis</i> Mez	SA		BR-CHA + PAR	C ₄ -MS
<i>D. swalleniana</i> Henrard	SA		BR-CHA + PAR	C ₄ -MS
<i>D. tenuis</i> (Nees) Henrard	SA		GUR + BR-UPL	C ₄ -MS
<i>D. texana</i> Hitchc.	NA		MR	C ₄ -MS
<i>D. venezuelae</i> Henrard	SA		GUR	C ₄ -MS
<i>D. villiculmis</i> Henrard	SA	Venezuela	AMR	C ₄ -MS
Subtribe Melinidinae				
<i>Chaetium bromoides</i> (J. Presl) Benth. ex Hemsl.	NA	Mexico	MR	C ₄ -PS
<i>C. cubanum</i> (C. Wright) Hitchc.	CB		CAR-WIP	C ₄ -MS
<i>C. festucoides</i> Nees	SA		AMR	C ₄ -MS
<i>Eriochloa acuminata</i> (J. Presl) Kunth	NA		NAAR + MR	C ₄ -PS
<i>E. boliviensis</i> Renvoize	SA		BR-UPL	C ₄ -PS
<i>E. contracta</i> Hitchc.	NA		MR	C ₄ -PS
<i>E. eppersii</i> Hitchc.	SA		AR	C ₄ -PS
<i>E. grandiflora</i> (Trin.) Benth.	SA		BR-UPL + CHA + PAR	C ₄ -PS
<i>E. lemmonii</i> Vasey & Scribn.	NA		MR	C ₄ -PS
<i>E. michauxii</i> (Poir.) Hitchc.	NA	USA	NAAR	C ₄ -PS
<i>E. montevidensis</i> Griseb.	SA		BR-CHA + PAR	C ₄ -PS
<i>E. nana</i> Arriaga	SA	Argentina	BR-CHA	C ₄ -PS
<i>E. pacifica</i> Mez	SA		AR	C ₄ -PS
<i>E. peruviana</i> Mez	SA		AR	C ₄ -PS
<i>E. sericea</i> (Scheele) Munro ex Vasey	NA		MR	C ₄ -PS
<i>E. setosa</i> (A. Rich.) Hitchc.	CB		CAR-CAP + WIP	C ₄ -PS
<i>E. tridentata</i> (Trin.) Kuhlman	SA		BR-CHA + PAR	C ₄ -PS
<i>E. weberbaueri</i> Mez	SA		AR	C ₄ -PS
<i>Scutachne amphistemon</i> (C. Wright) Hitchc. & Chase	CB		CAR-WIP	C ₄ -PS
<i>S. dura</i> (C. Wright) Hitchc. & Chase	CB		CAR-WIP	C ₄ -PS
<i>Urochloa acuminata</i> (Renvoize) Morrone & Zuloaga	SA	Brazil	BR-UPL	C ₄ -PS
<i>U. albicoma</i> (Swallen & Garcia-Barr.) Morrone & Zuloaga	SA	Colombia	AR	C ₄ -PS
<i>U. arizonica</i> (Scribn. & Merr.) Morrone & Zuloaga	NA		MR	C ₄ -PS
<i>U. ciliatissima</i> (Buckley) R. D. Webster	NA		MR	C ₄ -PS
<i>U. decidua</i> Morrone & Zuloaga	SA	Brazil	BR-UPL	C ₄ -PS
<i>U. discifera</i> (E. Fourn.) Morrone & Zuloaga	NA	Mexico	MR	C ₄ -PS
<i>U. lorentziana</i> (Mez) Morrone & Zuloaga	SA		BR-CHA	C ₄ -PS
<i>U. megastachya</i> (Nees ex Trin.) Morrone & Zuloaga	SA	Brazil	BR-UPL	C ₄ -PS
<i>U. meziana</i> (Hitchc.) Morrone & Zuloaga	NA	Mexico	MR	C ₄ -PS
<i>U. multiculma</i> (Andersson) Morrone & Zuloaga	SA	Ecuador	CAR-GP	C ₄ -PS

Appendix 1. Continued.

Taxon	Continent	Country	Floristic region/province	Kranz syndrome
<i>U. oblita</i> (Swallen) Morrone & Zuloaga	SA		AR	C ₄ -PS
<i>U. ophryodes</i> (Chase) Morrone & Zuloaga	NA	Mexico	MR	C ₄ -PS
<i>U. paucispicata</i> (Morong) Morrone & Zuloaga	SA		BR-CHA	C ₄ -PS
<i>U. texana</i> (Buckley) R. D. Webster	NA		MR	C ₄ -PS
<i>U. venosa</i> (Swallen) Morrone & Zuloaga	NA	Mexico	MR	C ₄ -PS
Subtribe Panicinae				
<i>Acroceras chaseae</i> Zuloaga & Morrone	SA	Brazil	BR-ATLP	C ₃
<i>A. excavatum</i> (Henrard) Zuloaga & Morrone	SA		BR-ATLP + PAR	C ₃
<i>A. fluminense</i> (Hack.) Zuloaga & Morrone	SA	Brazil	BR-ATLP	C ₃
<i>Dichanthelium adenorachis</i> (Zuloaga & Morrone) Zuloaga	SA	Brazil	BR-UPL	C ₃
<i>D. aequivaginum</i> (Swallen) Zuloaga	SA		AMR + BR-UPL	C ₃
<i>D. assurgens</i> (Renvoize) Zuloaga	SA		BR-UPL	C ₃
<i>D. boreale</i> (Nash) Freckmann	NA		NAAR	C ₃
<i>D. boscii</i> (Poir.) Gould & C. A. Clark	NA		NAAR	C ₃
<i>D. cabreriae</i> (Zuloaga & Morrone) Zuloaga	SA	Brazil	BR-UPL	C ₃
<i>D. caparoense</i> (Zuloaga & Morrone) Zuloaga	SA	Brazil	BR-UPL	C ₃
<i>D. clandestinum</i> (L.) Gould	NA		NAAR	C ₃
<i>D. commutatum</i> (Schult.) Gould	CB/NA		NAAR + CAR-WIP	C ₃
<i>D. congestum</i> (Renvoize) Zuloaga	SA	Brazil	BR-UPL	C ₃
<i>D. cucaense</i> (Zuloaga & Morrone) Zuloaga	SA	Brazil	BR-ATLP	C ₃
<i>D. cumbucana</i> (Renvoize) Zuloaga	SA	Brazil	BR-UPL	C ₃
<i>D. davidsei</i> (Zuloaga & Morrone) Zuloaga	SA		AMR	C ₃
<i>D. depauperatum</i> (Muhl.) Gould	NA		NAAR	C ₃
<i>D. ensifolium</i> (Baldwin ex Elliot) Gould	CB/NA		NAAR + CAR-WIP	C ₃
<i>D. heliophilum</i> (Chase ex Zuloaga & Morrone) Zuloaga	SA	Brazil	BR-UPL	C ₃
<i>D. itatiaiae</i> (Swallen) Zuloaga	SA	Brazil	BR-ATLP	C ₃
<i>D. latifolium</i> (L.) Harvill	NA		NAAR	C ₃
<i>D. laxiflorum</i> (Lam.) Gould	CB/NA		NAAR + CAR-WIP	C ₃
<i>D. leibergii</i> (Vasey) Freckmann	NA		NAAR	C ₃
<i>D. linearifolium</i> (Scribn.) Gould	NA		NAAR	C ₃
<i>D. macrospermum</i> Gould	NA	Mexico	MR	C ₃
<i>D. malacophyllum</i> (Nash) Gould	NA	USA	NAAR	C ₃
<i>D. nodatum</i> (Hitchc. & Chase) Gould	NA		NAAR	C ₃
<i>D. nudicaule</i> (Vasey) B. F. Hansen & Wunderlin	NA	USA	NAAR	C ₃
<i>D. oligosanthos</i> (Schult.) Gould	NA	USA	NAAR	C ₃
<i>D. ovale</i> (Elliott) Gould & C. A. Clark	NA		NAAR	C ₃
<i>D. pedicellatum</i> (Vasey) Gould	NA/MA		NAAR	C ₃
<i>D. perlongum</i> (Nash) Freckmann	NA	USA	NAAR	C ₃
<i>D. peristypum</i> (Zuloaga & Morrone) Zuloaga	SA	Brazil	BR-ATLP	C ₃
<i>D. petropolitanum</i> (Zuloaga & Morrone) Zuloaga	SA	Brazil	BR-ATLP	C ₃
<i>D. polyanthes</i> (Schult.) Mohlenbr.	NA	USA	NAAR	C ₃
<i>D. portoricense</i> (Desv. ex Ham.) B. F. Hansen & Wunderlin	CB/NA		NAAR + CAR-WIP	C ₃
<i>D. ravenelii</i> (Scribn. & Merr.) Gould	NA	USA	NAAR	C ₃
<i>D. sabulorum</i> (Lam.) Gould & C. A. Clark	SA		BR-ATLP + PAR	C ₃
<i>D. scabriusculum</i> (Elliott) Gould & C. A. Clark	NA	USA	NAAR	C ₃
<i>D. sciurotis</i> (Trin.) Davidse	SA	Brazil	BR-CP	C ₃
<i>D. scoparium</i> (Lam.) Gould	CB/NA		NAAR + CAR-WIP	C ₃
<i>D. sendulskyii</i> (Zuloaga & Morrone) Zuloaga	SA	Brazil	BR-UPL	C ₃
<i>D. stigmatum</i> (Trin.) Zuloaga	SA	Brazil	BR-ATLP + UPL	C ₃
<i>D. stipiflorum</i> (Renvoize) Zuloaga	SA	Brazil	BR-UPL	C ₃
<i>D. superatum</i> (Hack.) Zuloaga	SA	Brazil	BR-ATLP + UPL	C ₃
<i>D. surrectum</i> (Chase ex Zuloaga & Morrone) Zuloaga	SA	Brazil	BR-UPL	C ₃
<i>D. telmatum</i> (Swallen) Zuloaga	SA	Venezuela	GUR	C ₃
<i>D. willcoxianum</i> (Vasey) Freckmann	NA	USA	NAAR	C ₃
<i>D. xanthophysum</i> (A. Gray) Freckmann	NA		NAAR	C ₃
<i>D. yadkinense</i> (Ashe) Mohlenbr.	NA	USA	NAAR	C ₃
<i>Echinochloa chacoensis</i> P. W. Michael ex Renvoize	SA		BR-CHA	C ₄ -MS
<i>E. helodes</i> (Hack.) Parodi	SA		BR-CHA	C ₄ -MS
<i>E. holciformis</i> (Kunth) Chase	NA/MA		MR + CAR-CAP	C ₄ -MS
<i>E. jaliscana</i> McVaugh	NA	Mexico	MR	C ₄ -MS
<i>E. muricata</i> (P. Beauv.) Fernald	NA		NAAR + MR	C ₄ -MS

Appendix 1. Continued.

Taxon	Continent	Country	Floristic region/province	Kranz syndrome
<i>E. oplismenoides</i> (E. Fourn.) Hitchc.	NA	Mexico	MR	C ₄ -MS
<i>E. paludigena</i> Wiegand	NA	USA	NAAR	C ₄ -MS
<i>Lasiacis anomala</i> Hitchc.	CB/SA		AMR + CAR-WIP	C ₃
<i>L. linearis</i> Swallen	MA		CAR-CAP	C ₃
<i>L. rugellii</i> (Griseb.) Hitchc.	CB/MA		CAR-CAP + WIP	C ₃
<i>Panicum aquarum</i> Zuloaga & Morrone	SA		AMR	C ₄ -PS
<i>P. arctum</i> Swallen	SA		GUR	C ₃
<i>P. auricomum</i> Nees ex Trin.	SA	Brazil	BR-UPL	C ₃
<i>P. aztecanum</i> Zuloaga & Morrone	NA	Mexico	MR	C ₄ -PS
<i>P. bartlettii</i> Swallen	MA		CAR-CAP	C ₃
<i>P. bergii</i> Arechav.	SA		BR-CHA + PAR	C ₄ -PS
<i>P. brachyanthum</i> Steud.	NA	USA	NAAR	C ₃
<i>P. caaguazuense</i> Henrard	SA		BR-UPL + PAR	C ₃
<i>P. campestre</i> Nees ex Trin.	SA	Brazil	BR-UPL	C ₄ -PS
<i>P. capillare</i> L.	NA		MR	C ₄ -PS
<i>P. capillarioides</i> Vasey	NA		MR	C ₄ -PS
<i>P. cayoense</i> Swallen	MA		CAR-CAP	C ₃
<i>P. cervicatum</i> Chase	SA		GUR + BR-UPL	C ₄ -PS
<i>P. chasiae</i> Roseng., B. R. Arill. & Izag.	SA		BR-PAR	C ₄ -PS
<i>P. chloroleucum</i> Griseb.	SA	Argentina	AR	C ₄ -PS
<i>P. deciduum</i> Swallen	SA	Venezuela	GUR	C ₃
<i>P. decolorans</i> Kunth	NA	Mexico	MR	C ₄ -PS
<i>P. diffusum</i> Sw.	CB		CAR-WIP	C ₄ -PS
<i>P. ephemeroides</i> Zuloaga & Morrone	SA	Brazil	BR-UPL	C ₄ -PS
<i>P. exiguum</i> Mez	SA		BR-UPL + PAR	C ₄ -PS
<i>P. flexile</i> (Gatt.) Scribn.	NA		NAAR + MR	C ₄ -PS
<i>P. fonticulum</i> Swallen	SA	Venezuela	GUR	C ₃
<i>P. furvum</i> Swallen	MA	Guatemala	CAR-CAP	C ₄ -PS
<i>P. glabripes</i> Döll	SA		BR-PAR	C ₄ -PS
<i>P. granuliferum</i> Kunth	SA		GUR	C ₃
<i>P. guatemalense</i> Swallen	MA		CAR-CAP	C ₃
<i>P. hallii</i> Vasey	NA		MR	C ₄ -PS
<i>P. havardii</i> Vasey	NA		MR	C ₄ -PS
<i>P. hillmanii</i> Chase	NA	USA	MR	C ₄ -PS
<i>P. ichunense</i> Swallen	SA	Venezuela	GUR	C ₃
<i>P. incumbens</i> Swallen	MA		CAR-CAP	C ₃
<i>P. lacustre</i> Hitchc. & Ekman	CB		CAR-WIP	C ₄ -PS
<i>P. lepidulum</i> Hitchc. & Chase	NA	Mexico	MR	C ₄ -PS
<i>P. ligulare</i> Nees ex Trin.	SA		GUR + BR-UPL	C ₄ -PS
<i>P. longipedicellatum</i> Swallen	SA	Brazil	BR-ATLP	C ₃
<i>P. longissimum</i> (Mez) Henrard	SA	Paraguay	BR-PAR	C ₄ -PS
<i>P. machrisiana</i> Swallen	SA	Brazil	BR-UPL	C ₃
<i>P. magnispicula</i> Zuloaga, Morrone & Valls	SA	Brazil	BR-UPL	C ₄ -PS
<i>P. micranthum</i> Kunth	SA		GUR	C ₃
<i>P. missionum</i> Ekman	SA		BR-PAR	C ₃
<i>P. mohavense</i> Reeder	NA	USA	MR	C ₄ -PS
<i>P. mucronulatum</i> Mez	SA	Brazil	BR-CP	C ₄ -PS
<i>P. mystasipum</i> Zuloaga & Morrone	SA	Brazil	BR-UPL	C ₄ -PS
<i>P. nervosum</i> Lam.	SA		GUR + BR-UPL	C ₃
<i>P. noterophilum</i> Renvoize	SA	Brazil	BR-UPL	C ₃
<i>P. nutabundum</i> Zuloaga & Morrone	SA	Brazil	BR-UPL	C ₃
<i>P. olyroides</i> Kunth	SA		BR-UPL + PAR	C ₄ -PS
<i>P. orinocanum</i> Luces	SA	Venezuela	GUR	C ₃
<i>P. pampinosum</i> Hitchc. & Chase	NA		MR	C ₄ -PS
<i>P. pandum</i> Swallen	SA		GUR	C ₃
<i>P. parcum</i> Hitchc. & Chase	NA/MA		MR + CAR-CAP	C ₄ -PS
<i>P. parviglume</i> Hack.	MA		CAR-CAP	C ₃
<i>P. pedersenii</i> Zuloaga	SA		BR-PAR	C ₄ -PS
<i>P. peladoense</i> Henrard	SA		BR-UPL + CHA + PAR	C ₄ -PS
<i>P. penicillatum</i> Nees ex Trin.	SA	Brazil	BR-ATLP	C ₃
<i>P. petilum</i> Swallen	SA	Colombia	GUR	C ₃
<i>P. petrense</i> Swallen	SA	Venezuela	GUR	C ₃

Appendix 1. Continued.

Taxon	Continent	Country	Floristic region/province	Kranz syndrome
<i>P. philadelphicum</i> Bernh. ex Trin.	NA	USA	NAAR	C ₄ -PS
<i>P. pseudisachne</i> Mez	SA	Brazil	BR-UPL	C ₃
<i>P. quadriglume</i> (Döll) Hitchc.	SA		BR-UPL + PAR	C ₄ -PS
<i>P. racemosum</i> (P. Beauv.) Spreng.	SA		BR-ATLP	C ₄ -PS
<i>P. rhizogonum</i> Hack.	SA		BR-PAR	C ₃
<i>P. rivale</i> Swallen	SA		GUR	C ₃
<i>P. rupestre</i> Trin.	SA	Brazil	BR-UPL	C ₃
<i>P. subulatum</i> Spreng.	SA	Brazil	BR-UPL	C ₃
<i>P. tamaulipense</i> F. R. Waller & Morden	NA	Mexico	MR	C ₄ -PS
<i>P. tepuianum</i> Davidse & Zuloaga	SA	Venezuela	GUR	C ₃
<i>P. vaseyanum</i> Scribn. ex Beal	NA	Mexico	MR	C ₄ -PS
<i>P. verrucosum</i> Muhl.	NA	USA	NAAR	C ₃
<i>P. wettsteinii</i> Hack.	SA	Brazil	BR-UPL	C ₃
<i>P. yavitaense</i> Swallen	SA	Venezuela	GUR	C ₃
<i>Sacciolepis otachyrioides</i> Judz.	SA		GUR + AMR	C ₃
Subtribe Paspalinae				
<i>Acostia gracilis</i> Swallen	SA	Ecuador	AR	C ₄ -MS
<i>Amphicarpum mühlenbergianum</i> (Schult.) Hitchc.	NA	USA	NAAR	C ₄ -MS
<i>A. purshii</i> Kunth	NA	USA	NAAR	C ₄ -MS
<i>Anthaenanthia rufa</i> (Elliott) Schult.	NA	USA	NAAR	C ₄ -MS
<i>A. villaregalis</i> (McVaugh & R. Guzmán) Espejo & López-Ferrari	NA	Mexico	MR	C ₄ -MS
<i>A. villosa</i> (Michx.) P. Beauv.	NA	USA	NAAR	C ₄ -MS
<i>Anthaenantiopsis fiebrigii</i> (Mez) Parodi	SA		BR-UPL + PAR	C ₄ -MS
<i>A. perforata</i> (Nees) Parodi	SA		BR-UPL	C ₄ -MS
<i>A. rojasiana</i> Parodi	SA		BR-UPL + PAR	C ₄ -MS
<i>A. trachystachya</i> (Nees) Mez ex Pilg.	SA		BR-UPL	C ₄ -MS
<i>Axonopus amapaensis</i> G. A. Black	SA	Brazil	AMR	C ₄ -MS
<i>A. andinus</i> G. A. Black	SA	Bolivia	AR	C ₄ -MS
<i>A. apricus</i> G. A. Black	SA	Brazil	BR-UPL	C ₄ -MS
<i>A. arcuatus</i> (Mez) G. A. Black	SA	Brazil	BR-UPL	C ₄ -MS
<i>A. argentinus</i> Parodi	SA		BR-UPL + CHA + PAR	C ₄ -MS
<i>A. arsenei</i> Swallen	NA	Mexico	MR	C ₄ -MS
<i>A. boliviensis</i> Renvoize	SA	Bolivia	BR-UPL	C ₄ -MS
<i>A. brasiliensis</i> (Spreng.) Kuhlmann	SA		BR-UPL + PAR	C ₄ -MS
<i>A. canescens</i> (Nees ex Trin.) Pilg.	SA		AMR + BR-UPL	C ₄ -MS
<i>A. carajasensis</i> Bastos	SA	Brazil	GUR	C ₄ -MS
<i>A. casiquiarensis</i> Davidse	SA		GUR	C ₄ -MS
<i>A. caulescens</i> (Mez) Henrard	SA		GUR	C ₄ -MS
<i>A. chaseae</i> G. A. Black	SA	Brazil	BR-UPL	C ₄ -MS
<i>A. chimantensis</i> Davidse	SA	Venezuela	GUR	C ₄ -MS
<i>A. chrysostachyus</i> (Lag.) Chase	SA		BR-ATLP + UPL	C ₄ -MS
<i>A. ciliatifolius</i> Swallen	MA		CAR-CAP	C ₄ -MS
<i>A. comans</i> (Trin. ex Döll) Henrard	SA		BR-UPL	C ₄ -MS
<i>A. comatus</i> (Mez) Swallen	SA	Brazil	BR-UPL	C ₄ -MS
<i>A. complanatus</i> (Nees) Dedecca	SA	Brazil	BR-CP	C ₄ -MS
<i>A. cuatrecasasii</i> G. A. Black	SA		AMR	C ₄ -MS
<i>A. debilis</i> G. A. Black	CB		CAR-WIP	C ₄ -MS
<i>A. deludens</i> Chase	NA	Mexico	MR	C ₄ -MS
<i>A. elegantulus</i> (J. Presl) Hitchc.	SA		AR	C ₄ -MS
<i>A. eminens</i> (Nees) G. A. Black	SA		AMR + BR-UPL	C ₄ -MS
<i>A. equitans</i> Hitchc. & Chase	CB/SA		AMR + CAR-WIP	C ₄ -MS
<i>A. fastigiatus</i> (Nees ex Trin.) Kuhlmann	SA	Brazil	BR-UPL	C ₄ -MS
<i>A. flabelliformis</i> Swallen	SA		GUR + AMR	C ₄ -MS
<i>A. furcatus</i> (Flüggé) Hitchc.	CB/NA		NAAR + CAR-WIP	C ₄ -MS
<i>A. grandifolius</i> Renvoize	SA	Brazil	BR-UPL	C ₄ -MS
<i>A. herzogii</i> (Hack.) Hitchc.	SA		BR-UPL	C ₄ -MS
<i>A. hirsutus</i> G. A. Black	SA		BR-UPL	C ₄ -MS
<i>A. iridifolius</i> (Poepp.) G. A. Black	SA		AR + GUR	C ₄ -MS
<i>A. jeanyae</i> Davidse	MA		CAR-CAP	C ₄ -MS
<i>A. jesuíticus</i> (Araujo) Valls	SA	Brazil	BR-PAR	C ₄ -MS
<i>A. junciformis</i> G. A. Black	SA	Brazil	BR-UPL	C ₄ -MS

Appendix 1. Continued.

Taxon	Continent	Country	Floristic region/province	Kranz syndrome
<i>A. laxiflorus</i> (Trin.) Chase	SA		GUR + AMR	C ₄ -MS
<i>A. laxus</i> Luces	SA	Venezuela	AMR	C ₄ -MS
<i>A. longispicus</i> (Döll) Kuhlmann	SA		AMR	C ₄ -MS
<i>A. marginatus</i> (Trin.) Chase	SA		BR-UPL	C ₄ -MS
<i>A. mathewsii</i> (Mez) Hitchc.	SA		AR	C ₄ -MS
<i>A. mexicanus</i> G. A. Black	NA	Mexico	MR	C ₄ -MS
<i>A. micay</i> García-Barr.	MA/SA		AR + CAR-CAP	C ₄ -MS
<i>A. monticola</i> G. A. Black	SA	Brazil	BR-UPL	C ₄ -MS
<i>A. morronei</i> Giraldo-Cañas	SA	Colombia	AMR	C ₄ -MS
<i>A. obtusifolius</i> (Raddi) Chase	SA		BR-UPL + PAR	C ₄ -MS
<i>A. oiapocensis</i> G. A. Black	SA	Brazil	GUR	C ₄ -MS
<i>A. passourae</i> G. A. Black	SA	French Guiana	AMR	C ₄ -MS
<i>A. pellitus</i> (Nees ex Trin.) Hitchc. & Chase	SA	Brazil	BR-UPL	C ₄ -MS
<i>A. pennellii</i> G. A. Black	SA		GUR	C ₄ -MS
<i>A. piccae</i> Giraldo-Cañas	SA		GUR	C ₄ -MS
<i>A. polydactylus</i> (Steud.) Dedecca	SA	Brazil	BR-CP	C ₄ -MS
<i>A. polystachyus</i> G. A. Black	SA	Brazil	BR-UPL + PAR	C ₄ -MS
<i>A. pressus</i> (Nees ex Steud.) Parodi	SA		BR-UPL	C ₄ -MS
<i>A. pubivaginatulus</i> Henrard	SA		AMR + BR-CP	C ₄ -MS
<i>A. ramboi</i> G. A. Black	SA	Brazil	BR-PAR	C ₄ -MS
<i>A. ramosus</i> Swallen	SA		GUR	C ₄ -MS
<i>A. rosei</i> (Scribn. & Merr.) Chase	NA	Mexico	MR	C ₄ -MS
<i>A. rosengurtii</i> G. A. Black	SA		BR-PAR	C ₄ -MS
<i>A. rupestris</i> Davidse	SA	Brazil	BR-UPL	C ₄ -MS
<i>A. senescens</i> (Döll) Henrard	SA		AMR	C ₄ -MS
<i>A. siccus</i> (Nees) Kuhlmann	SA		BR-PAR	C ₄ -MS
<i>A. steyermarkii</i> Swallen	SA	Venezuela	GUR	C ₄ -MS
<i>A. succulentus</i> G. A. Black	SA	Paraguay	BR-PAR	C ₄ -MS
<i>A. suffultiformis</i> G. A. Black	SA	Venezuela	GUR	C ₄ -MS
<i>A. suffultus</i> (Mikan ex Trin.) Parodi	SA		BR-PAR	C ₄ -MS
<i>A. sulcatus</i> G. A. Black	SA	Brazil	AMR	C ₄ -MS
<i>A. surinamensis</i> (Hochst. ex Steud.) Henrard	SA		GUR + AMR	C ₄ -MS
<i>A. triglochinooides</i> (Mez) Dedecca	SA	Brazil	AMR	C ₄ -MS
<i>A. uninodis</i> (Hack.) G. A. Black	SA		BR-UPL + PAR	C ₄ -MS
<i>A. villosus</i> Swallen	SA	Venezuela	GUR	C ₄ -MS
<i>A. volcanicus</i> R. W. Pohl	MA		CAR-CAP	C ₄ -MS
<i>A. yutajensis</i> G. A. Black	SA	Venezuela	GUR	C ₄ -MS
<i>A. zuloagae</i> Giraldo-Cañas	SA	Colombia	GUR	C ₄ -MS
<i>Canastra lanceolata</i> (Filg.) Morrone, Zuloaga, Davidse & Filg.	SA	Brazil	BR-UPL	C ₃
<i>Centrochloa singularis</i> Swallen	SA	Brazil	BR-UPL	C ₄ -MS
<i>Echinolaena ecuadoriana</i> Filg.	SA	Ecuador	AR	C ₃
<i>E. inflexa</i> (Poir.) Chase	SA		BR-UPL	C ₃
<i>E. minarum</i> (Nees) Pilg.	SA		BR-UPL + PAR	C ₃
<i>E. oplismenoides</i> (Munro ex Döll) Stieber	SA		BR-UPL + AR	C ₃
<i>E. standleyi</i> (Hitchc.) Stieber	MA		CAR-CAP	C ₃
<i>Gerritea pseudopetiolata</i> Zuloaga, Morrone & Killeen	SA	Bolivia	AR	C ₃
<i>Homolepis longispicula</i> (Döll) Chase	SA	Brazil	BR-UPL	C ₃
<i>H. villaricensis</i> (Mez) Zuloaga & Soderstr.	SA		BR-PAR	C ₃
<i>Hymenachne grumosa</i> (Nees) Zuloaga	SA		BR-PAR	C ₃
<i>H. pernambucense</i> (Spreng. ex Mez) Zuloaga	SA		BR-ATLP + PAR	C ₃
<i>Ichnanthus annuus</i> Killeen & Kirpes	SA		BR-UPL + PAR	C ₃
<i>I. bambusiflorus</i> (Trin.) Döll	SA	Brazil	BR-UPL + ATLP	C ₃
<i>I. breviscrobis</i> Döll	SA		AMR	C ₃
<i>I. camporum</i> Swallen	SA	Brazil	BR-UPL	C ₃
<i>I. ephemeroblepharis</i> G. A. Black & Fróes ex G. A. Black & Pires	SA		GUR	C ₃
<i>I. glaber</i> (Raddi) Hitchc.	SA	Brazil	BR-ATLP	C ₃
<i>I. grandifolius</i> (Döll) Zuloaga & Soderstr.	SA	Brazil	BR-ATLP	C ₃
<i>I. hirtus</i> (Raddi) Chase	SA		BR-ATLP	C ₃
<i>I. hoffmannseggii</i> (Roem. & Schult.) Döll	SA		AMR	C ₃
<i>I. lanceolatus</i> Scribn. & J. G. Sm.	MA		CAR-CAP	C ₃

Appendix 1. Continued.

Taxon	Continent	Country	Floristic region/province	Kranz syndrome
<i>I. leptophyllus</i> Döll	SA	Brazil	AMR	C ₃
<i>I. longiglumis</i> Mez	SA	Brazil	BR-UPL	C ₃
<i>I. mayarensis</i> (C. Wright) Hitchc.	CB		CAR-WIP	C ₃
<i>I. mollis</i> Ekman	SA	Brazil	BR-UPL	C ₃
<i>I. procurrens</i> (Nees ex Trin.) Swallen	SA		BR-UPL + PAR	C ₃
<i>I. riedelii</i> (Trin.) Döll	SA	Brazil	BR-ATLP	C ₃
<i>I. tarjjanus</i> K. E. Rogers	SA		AR	C ₃
<i>I. tarumanensis</i> G. A. Black & Fróes	SA	Brazil	AMR	C ₃
<i>I. tectus</i> Swallen	SA	Venezuela	GUR	C ₃
<i>I. zehntneri</i> Mez	SA	Brazil	BR-UPL	C ₃
<i>Mesosetum agropyroides</i> Mez	SA		BR-UPL	C ₄ -MS
<i>M. alatum</i> Filg.	SA	Brazil	BR-UPL	C ₄ -MS
<i>M. annuum</i> Swallen	SA	Brazil	BR-UPL	C ₄ -MS
<i>M. ansatum</i> (Trin.) Kuhlman	SA	Brazil	BR-UPL	C ₄ -MS
<i>M. arenarium</i> Swallen	SA	Brazil	BR-UPL	C ₄ -MS
<i>M. bifarium</i> (Hack.) Chase	SA	Brazil	BR-UPL	C ₄ -MS
<i>M. blakei</i> Swallen	MA		CAR-CAP	C ₄ -MS
<i>M. chlorostachyum</i> (Döll) Chase	SA		AMR	C ₄ -MS
<i>M. comatum</i> Swallen	SA	Argentina	BR-PAR	C ₄ -MS
<i>M. elytrochaetum</i> (Hack.) Swallen	SA	Brazil	AMR	C ₄ -MS
<i>M. exaratum</i> (Trin.) Chase	SA	Brazil	BR-UPL	C ₄ -MS
<i>M. ferrugineum</i> (Trin.) Chase	SA	Brazil	BR-UPL	C ₄ -MS
<i>M. gibbosum</i> (Renvoize) Filg.	SA	Brazil	BR-UPL	C ₄ -MS
<i>M. longiaristatum</i> Filg.	SA	Brazil	BR-UPL	C ₄ -MS
<i>M. pappophorum</i> (Nees) Kuhlman	SA		BR-UPL + AMR	C ₄ -MS
<i>M. penicillatum</i> Mez	SA	Brazil	BR-UPL	C ₄ -MS
<i>M. pittieri</i> Hitchc.	MA		CAR-CAP	C ₄ -MS
<i>M. rottboellioides</i> (Kunth) Hitchc.	SA		GUR + AMR	C ₄ -MS
<i>M. sclerochloa</i> (Trin.) Hitchc.	SA	Brazil	BR-UPL	C ₄ -MS
<i>M. stoloniferum</i> Swallen	MA		CAR-CAP	C ₄ -MS
<i>M. wrightii</i> Hitchc.	CB		CAR-WIP	C ₄ -MS
<i>Ophiochloa hydrolythica</i> Filg., Davidse & Zuloaga	SA	Brazil	BR-UPL	C ₄ -MS
<i>Oplismenopsis najada</i> (Hack. & Arechav.) Parodi	SA		BR-PAR	C ₃
<i>Otachyrium aquaticum</i> Send. & Soderstr.	SA	Brazil	BR-UPL	C ₃
<i>O. boliviensis</i> Renvoize	SA	Bolivia	BR-UPL	C ₃
<i>O. grandiflorum</i> Send. & Soderstr.	SA		GUR + BR-UPL	C ₃
<i>O. piligerum</i> Send. & Soderstr.	SA	Brazil	BR-UPL	C ₃
<i>O. pterygodium</i> (Trin.) Pilg.	SA	Brazil	BR-UPL	C ₃
<i>O. seminudum</i> Hack. ex Send. & Soderstr.	SA	Brazil	BR-UPL	C ₃
<i>O. succisum</i> (Swallen) Send. & Soderstr.	SA		BR-UPL + AMR	C ₃
<i>Panicum acicularifolium</i> Renvoize & Zuloaga	SA	Brazil	BR-UPL	C ₃
<i>P. anceps</i> Michx.	NA	USA	NAAR	C ₄ -MS
<i>P. andreaum</i> Mez	SA		AR	C ₃
<i>P. animarum</i> Renvoize	SA	Brazil	BR-UPL	C ₃
<i>P. aristellum</i> Döll	SA	Brazil	BR-UPL	C ₃
<i>P. bahiense</i> Renvoize	SA	Brazil	BR-UPL	C ₃
<i>P. beyeri</i> Hitchc. & Ekman	CB		CAR-WIP	C ₄ -MS
<i>P. biglandulare</i> Scribn. & J. G. Sm.	MA		CAR-CAP	C ₃
<i>P. brachystachyum</i> Steud.	SA	Brazil	BR-UPL	C ₃
<i>P. bresolinii</i> L. B. Sm. & Wassh.	SA	Brazil	BR-PAR	C ₃
<i>P. chapadense</i> Swallen	SA	Brazil	BR-UPL	C ₃
<i>P. chnoodes</i> Trin.	SA		GUR + BR-UPL	C ₃
<i>P. cipoense</i> Renvoize & Send.	SA	Brazil	BR-UPL	C ₃
<i>P. condensatum</i> Bertol.	SA	Brazil	BR-ATLP	C ₃
<i>P. crateriferum</i> Sohns	NA	Mexico	MR	C ₃
<i>P. durifolium</i> Renvoize & Zuloaga	SA	Brazil	BR-UPL	C ₃
<i>P. eligulatum</i> N. E. Br.	SA		GUR + BR-UPL	C ₃
<i>P. euprepes</i> Renvoize	SA	Brazil	BR-UPL	C ₃
<i>P. fontanale</i> Swallen	SA	Venezuela	GUR	C ₃
<i>P. glaziovii</i> Hack.	SA	Brazil	BR-UPL	C ₃
<i>P. hemitomom</i> Schult.	CB/NA		NAAR + CAR-WIP	C ₃

Appendix 1. Continued.

Taxon	Continent	Country	Floristic region/province	Kranz syndrome
<i>P. irregulare</i> Swallen	MA/SA		CAR-CAP + AR	C ₃
<i>P. jauanum</i> Davidse	SA	Venezuela	GUR	C ₃
<i>P. lagostachyum</i> Renvoize & Zuloaga	SA	Brazil	BR-UPL	C ₃
<i>P. latissimum</i> Mikan ex Trin.	SA	Brazil	BR-ATLP	C ₃
<i>P. leptachne</i> Döll	SA	Brazil	BR-ATLP	C ₃
<i>P. longum</i> Hitchc. & Chase	NA	Mexico	MR	C ₃
<i>P. loreum</i> Trin.	SA	Brazil	BR-UPL	C ₃
<i>P. lutzii</i> Swallen	SA	Brazil	BR-UPL	C ₃
<i>P. marauense</i> Renvoize & Zuloaga	SA	Brazil	BR-UPL	C ₃
<i>P. molinioides</i> Trin.	SA	Brazil	BR-UPL	C ₃
<i>P. obtusum</i> Kunth	NA		MR	C ₄ -MS
<i>P. petersonii</i> Hitchc. & Ekman	CB		CAR-WIP	C ₄ -MS
<i>P. piauiense</i> Swallen	SA	Brazil	BR-UPL	C ₃
<i>P. poliophyllum</i> Renvoize & Zuloaga	SA	Brazil	BR-UPL	C ₃
<i>P. prionitis</i> Nees	SA		BR-PAR	C ₄ -MS
<i>P. restingae</i> Renvoize & Zuloaga	SA	Brazil	BR-UPL	C ₃
<i>P. rude</i> Nees	SA	Brazil	BR-ATLP + UPL	C ₃
<i>P. saccolepidoides</i> Renvoize & Zuloaga	SA	Brazil	BR-UPL	C ₃
<i>P. scabridum</i> Döll	SA		AMR	C ₃
<i>P. sipapoense</i> Swallen	SA	Venezuela	GUR	C ₃
<i>P. soderstromii</i> Zuloaga & Send.	SA	Brazil	BR-UPL	C ₃
<i>P. stagnatile</i> Hitchc. & Chase	NA/MA		MR + CAR-CAP	C ₃
<i>P. stevensianum</i> Hitchc. & Chase	CB/SA		AMR + CAR-WIP	C ₃
<i>P. steyermarkii</i> Swallen	SA	Venezuela	GUR	C ₃
<i>P. subtiramulosum</i> Renvoize & Zuloaga	SA	Brazil	BR-UPL	C ₃
<i>P. teretifolium</i> Hack.	SA	Brazil	BR-UPL	C ₃
<i>P. tijucae</i> Renvoize	SA	Brazil	BR-UPL	C ₃
<i>P. trinii</i> Kunth	SA	Brazil	BR-UPL	C ₃
<i>P. tuerckheimii</i> Hack.	MA		CAR-CAP	C ₄ -MS
<i>P. vaginiviscosum</i> Renvoize & Zuloaga	SA	Brazil	BR-UPL	C ₃
<i>P. validum</i> Mez	SA		BR-PAR	C ₄ -MS
<i>Paspalum acutifolium</i> León	CB		CAR-WIP	C ₄ -MS
<i>P. acutum</i> Chase	MA		CAR-CAP	C ₄ -MS
<i>P. adoperiens</i> (E. Fourn.) Chase	MA		CAR-CAP	C ₄ -MS
<i>P. affine</i> Steud.	MA		CAR-CAP	C ₄ -MS
<i>P. alaini</i> León	CB		CAR-WIP	C ₄ -MS
<i>P. albidulum</i> Henrard	SA		GUR	C ₄ -MS
<i>P. almum</i> Chase	SA		BR-CHA	C ₄ -MS
<i>P. alterniflorum</i> A. Rich.	CB		CAR-WIP	C ₄ -MS
<i>P. altsonii</i> Chase	SA		GUR	C ₄ -MS
<i>P. ammodes</i> Trin.	SA		GUR + BR-UPL	C ₄ -MS
<i>P. amphiacarpum</i> Ekman	CB		CAR-WIP	C ₄ -MS
<i>P. andersonii</i> Mez	SA	Peru	AR	C ₄ -MS
<i>P. apiculatum</i> Döll	SA		GUR + AMR	C ₄ -MS
<i>P. approximatum</i> Döll	SA		BR-UPL	C ₄ -MS
<i>P. arsenei</i> Chase	NA	Mexico	MR	C ₄ -MS
<i>P. arundinellum</i> Mez	SA		BR-PAR	C ₄ -MS
<i>P. aspidiotes</i> Trin.	SA		GUR + BR-UPL	C ₄ -MS
<i>P. atabapense</i> Davidse & Zuloaga	SA	Venezuela	GUR	C ₄ -MS
<i>P. azuayense</i> Sohns	SA	Ecuador	AR	C ₄ -MS
<i>P. bakeri</i> Hack.	CB/SA		AMR + CAR-WIP	C ₄ -MS
<i>P. barbinode</i> Hack.	SA	Brazil	BR-UPL	C ₄ -MS
<i>P. barclayii</i> Chase	SA	Peru	AR	C ₄ -MS
<i>P. bertonii</i> Hack.	SA		BR-PAR	C ₄ -MS
<i>P. biaristatum</i> Filg. & Davidse	SA	Brazil	BR-UPL	C ₄ -MS
<i>P. bifidifolium</i> Soderstr.	SA	Guyana	GUR	C ₄ -MS
<i>P. bifidum</i> (Bertol.) Nash	NA	USA	NAAR	C ₄ -MS
<i>P. bonplandianum</i> Flügge	SA		AR	C ₄ -MS
<i>P. botteri</i> (E. Fourn.) Chase	NA/MA		MR + CAR-CAP	C ₄ -MS
<i>P. brachytrichum</i> Hack.	SA	Brazil	BR-UPL	C ₄ -MS
<i>P. breve</i> Chase	CB		CAR-WIP	C ₄ -MS
<i>P. buchtienii</i> Hack.	SA	Bolivia	AR	C ₄ -MS
<i>P. burchelli</i> Munro ex Oliv.	SA	Brazil	BR-UPL	C ₄ -MS

Appendix 1. Continued.

Taxon	Continent	Country	Floristic region/province	Kranz syndrome
<i>P. burmanii</i> Filg., Morrone & Zuloaga	SA	Brazil	BR-UPL	C ₄ -MS
<i>P. cachimboense</i> Davidse, Morrone & Zuloaga	SA	Brazil	BR-UPL	C ₄ -MS
<i>P. campinarum</i> Filg. & Davidse	SA	Brazil	AMR	C ₄ -MS
<i>P. capillifolium</i> Nash	CB		CAR-WIP	C ₄ -MS
<i>P. centrale</i> Chase	MA		CAR-CAP	C ₄ -MS
<i>P. cerasia</i> (Kuntze) Chase	SA		AR	C ₄ -MS
<i>P. chacoense</i> Parodi	SA		BR-CHA	C ₄ -MS
<i>P. chaffanjonii</i> Maury	SA	Venezuela	GUR	C ₄ -MS
<i>P. chaseanum</i> Parodi	SA		BR-CHA	C ₄ -MS
<i>P. cinerascens</i> (Döll) A. G. Burm. & C. N. Bastos	SA		GUR + BR-UPL	C ₄ -MS
<i>P. circulare</i> Nash	NA	USA	NAAR	C ₄ -MS
<i>P. clandestinum</i> Swallen	SA	Brazil	BR-UPL	C ₄ -MS
<i>P. commune</i> Lillo	SA		AR	C ₄ -MS
<i>P. compressifolium</i> Swallen	SA		BR-UPL + PAR	C ₄ -MS
<i>P. conduplicatum</i> Canto-Dorow, Valls & Longhi-Wagner	SA	Brazil	BR-PAR	C ₄ -MS
<i>P. cordaense</i> Swallen	SA	Brazil	BR-UPL	C ₄ -MS
<i>P. cordatum</i> Hack.	SA		GUR + BR-UPL	C ₄ -MS
<i>P. costaricense</i> Mez	MA		CAR-CAP	C ₄ -MS
<i>P. costellatum</i> Swallen	SA	Brazil	BR-UPL	C ₄ -MS
<i>P. crinitum</i> Chase	NA	Mexico	MR	C ₄ -MS
<i>P. crispatum</i> Hack.	SA		BR-UPL	C ₄ -MS
<i>P. crispulum</i> Swallen	SA	Brazil	BR-UPL	C ₄ -MS
<i>P. cromyorrhizon</i> Trin. ex Döll	SA		BR-PAR	C ₄ -MS
<i>P. crustarium</i> Swallen	SA	Brazil	BR-UPL	C ₄ -MS
<i>P. culiacanum</i> Vasey	NA/MA		MR + CAR-CAP	C ₄ -MS
<i>P. curasavicum</i> Chase	CB		CAR-WIP	C ₄ -MS
<i>P. cymbiforme</i> E. Fourn.	NA/MA		MR + CAR-CAP	C ₄ -MS
<i>P. dasytrichium</i> Dusén ex Swallen	SA	Brazil	BR-UPL	C ₄ -MS
<i>P. dedecae</i> Quarín	SA		BR-UPL + PAR	C ₄ -MS
<i>P. delicatum</i> Swallen	SA		GUR + BR-UPL	C ₄ -MS
<i>P. difforme</i> J. Le Conte	NA	USA	NAAR	C ₄ -MS
<i>P. dilatatum</i> Poir.	SA		BR-PAR	C ₄ -MS
<i>P. dispar</i> Chase	CB		CAR-WIP	C ₄ -MS
<i>P. dissectum</i> (L.) L.	CB/NA		NAAR + CAR-WIP	C ₄ -MS
<i>P. distachyon</i> Poir. ex Trin.	CB		CAR-WIP	C ₄ -MS
<i>P. distortum</i> Chase	CB		CAR-WIP	C ₄ -MS
<i>P. divergens</i> Döll	SA	Brazil	BR-UPL	C ₄ -MS
<i>P. durifolium</i> Mez	SA		BR-PAR	C ₄ -MS
<i>P. edmondii</i> León	CB		CAR-WIP	C ₄ -MS
<i>P. ekmanianum</i> Henrard	SA		AR	C ₄ -MS
<i>P. ellipticum</i> Döll	SA	Brazil	BR-UPL	C ₄ -MS
<i>P. equitans</i> Mez	SA		BR-PAR	C ₄ -MS
<i>P. erectum</i> Chase	NA	Mexico	MR	C ₄ -MS
<i>P. erianthoides</i> Lindm.	SA		BR-PAR	C ₄ -MS
<i>P. eucomum</i> Nees ex Trin.	SA	Brazil	BR-UPL	C ₄ -MS
<i>P. exaltatum</i> J. Presl	SA		BR-PAR	C ₄ -MS
<i>P. expansum</i> Döll	SA	Brazil	BR-UPL	C ₄ -MS
<i>P. falcatum</i> Nees ex Steud.	SA		BR-UPL + PAR	C ₄ -MS
<i>P. filifolium</i> Nees ex Steud.	SA	Brazil	BR-UPL	C ₄ -MS
<i>P. filiforme</i> Sw.	CB		CAR-WIP	C ₄ -MS
<i>P. flaccidum</i> Nees	SA		BR-UPL	C ₄ -MS
<i>P. flavum</i> J. Presl	SA		AR	C ₄ -MS
<i>P. floridanum</i> Michx.	NA	USA	NAAR	C ₄ -MS
<i>P. formosum</i> Swallen	SA	Brazil	BR-UPL	C ₄ -MS
<i>P. galapageium</i> Chase	SA	Ecuador	CAR-GP	C ₄ -MS
<i>P. geminiflorum</i> Steud.	SA		AMR + BR-UPL	C ₄ -MS
<i>P. gemmosum</i> Chase ex Renvoize	SA	Brazil	BR-UPL	C ₄ -MS
<i>P. giganteum</i> Baldwin ex Vasey	NA	USA	NAAR	C ₄ -MS
<i>P. glabrinode</i> (Hack.) Morrone & Zuloaga	SA		BR-PAR	C ₄ -MS
<i>P. glaucescens</i> Hack.	SA		BR-UPL + CHA + PAR	C ₄ -MS
<i>P. goyasense</i> Davidse, Morrone & Zuloaga	SA	Brazil	BR-UPL	C ₄ -MS
<i>P. guaricense</i> Swallen	SA	Venezuela	AMR	C ₄ -MS

Appendix 1. Continued.

Taxon	Continent	Country	Floristic region/province	Kranz syndrome
<i>P. guenoarum</i> Arechav.	SA		BR-UPL + CHA + PAR	C ₄ -MS
<i>P. guttatum</i> Trin.	SA	Brazil	BR-UPL	C ₄ -MS
<i>P. haenkeanum</i> J. Presl	SA	Peru	AR	C ₄ -MS
<i>P. hartwegianum</i> E. Fourn.	NA	Mexico	MR	C ₄ -MS
<i>P. hatschbachii</i> Zuloaga & Morrone	SA	Brazil	BR-UPL	C ₄ -MS
<i>P. haumanii</i> Parodi	SA		BR-PAR	C ₄ -MS
<i>P. hintonii</i> Chase	NA	Mexico	MR	C ₄ -MS
<i>P. hirtum</i> Kunth	SA	Colombia	AR	C ₄ -MS
<i>P. hispidum</i> Swallen	MA	Guatemala	CAR-CAP	C ₄ -MS
<i>P. hitchcockii</i> Chase	MA/SA		CAR-CAP + AR	C ₄ -MS
<i>P. imbricatum</i> Filg.	SA	Brazil	BR-UPL	C ₄ -MS
<i>P. inconstans</i> Chase	SA		AR	C ₄ -MS
<i>P. indecorum</i> Mez	SA		BR-PAR	C ₄ -MS
<i>P. insulare</i> Ekman ex Chase	CB		CAR-WIP	C ₄ -MS
<i>P. ionanthum</i> Chase	SA		BR-PAR	C ₄ -MS
<i>P. jaliscanum</i> Chase	NA/MA		MR + CAR-CAP	C ₄ -MS
<i>P. jesuiticum</i> Parodi	SA		BR-PAR	C ₄ -MS
<i>P. jimenezii</i> Chase	MA	Costa Rica	CAR-CAP	C ₄ -MS
<i>P. killipii</i> (Hitchc.) Zuloaga and Soderstr.	SA	Peru	AR	C ₄ -MS
<i>P. lachneum</i> Nees ex Steud.	SA		BR-UPL	C ₄ -MS
<i>P. lacustre</i> Chase ex Swallen	SA	Brazil	AMR	C ₄ -MS
<i>P. laeve</i> Michx.	NA	USA	NAAR	C ₄ -MS
<i>P. lanciflorum</i> Trin.	SA		GUR + BR-UPL	C ₄ -MS
<i>P. latipes</i> Swallen	SA	Brazil	BR-UPL	C ₄ -MS
<i>P. lenticulare</i> Kunth	SA	Venezuela	AMR	C ₄ -MS
<i>P. lentiferum</i> Lam.	NA	USA	NAAR	C ₄ -MS
<i>P. lentifinosum</i> J. Presl	NA/MA		MR + CAR-CAP	C ₄ -MS
<i>P. leptachne</i> Chase	NA	Mexico	MR	C ₄ -MS
<i>P. lilloi</i> Hack.	SA		BR-PAR	C ₄ -MS
<i>P. limbatum</i> Henrard	SA		BR-PAR	C ₄ -MS
<i>P. lindenianum</i> A. Rich.	CB		CAR-WIP	C ₄ -MS
<i>P. loefgrenii</i> Ekman	SA		BR-CP	C ₄ -MS
<i>P. longiaristatum</i> Davidse & Filg.	SA	Brazil	BR-UPL	C ₄ -MS
<i>P. longicuspe</i> Nash	NA	Mexico	MR	C ₄ -MS
<i>P. longipilum</i> Nash	NA	USA	NAAR	C ₄ -MS
<i>P. longum</i> Chase	NA	Mexico	MR	C ₄ -MS
<i>P. macranthecium</i> Parodi	SA		BR-UPL	C ₄ -MS
<i>P. macrophyllum</i> Kunth	SA		AR	C ₄ -MS
<i>P. madorense</i> Renvoize	SA	Brazil	BR-UPL	C ₄ -MS
<i>P. malmeanum</i> Ekman	SA		BR-UPL	C ₄ -MS
<i>P. mandiocanum</i> Trin.	SA		BR-UPL + PAR	C ₄ -MS
<i>P. marmoratum</i> Kuhlm.	SA	Brazil	BR-UPL	C ₄ -MS
<i>P. mayanum</i> Chase	MA	Mexico	CAR-CAP	C ₄ -MS
<i>P. minarum</i> Hack.	SA	Brazil	BR-UPL	C ₄ -MS
<i>P. modestum</i> Mez	SA		BR-PAR	C ₄ -MS
<i>P. monostachyum</i> Vasey	NA		NAAR	C ₄ -MS
<i>P. morichalense</i> Davidse, Zuloaga & Filg.	SA		GUR + AMR	C ₄ -MS
<i>P. multinervium</i> A. G. Burm.	SA		GUR + BR-UPL	C ₄ -MS
<i>P. mutabile</i> Chase	NA	Mexico	MR	C ₄ -MS
<i>P. nanum</i> C. Wright ex Griseb.	CB		CAR-WIP	C ₄ -MS
<i>P. nelsonii</i> Chase	NA	Mexico	MR	C ₄ -MS
<i>P. nesioties</i> Chase	CB		CAR-WIP	C ₄ -MS
<i>P. nicorae</i> Parodi	SA		BR-PAR	C ₄ -MS
<i>P. niquelandiae</i> Filg.	SA	Brazil	BR-UPL	C ₄ -MS
<i>P. nudatum</i> Luces	SA		AMR + BR-UPL	C ₄ -MS
<i>P. nummularium</i> Chase ex Sendulsky & A. G. Burm.	SA	Brazil	BR-ATLP + UPL	C ₄ -MS
<i>P. oteroi</i> Swallen	SA	Brazil	BR-UPL	C ₄ -MS
<i>P. ovale</i> Nees ex Steud.	SA		BR-PAR	C ₄ -MS
<i>P. pallens</i> Swallen	SA		BR-UPL	C ₄ -MS
<i>P. pallidum</i> Kunth	SA		AR	C ₄ -MS
<i>P. palmeri</i> Chase	NA	Mexico	MR	C ₄ -MS
<i>P. paludosum</i> Swallen	SA	Brazil	BR-UPL	C ₄ -MS
<i>P. palustre</i> Mez	SA		BR-PAR	C ₄ -MS
<i>P. pauciciliatum</i> (Parodi) Herter	SA		BR-PAR	C ₄ -MS

Appendix 1. Continued.

Taxon	Continent	Country	Floristic region/province	Kranz syndrome
<i>P. paucifolium</i> Swallen	SA		BR-PAR	C ₄ -MS
<i>P. peckii</i> F. T. Hubb.	MA		CAR-CAP	C ₄ -MS
<i>P. penicillatum</i> Hook. f.	SA		AR	C ₄ -MS
<i>P. petilum</i> Chase	SA		GUR	C ₄ -MS
<i>P. petrense</i> A. G. Burm.	SA	Brazil	BR-UPL	C ₄ -MS
<i>P. petrosum</i> Swallen	SA	Colombia	GUR	C ₄ -MS
<i>P. phyllorachis</i> Hack.	SA	Brazil	BR-UPL	C ₄ -MS
<i>P. pictum</i> Ekman	MA/SA		CAR-CAP + AMR	C ₄ -MS
<i>P. pilgerianum</i> Chase	SA		AR	C ₄ -MS
<i>P. pissinum</i> Swallen	SA	Brazil	BR-UPL	C ₄ -MS
<i>P. planum</i> Hack.	SA		BR-PAR	C ₄ -MS
<i>P. pontanalis</i> Swallen	SA	Brazil	BR-UPL	C ₄ -MS
<i>P. praecox</i> Walter	NA	USA	NAAR	C ₄ -MS
<i>P. procurrens</i> Quarín	SA		BR-PAR	C ₄ -MS
<i>P. proximum</i> Mez	SA		BR-UPL + PAR	C ₄ -MS
<i>P. quadrifarium</i> Lam.	SA		BR-PAR	C ₄ -MS
<i>P. quarinii</i> Morrone & Zuloaga	SA		BR-PAR	C ₄ -MS
<i>P. racemosum</i> Lam.	SA		AR	C ₄ -MS
<i>P. ramboi</i> I. L. Barreto	SA	Brazil	BR-PAR	C ₄ -MS
<i>P. rectum</i> Nees	SA	Brazil	BR-UPL	C ₄ -MS
<i>P. redondense</i> Swallen	SA	Brazil	BR-UPL	C ₄ -MS
<i>P. reduncum</i> Nees ex Steud.	SA	Brazil	BR-UPL	C ₄ -MS
<i>P. redundans</i> Chase	SA	Ecuador	CAR-GP	C ₄ -MS
<i>P. regnellii</i> Mez	SA		BR-UPL + PAR	C ₄ -MS
<i>P. remotum</i> J. Rémy	SA		AR	C ₄ -MS
<i>P. reptatum</i> Hitchc. & Chase	CB		CAR-WIP	C ₄ -MS
<i>P. restingense</i> Renvoize	SA	Brazil	BR-UPL	C ₄ -MS
<i>P. reticulinerve</i> Renvoize	SA	Bolivia	BR-UPL	C ₄ -MS
<i>P. riedellii</i> Mez	SA	Brazil	BR-UPL	C ₄ -MS
<i>P. riparium</i> Nees	SA		AMR	C ₄ -MS
<i>P. rocanum</i> León	CB		CAR-WIP	C ₄ -MS
<i>P. rottboellioides</i> C. Wright	CB		CAR-WIP	C ₄ -MS
<i>P. rufum</i> Nees ex Steud.	SA		BR-PAR	C ₄ -MS
<i>P. rugulosum</i> Morrone & Zuloaga	SA	Ecuador	AR	C ₄ -MS
<i>P. rupestre</i> Trin.	CB		CAR-WIP	C ₄ -MS
<i>P. rupium</i> Renvoize	SA	Brazil	BR-UPL	C ₄ -MS
<i>P. sauetii</i> Chase	CB		CAR-WIP	C ₄ -MS
<i>P. scalare</i> Trin.	SA	Brazil	BR-UPL	C ₄ -MS
<i>P. schultesii</i> Swallen	SA	Colombia	GUR	C ₄ -MS
<i>P. scutatatum</i> Nees ex Trin.	SA	Brazil	BR-UPL + CP	C ₄ -MS
<i>P. simplex</i> Morong	SA		BR-CHA	C ₄ -MS
<i>P. sodiroanum</i> Hack.	SA		AR	C ₄ -MS
<i>P. soukupii</i> Carbonó	SA	Peru	AR	C ₄ -MS
<i>P. squamulatum</i> E. Fourn.	NA/MA		MR + CAR-CAP	C ₄ -MS
<i>P. strigosum</i> Döll ex Chase	SA	Brazil	BR-ATLP	C ₄ -MS
<i>P. subciliatum</i> Chase	MA/SA		CAR-CAP + AMR	C ₄ -MS
<i>P. subfalcatum</i> (Döll) Tutin	SA	Venezuela	AMR	C ₄ -MS
<i>P. subsesquiglume</i> Döll	SA	Brazil	BR-UPL	C ₄ -MS
<i>P. telmatum</i> Swallen	SA		BR-UPL	NA
<i>P. tilletii</i> Davidse & Zuloaga	SA		GUR	C ₄ -MS
<i>P. tinctum</i> Chase	NA/MA		MR + CAR-CAP	C ₄ -MS
<i>P. toluensis</i> R. Guzmán	NA	Mexico	MR	C ₄ -MS
<i>P. trianae</i> Pilg.	SA		AR	C ₄ -MS
<i>P. trichophyllum</i> Henrard	SA		BR-UPL	C ₄ -MS
<i>P. trichostomum</i> Hack.	SA	Brazil	BR-UPL	C ₄ -MS
<i>P. trinii</i> Swallen	SA		AR	C ₄ -MS
<i>P. tuberosum</i> Mez	SA	Peru	AR	C ₄ -MS
<i>P. turriforme</i> R. W. Pohl	MA		CAR-CAP	C ₄ -MS
<i>P. umbrosum</i> Trin.	SA		BR-UPL + PAR	C ₄ -MS
<i>P. urbanianum</i> Ekman ex Hitchc.	CB		CAR-WIP	C ₄ -MS
<i>P. urvillei</i> Steud.	SA		BR-UPL + PAR	C ₄ -MS
<i>P. usteri</i> Hack.	SA		BR-PAR	C ₄ -MS

Appendix 1. Continued.

Taxon	Continent	Country	Floristic region/province	Kranz syndrome
<i>P. uyucense</i> R. W. Pohl	MA	Honduras	CAR-CAP	C ₄ -MS
<i>P. validum</i> Swallen	SA	Brazil	BR-UPL	C ₄ -MS
<i>P. variable</i> (E. Fourn.) Nash	NA/MA		MR + CAR-CAP	C ₄ -MS
<i>P. venezuelae</i> (Chase) A. G. Burm.	SA	Venezuela	GUR	C ₄ -MS
<i>P. virletii</i> E. Fourn.	NA	Mexico	MR	C ₄ -MS
<i>P. volcanensis</i> Zuloaga, Morrone & Denham	SA		AR	C ₄ -MS
<i>P. zuloagae</i> Davidse & Filg.	SA	Brazil	BR-UPL	C ₄ -MS
<i>Phanopyrum gymnocarpon</i> (Elliott) Nash	NA	USA	NAAR	C ₃
<i>Plagiantha tenella</i> Renvoize	SA	Brazil	BR-UPL	C ₃
<i>Reimarochloa aberrans</i> (Döll) Chase	SA		AMR	C ₄ -MS
<i>R. oligostachya</i> (Munro ex Benth.) Hitchc.	CB/NA		NAAR + CAR-WIP	C ₄ -MS
<i>Spheneria kegelii</i> (Müll. Hal.) Pilg.	SA		BR-UPL + AMR	C ₃ /C ₄
<i>Steinchisma cuprea</i> (Hitchc. & Chase) W. V. Br.	NA	Mexico	MR	
<i>S. decipiens</i> (Nees ex Trin.) W. V. Br.	SA		GUR + BR-CHA + UPL + PAR	C ₃ /C ₄
<i>S. exiguiflora</i> (Griseb.) W. V. Br.	CB		CAR-WIP	C ₃ /C ₄
<i>S. spathellosa</i> (Döll) Renvoize	SA		BR-PAR	C ₃ /C ₄
<i>S. stenophylla</i> (Hack.) Zuloaga & Morrone	SA		BR-UPL + AMR	C ₃ /C ₄
<i>Streptostachys asperifolia</i> Desv.	CB/SA		AMR + BR-UPL + CAR-WIP	C ₄ -MS
<i>S. macrantha</i> (Trin.) Zuloaga & Morrone	SA		BR-UPL	C ₄ -MS
<i>S. ramosa</i> Zuloaga & Soderstr.	SA	Brazil	BR-UPL	C ₄ -MS
<i>S. rigidifolia</i> Filg., Morrone & Zuloaga	SA	Brazil	BR-UPL	C ₄ -MS
<i>Tatianyxa arnacites</i> (Trin.) Zuloaga & Soderstr.	SA	Brazil	BR-UPL	C ₄ -MS
<i>Thrasya achlysophila</i> Soderstr.	SA	Guyana	GUR	C ₄ -MS
<i>T. auricoma</i> A. G. Burm.	SA	Brazil	BR-UPL	C ₄ -MS
<i>T. axillaris</i> (Swallen) A. G. Burm. ex Judz.	SA		GUR	C ₄ -MS
<i>T. crucensis</i> Killeen	SA	Bolivia	BR-UPL	C ₄ -MS
<i>T. glaziovii</i> A. G. Burm.	SA	Brazil	BR-UPL	C ₄ -MS
<i>T. granitica</i> A. G. Burm.	SA	Suriname	GUR	C ₄ -MS
<i>T. hitchcockii</i> Chase	MA/SA		CAR-CAP + AMR	C ₄ -MS
<i>T. longiligulata</i> Bastos & A. G. Burm.	SA	Brazil	BR-UPL	NA
<i>T. mosquitensis</i> Davidse & A. G. Burm.	MA		CAR-CAP	NA
<i>T. oreophila</i> A. G. Burm.	SA	Brazil	BR-UPL	NA
<i>T. parvula</i> A. G. Burm.	SA	Brazil	AMR	C ₄ -MS
<i>T. paspaloides</i> Kunth	CB/SA		CAR-WIP + AMR	C ₄ -MS
<i>T. scandens</i> (Trin.) Soderstr. & A. G. Burm.	SA		GUR	C ₄ -MS
<i>T. schumannii</i> (Pilg.) Pilg.	SA	Brazil	BR-UPL	C ₄ -MS
<i>T. seminuda</i> A. G. Burm.	SA	Brazil	GUR + BR-UPL	C ₄ -MS
<i>T. setosa</i> Swallen	SA	Venezuela	GUR	C ₄ -MS
<i>T. stricta</i> A. G. Burm.	SA		GUR	C ₄ -MS
<i>T. thrasyoides</i> (Trin.) Chase	SA		BR-UPL	C ₄ -MS
<i>Thrasypopsis juergensii</i> (Hack.) Soderstr. & A. G. Burm.	SA	Brazil	BR-PAR	C ₄ -MS
<i>T. repanda</i> (Nees ex Trin.) Parodi	SA	Brazil	BR-UPL + PAR	C ₄ -MS
<i>Triscenia ovina</i> Griseb.	CB		CAR-WIP	C ₃
Subtribe Setariinae				
<i>Panicum plenum</i> Hitchc. & Chase	NA		MR	C ₄ -MS
<i>Paspalidium chapmanii</i> (Vasey) R. W. Pohl	CB/NA		CAR-CAP + WIP + NAAR	C ₄ -MS
<i>Setaria alonsoi</i> Pensiero & Anton	SA	Argentina	BR-CHA	C ₄ -MS
<i>S. arizonica</i> Rominger	NA		MR	C ₄ -MS
<i>S. barbinodis</i> R. A. W. Herrm.	SA	Bolivia	AR	C ₄ -MS
<i>S. cernua</i> Kunth	SA	Ecuador	AR	C ₄ -MS
<i>S. cordobensis</i> R. A. W. Herrm.	SA		AR	C ₄ -MS
<i>S. corrugata</i> (Elliott) Schult.	CB/NA		NAAR + CAR-WIP	C ₄ -MS
<i>S. distantiflora</i> (A. Rich.) Pilg.	CB		CAR-WIP	C ₄ -MS
<i>S. fiebrigii</i> R. A. W. Herrm.	SA		BR-CHA	C ₄ -MS
<i>S. globulifera</i> (Steud.) Griseb.	SA		BR-CHA + PAR	C ₄ -MS
<i>S. hunzikeri</i> Anton	SA		BR-CHA	C ₄ -MS
<i>S. lachnea</i> (Nees) Kunth	SA		BR-CHA	C ₄ -MS
<i>S. latifolia</i> (Scribn.) R. A. W. Herrm.	NA	Mexico	MR	C ₄ -MS
<i>S. leonis</i> (Ekman) León	CB		CAR-WIP	C ₄ -MS
<i>S. longipila</i> E. Fourn.	MA		CAR-CAP	C ₄ -MS
<i>S. mendocina</i> Phil.	SA	Argentina	BR-CHA	C ₄ -MS
<i>S. oblongata</i> (Griseb.) Parodi	SA		BR-CHA	C ₄ -MS
<i>S. palmeri</i> Henrard	NA	Mexico	MR	C ₄ -MS

Appendix 1. Continued.

Taxon	Continent	Country	Floristic region/province	Kranz syndrome
<i>S. pampeana</i> Parodi ex Nicora	SA		BR-CHA	C ₄ -MS
<i>S. paraguayensis</i> Pensiero	SA		BR-CHA	C ₄ -MS
<i>S. parodii</i> Nicora	SA		BR-CHA	C ₄ -MS
<i>S. paucifolia</i> (Morong) Lindm.	SA		BR-UPL + CHA	C ₄ -MS
<i>S. pflanzii</i> Pensiero	SA		BR-CHA	C ₄ -MS
<i>S. pradana</i> (León) León	CB		CAR-WIP	C ₄ -MS
<i>S. reverchonii</i> (Vasey) Pilg.	NA		MR	C ₄ -MS
<i>S. rosenfurtii</i> Nicora	SA		BR-CHA	C ₄ -MS
<i>S. scabrifolia</i> (Nees) Kunth	SA		BR-UPL + CHA	C ₄ -MS
<i>S. scheelei</i> (Steud.) Hitchc.	NA		MR	C ₄ -MS
<i>S. stolonifera</i> Boldrini	SA		BR-CHA	C ₄ -MS
<i>S. submacrostachya</i> Lucas	SA	Venezuela	GUR	C ₄ -MS
<i>S. texana</i> Emery	NA		MR	C ₄ -MS
<i>S. utowanaeae</i> (Scribn.) Pilg.	CB/SA		CAR-WIP + AMR	C ₄ -MS
<i>S. vaginata</i> Spreng.	SA		BR-CHA	C ₄ -MS
<i>S. variiifolia</i> (Swallen) Davidse	MA		CAR-CAP	C ₄ -MS
<i>S. villosissima</i> (Scribn. & Merr.) K. Schum.	NA		MR	C ₄ -MS
<i>Setariopsis latiglumis</i> (Vasey) Scribn.	NA	Mexico	MR	C ₄ -MS
Tribe Steyermarkochloae				
<i>Arundoclaytonia dissimilis</i> Davidse & R. P. Ellis	SA	Brazil	AMR	C ₃
<i>Steyermarkochloa unifolia</i> Davidse & R. P. Ellis	SA		AMR	C ₃