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On the Taxonomic Position of *Panicum aristellum* (Poaceae: Panicoideae: Paniceae)

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ABSTRACT. In a recent treatment, the genus *Panicum* was restricted to subgenus *Panicum* based on molecular, morphological, and anatomical data. Also, other species of *Panicum* were transferred to different genera of the Paniceae, such as *Dichanthelium*, *Hymenachne*, *Phanopyrum*, and *Steinchisma*, while the remaining American species of *Panicum* were temporarily placed as incertae sedis taxa. Therefore, these incertae sedis species are in need of a new taxonomic status within the tribe. In this study, the taxonomic position of *Panicum aristellum*, an endemic species of central and southeastern Brazil, is evaluated using morphological and anatomical characters, together with sequence data from *ndhF*, a molecular marker from the chloroplast. The sequence of *Panicum aristellum* was analyzed together with other species of the subfamily Panicoideae. This species grouped with the genus *Canastra* in a well-supported clade. Several synapomorphies characterized the clade: caespitose plants, keeled sheaths, aristate spikelets, scabrous bracts, the number of nerves of the glumes and lower lemma, the presence of a lower palea and lower flower, a non-indurate upper anthecium, and a similar geographical distribution. In addition, both species are C_3 with non-Kranz anatomy. As a result, the new combination ***Canastra aristella*** is proposed and the species is compared to putatively related genera within the Paniceae.

KEYWORDS: *Panicum*, *Canastra*, Poaceae, Panicoideae, Paniceae, taxonomy.

The genus *Panicum* L. was traditionally considered one of the largest of the Poaceae, with ~450 species worldwide distributed primarily in tropical and subtropical regions. *Panicum* was notoriously variable in its vegetative, anatomical, and physiological characters (Ellis 1988; Crins 1991). This variation lead to a controversial delimitation of the genus and also of its subgenera and species (Hitchcock and Chase 1910, 1915; Stapf 1917–1934; Pilger 1931, 1940; Hsu 1965; Brown 1977; Gould and Clark 1978; Zuloaga and Soderstrom 1985; Zuloaga 1987; Gómez-Martínez and Culham 2000; Zuloaga et al. 2000; Duvall et al. 2001; Giussani et al. 2001; Aliscioni et al. 2003; Simon and Jacobs 2003) and, since it was first described by Linneaus in 1753, many taxa have been segregated to different genera of the tribe Paniceae. In a recent phylogenetic analysis of *Panicum*, based on *ndhF* sequences, morphology, and anatomy, *Panicum* was restricted to species of subgenus *Panicum* comprising ca. 100 species in five sections: *Dichotomiflora*, *Panicum*, *Rudgeana*, *Virgata*, and *Urvilleana* (Aliscioni et al. 2003). All these taxa were clustered in a highly supported monophyletic group (97% bootstrap, and 6 decay) and the genus *Panicum* was then circumscribed by several morphological and anatomical synapomorphies. All species of *Panicum* are C_4 of the NAD-me photosynthetic subtype, with chloroplast centrifugally or centripetally orientated in the outer parenchymatous sheath and have a basic chromosome number of $x = 9$. Also, *Panicum* includes caespitose species with membranous-ciliate ligules, open panicles with spikelets on long pedicels, upper and lower lemma (5–)7–13-nerved, and upper anthecium indurated with compound papillae at the apex of the upper palea.

This circumscription matches previous results sustained by different authors (Gómez-Cuhlman 2000; Zuloaga et al. 2000; Duvall et al. 2001; Giussani et al. 2001). As a result of the present delimitation of *Panicum*, several subgenera and species have been placed in other genera, such as *Hymenachne*, *Megathyrsus*, *Dichanthelium*, *Phanopyrum*, and *Steinchisma* (Zuloaga et al. 1998, 2003; Aliscioni et al. 2003; Simon and Jacobs 2003; Barkworth 2004). Nevertheless, other sections and species of *Panicum*, which show significant variability, are in need of a definite placement within the tribe Paniceae. Among these taxa, *Panicum aristellum* Döll is the only remaining species in *Panicum* with awns present on both glumes; in addition, *P. aristellum* has a membranous upper anthecium and its anatomy is typically non-Kranz.

The purpose of this study is to evaluate the taxonomic position of *Panicum aristellum* based on new molecular evidence from the *ndhF* gene (NADH-DH subunit F), together with several morphological and anatomical characters.

MATERIALS AND METHODS

Morphological and Anatomical Analyses. Morphological data are based on field collections and study of herbaria collections. For anatomical studies, the second leaf below the inflorescence was selected. Specimens compared were *Longhi-Wagner et al. 9659* and *Kuhlmann 2774.* Transverse sections of dried leaf blades were prepared after desilicification in 10% hydrofluoric acid (Breakwell 1914). Midblade transverse sections were made by hand, dyed with Safranin and mounted in semi-permanent microscope slides with gelatine-glycerin. Epidermal peels of leaf blades were pre-

Fig. 1. Field photographs of *Canastra aristella*. A. View of the habitat in Serra do Caraça, Minas Gerais, Brazil. B, C. Habit. D. Detail of a portion of the inflorescence (from *Longhi Wagner et al. 9659*).

pared by removing the mesophyll and vascular tissue with a scapel following procedures in Metcalfe (1960). The epidermis was stained in safranin. The standardized terminology of Ellis (1976, 1979) was used to describe leaf anatomy. Epidermal preparations were viewed on a Zeiss 940 A scanning electron microscope of the Darwinion Institute, operating at 10–20 kV.

DNA Sequencing. A specimen of *Panicum aristellum* (*Longhi-Wagner et al. 9659*) was field collected and dried in silica gel. DNA extraction was conducted using modified CTAB protocols similar to those used by Giussani et al. (2001). The *ndhF* gene was amplified via the polymerase chain reaction (PCR) using a *Taq* mediated protocol (Promega Corp.) and two pairs of primers specified by Olmstead and Sweere (1994): 5F/972R and 972F/2110R. These primers, and F536, R536, F1318, and R1821 were used for the sequencing reactions to get forward and reverse strands with a minimum overlap of 90%. Cleaning of PCR products and sequencing reactions were performed by Macrogen, Inc. To edit and assemble the sequences, we used the program Chromas Pro version 1.22 (Technelysium Pty, Ltd). The sequences were translated to check for stop codons and then manually aligned using the program BioEdit version 5.0.9 (Hall 1999). The complete sequence was submitted to GenBank.

Outgroup Selection. We added the sequence of *ndhF* corresponding to *Panicum aristellum* into a larger sample that includes all available sequences of *Panicum* (Aliscioni et al. 2003), and a broad sample of the Paniceae genera representing about 30% of the tribe (Giussani et al. 2001; Appendix 1). Representatives of tribe Andropogoneae, as well as members of tribes Thysanolaeneae (Arundinoideae), and Centotheceae (Centothecoideae) were also included. A total of 114 taxa comprised the matrix used in the molecular phylogenetic studies. The aligned matrix was submitted to TreeBASE (study accession S1528).

Phylogenetic Analysis. A maximum parsimony analysis was performed using Nona version 2.0 (Goloboff 1997) with all characters equally weighted and gaps scored as missing data. Overall, 3.5% of the data matrix cells were scored as gaps. Winclada version 1.00.08 (Nixon 2002) was used to construct trees. All informative characters were considered unordered. Searches were performed using ''mult*1000''. It stores one most-parsimonious tree in memory per replicate, and repeats the process 1000 times. The shortest trees retained from the subsearches were then TBR swapped to completion with the ''max*'' command. A strict consensus tree was generated from the most parsimonious trees. To assess relative support for clades, bootstrap analyses were performed; a total of 1,000 replicates of heuristic searches were done using random taxon entry followed by tree bisection-reconnection (TBR).

RESULTS

Leaf Blade Anatomy .TRANSVERSE SECTION. OUTLINE (FIG. 3). Open, V-shaped, with the margins slightly recurved; leaf thickness 265–295 μm, arms of the lamina symmetrical. *Ribs and furrows:* adaxial ribs and furrows slightly developed, usually larger adjacent to the keel; abaxial ribs and furrows indistinguishable; ribs associated with first- and second-order vascular bundles, the apex flat; furrows 1/6–1/5 deep in relation to the width of the lamina. *Keel*: developed, flattened on the adaxial side and rounded on the abaxial side, associated with adaxial colourless parenchyma, and 8–12 first-order and 7–10 second-order vascular bundles. *Vascular bundle arrangement*: 7–9 first-order vascular bundles on either side of the keel; one or three second vascular bundles between contiguous vascular bun-

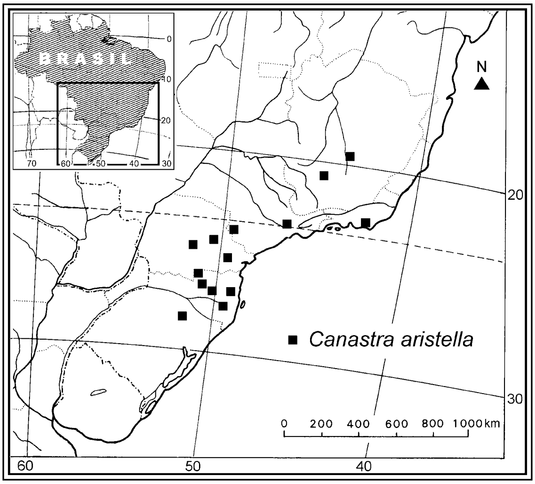

FIG. 2. Distribution of *Canastra aristella*.

dles; all vascular bundles centrally located in the blade or slightly abaxially displaced. First-order vascular bundles circular in outline; metaxylem vessel elements wider than the parenchyma sheath cells, with angular walls; phloem tissue adjoining the inner bundle sheath. Second-order vascular bundles circular in outline, with xylem and phloem tissue distinguishable. *Vascular bundle sheaths:* outer first-order bundle sheaths consisting of 11–15 parenchyma cells, with abaxial interruption of sclerenchyma girders; outer second-order bundle sheath cells completely surrounding the vascular bundles, with 7–9 parenchyma cells; parenchyma sheath cells inflated with thin walls and lacking chloroplast; adaxial bundle sheath extension present in the second-order vascular bundle sheaths, usually uniseriate and consisting of 1–3 cells, colorless cells very similar to the outer bundle sheaths; mestome bundle sheaths complete, surrounding the xylem and phloem tissue. *Sclerenchyma*: minute, adaxial and abaxial girders associated with first- and second-order vascular bundles. Small sclerenchyma cap in the margin. *Mesophyll*: chlorenchyma irregularly radiate around the vascular bundle sheaths, always with more than 5 chlorenchyma cells between consecutive vascular bundle sheaths. Fusoid cells absent. *Adaxial epidermal cells*: bulliform cells present in the adaxial furrows between vascular bundles, fan-shaped, in restricted groups of 4–6 cells, occupying up to 1/3 of the blade thickness. Epidermal cells small, regular in size, the outer walls flattened and with continuous and thickened cuticle. Macrohairs and prickles absent or present; papillae absent. *Abaxial epidermal cells*: bulliform cells absent, cuticle thickened; macrohairs and prickles present or absent; papillae absent.

ABAXIAL EPIDERMIS (FIG. 4A). ZONATION. Costal and intercostal zones distinguishable; costal zone formed of 4–10 rows of long cells; intercostal zone consisting of 12–15 rows of long cells. *Intercostal long cells:* elongated rectangularly, more than 5 times longer than wide, anticlinal walls parallel, end walls vertical; anticlinal walls undulated; anticlinal and transversal walls uniformly thickened; short cells single or in cork-silica cells pair. *Stomata complex:* triangular, 32.5–39 μm long, 23–27.5 μm wide, 6–8 longitudinal rows of stomata per intercostal zone, usually separated by one interstomatal long-cells between consecutive stomata in a row. *Intercostal short cells:* Solitary, transversely elongated or in silica-suberose pairs; cork cells rectangular, with undulated walls. *Microhairs:* bicellular, elongated, finger-like, 65–78 μm long, distal cells with very thin walls and tapered at the apex; basal cells equal or slightly longer than the distal cells. *Papillae:* absent. *Prickle hairs:* absent or present, small and with the base shorter than the stomata; barb longer than the base. *Macrohairs*: absent or present; unicellular when present, cushion-based. Costal silica bodies dumbell-shaped; intercostal silica bodies tall and narrow, transversely elongated.

ADAXIAL EPIDERMIS (FIG. 4 B–D). Epidermal cells similar to the abaxial surface, except for the presence

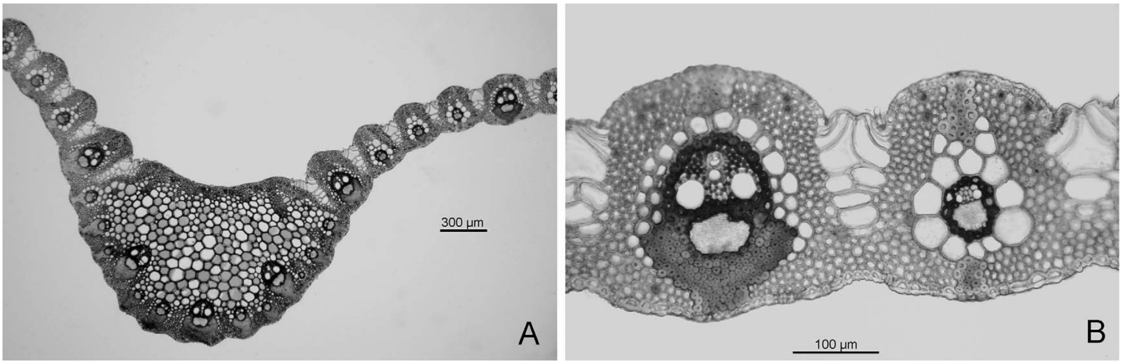

FIG. 3. Cross section of the leaf blade anatomy of *Canastra aristella*. A. General aspect of the keel, with portions of the leaf blade. B. Portion of the leaf blade showing first- and second-order vascular bundles.

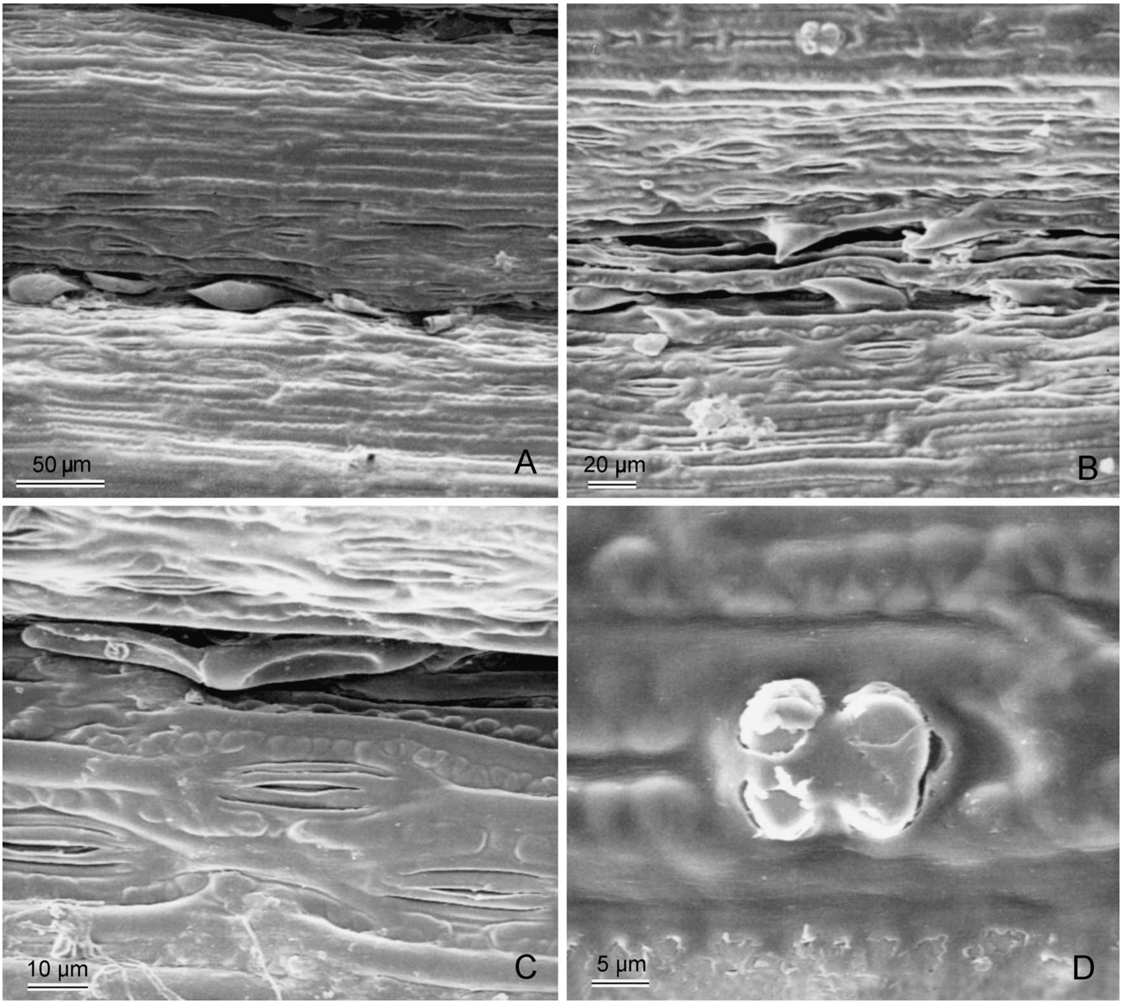

FIG. 4. Scanning electron micrographs of leaf blades of *Canastra aristella*. A. Abaxial epidermis showing costal and intercostal zones. B. Adaxial epidermis showing costal and intercostal zones. C. Detailed view of B, with stomata and bicellular microhairs. D. Costal silica body in the adaxial epidermis.

of a central band of isodiametric cells, 4–6 cells wide, in the intercostal zones.

As seen by its anatomical features, *Panicum aristellum* is a non-Kranz species, with two bundles around each vascular bundle, the outer parenchymatic, and without specialized chloroplasts, the inner one mestomatic; more than 5 cells are present between contiguous vascular bundles. These characters ally *P. aristellum* to *C. lanceolata*, also a non-Kranz species; however, fusoid cells are only present in *C. lanceolata*.

Molecular Phylogeny. The data set comprised 114 taxa and 2061 base pairs, including indels. A total of 430 characters were parsimony-informative and used in the analyses. The cladistic analyses found 4176 most parsimonious trees of 1459 steps (CI = 0.43, RI = 0.77). *Panicum aristellum* was related to the Paniceae genera with $x = 10$ basic chromosome number, and included within the ''Ambiguous clade'' of Giussani et al. (2001). This taxon grouped with *Canastra lanceolata* and was highly supported by the bootstrap analysis (99%). The clade was also present in the strict consensus of all shortest trees (Fig. 5).

DISCUSSION

Panicum aristellum was described by Döll (1877), who emphazised the presence of awns on both glumes of the spikelet, and based on overall aspect, initially related the species to the genus *Ichnanthus*, although Döll mentioned the absence of wings or scars at the base of the upper lemma, characteristic of the latter genus.

Afterwards, the taxonomic position of *P. aristellum* was discussed in several contributions (Chase unpublished ms.; Zuloaga and Soderstrom 1985; Zuloaga 1987; Zuloaga et al. 1993). Chase (unpublished ms.)

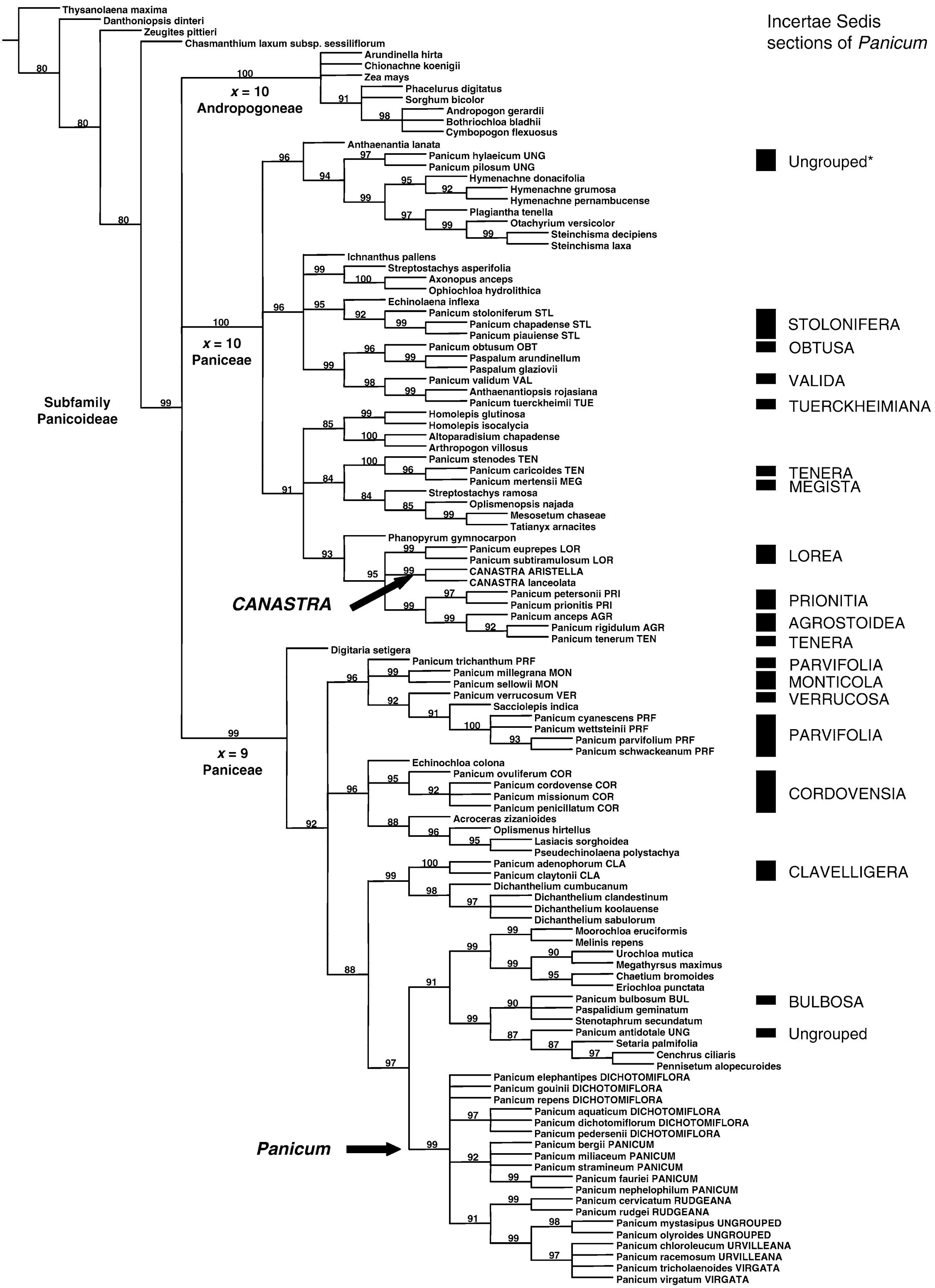

FIG. 5. Strict consensus tree of the Panicoid grasses using the *ndhF* chloroplast gene. The phylogeny shows the relationships between *Canastra aristella* and related taxa. Bootstrap values are shown above branches. Sections of *Panicum*, including incertae sedis species, and ungrouped species are shown on the right side, and the first three letters of each section or ungrouped taxon follow the species names. Other significant monophyletic clades are shown on the left side. * *P. hylaeicum* and *P. pilosum*, previously treated within sect. *Laxa*, are here considered ungrouped species.

pointed out that *P. aristellum* was an outlying species of *Panicum*, by the presence of aristate spikelets, and related to *Panicum najadum* Hack. [now *Oplismenopsis najada* (Hack.) Parodi, a monotypic and endemic genus of Argentina and Uruguay], which also is characterized by the presence of aristate spikelets. Zuloaga and Soderstom (1985) mantained *P. aristellum* within *Panicum* in a study of the outlying species of the genus, indicating this taxon was related to *Hymenachne* and species of the Laxa Group of *Panicum* on the basis of a common membranous upper anthecium. Zuloaga (1987) included *P. aristellum* in sect. *Laxa* of *Panicum*, indicating its dubious position, a criterion also followed by Cavalheiro and Longhi-Wagner (1991). Zuloaga et al. (1993), in a phenetic analysis of *Panicum*, considered the species as ungrouped within the genus; in that study *P. aristellum* shows morphological affinities with sect. *Lorea* of *Panicum*. But it should be noted that Zuloaga et al. (1993) did not consider the aristate spikelets in their study.

Based on the *ndhF* molecular phylogeny of the subfamily Panicoideae, Gómez-Martínez and Culham (2000), Giussani et al. (2001), and Aliscioni et al. (2003) showed three major clades within the Panicoideae; all three clades are associated with a basic chromosome number: Andropogoneae with basic chromosome number $x = 10$, Paniceae $x = 10$, and Paniceae $x = 9$. The latter includes the genus *Panicum* as circumscribed in Aliscioni et al. (2003). The results of our phylogenetic analysis (Fig. 5) are similar to the results shown in Giussani et al. (2001) and Aliscioni et al. (2003).

Our analysis of *ndhF* sequence data showed that *Panicum aristellum* was grouped with several species of *Panicum* incertae sedis and other genera of the Paniceae $x = 10$ clade (Fig. 5). Thus *P. aristellum* is not part of *Panicum* sensu stricto. Furthermore, *Panicum aristellum* is shown to be sister to *Canastra lanceolata* with 99% bootstrap support. This relationship is also supported by morphological and anatomical characters that represent synapomorphies for the clade such as: similar plant habit, keeled sheaths, presence of aristate spikelets, scabrous bracts, nervation of the glumes and lower lemma, presence of a lower palea and lower flower, non-indurate upper anthecium, and a non-Kranz anatomy: both species have two bundles around each vascular bundle, the outer parenchymatic, without specialized chloroplasts, the inner bundle mestomatic; more than five cells are present between contiguous vascular bundles. In addition, both species are endemic of central and southeastern Brazil.

The *Canastra* clade is grouped in a trichotomy with several incertae sedis sections of *Panicum*: *Lorea*, *Prionitia*, *Agrostoidea* and one species of sect. *Tenera*. *Phanopyrum gymnocarpon* is grouped as the sister group to this trichotomy (Fig. 5). Table 1 shows morphological and anatomical characters that distinguish *Canastra* from these taxa.

Therefore, based on the phylogenetic results and the morphological and anatomical characters, *Panicum aristellum* is here transferred to *Canastra*. Future work is needed to establish the appropriate genus names for the other insertae sedis sections of *Panicum*.

TAXONOMIC TREATMENT

Canastra aristella (Döll) Zuloaga & Morrone, comb. nov. *Panicum aristellum* Döll in Mart., Fl. Bras. 1(2): 221. 1877, as ''*Panicum aristella*''.–TYPE: BRAZIL. Minas Gerais: Jardim, 29 Nov. 1845, *J.F. Widgren s.n. [924]* (holotype: S; isotypes: P!, photo SI!, R-3826!, US-702302!, photo SI!, US-80468!). Fig. 1.

Illustrations. Zuloaga and Soderstrom (1985: 37, Fig. 14).

Cespitose or shortly rhizomatous perennials. *Culms* erect, 1–2 m tall, many-noded, simple, cylindrical, glabrous to hirsute; internodes solid or with a small lumen, 15–40 cm long; *nodes* compressed, glabrous. *Sheaths* shorter than the internodes, solid or with a small lumen, 10–30 cm long, keeled, rigid, overlapping at the base, glabrous or papillose-pilose along the margins. *Ligules* membranous-ciliate, 0.5–0.7 mm long; collar inconspicuous. *Blades* linear-lanceolate, 45–75 cm long, 1–1.8 cm wide, acuminate, narrow and involute toward the base, becoming flattened and wider, sometimes with the margins involute, rigid, pubescent toward the base on the adaxial surface, otherwise glabrous, the margins scabrous, midnerve prominent. *Inflorescences* 20–40 cm long, 7–20 cm wide, multiflowered, lax and open to contracted, pyramidal to oblong, the branches diverging from the axis with the spikelets congested along the secondary branches; main axis cylindrical, scabrous, the branches alternate, triquetrous, markedly scabrous, densely to sparsely hirsute, pulvini glabrous to pubescent; pedicels short, scabrous or occasionally hirsute. *Spikelets* 3.8–5.7 mm long, 0.7–1 mm wide, 3.1–3.9 mm long without the awns, lanceolate, brown, the glumes and lower lemma herbaceous, prominently scabrous on the nerves. *Lower glume* 2.3–3.6 mm long, ovate-lanceolate, the awn 0.9–1.8 mm long, about as long as the lower lemma, 1–3 nerved, the midnerve and awn, as well as the margins, markedly scabrous, the inner surface scabrous toward the apex. *Upper glume* 3.7–5.7 mm long, markedly scabrous at the apex on the inner surface, 5-nerved, the nerves scabrous, the central nerve extending into an awn 0.7–2 mm long, this twisted or not. *Lower lemma* oblong, acute, 3.8–3.6 mm long, awnless, 3–5 nerved, the midnerve scabrous. *Lower palea* lanceolate, 2.3–3.1 mm long, 0.5–0.7 mm wide, hyaline glabrous, with scabrous, denticulate margins; male flower present, stamens 3. *Upper anthecium* 2.3–3.1 mm long, long-ellip-

TABLE 1. Comparison of *Canastra* with related taxa as shown in the molecular phylogeny.

Characters	*Canastra*	*Panicum* sect. *Lorea*	*Panicum* sect. *Prionitia*	*Panicum* sect. *Agrostoidea*	*Panicum tenerum*	*Phanopyrum*
Lower and upper glume	awned	not awned	not awned	not awned	not awned	not awned
Length of lower glume	1/2–1/3	1/2–4/5	1/2–3/4	1/3–2/3	1/2	3/4–4/5
Lower palea	present	present	present	present	present	absent
Lower flower	present	present or absent	present	absent	absent	absent
Upper anthecium/upper glume, relative length	1/1	1/1	1/1	1/2–3/4	3/4	1/4–1/3
Upper anthecium texture	membranous	indurate	indurate	indurate	indurate	indurate
Upper anthecium ornamentation	smooth, with prickle hairs and silica cells at the apex	smooth	smooth and glabrous, occasionally with prickle hairs	smooth and glabrous, with manifest prickle hairs at the apex of the lemma	smooth and glabrous, with prickle hairs at the apex	smooth
Upper anthecium apex	gaping at maturity	closed	closed	closed	closed	closed
Upper anthecium	non-stipitate	non-stipitate	non-stipitate	non-stipitate	non-stipitate	stipitate
Anatomical type	C_3	C_3	C_4 NADP-me	C_4 NADP-me	C_4 NADP-me	C_3
Sheaths	keeled	rounded	keeled	keeled	rounded	rounded
Habitat	margins of puddles, streams or river	among rocks, open fields	margins of puddles, streams or river	open fields on sand soils	savannas humid	margins of streams and lakes
Distribution	Brazil, Cerrado	Brazil and Venezuela, Cerrado and Guiana	Brazil to Argentina and Cuba	USA to Mesoamerica and the Caribbean	USA to Mesoamerica and the Caribbean	USA

soid, membranous, smooth, pale to brown, with prominent hooks toward the apex of the lemma and palea and on the margins of the lemma, also with silica cells, bicellular microhairs and stomata at the apex of both lemma and palea; lemma 5-nerved; lodicules 2, conduplicate; stamens 3, stigmas 2 with the styles united at the base. *Caryopsis* long-ellipsoid, 1.6 mm long, 0.6 mm wide, dark brown; hilum oblong, embryo 1/3 the length of the caryopsis.

Observations. *Canastra aristella* can be separated from *C. lanceolata* by plant size (1–2 m tall in *C. aristella* vs. 50–60 cm tall in *C. lanceolata*), blade outline (keeled vs. flat), blade length (45–75 × 1–1.8 cm vs. 15–30 × 0.4–0.7 cm in *C. lanceolata*), axillary inflorescences (present in *C. lanceolata*), size of terminal inflorescences (20–40 × 7–20 cm vs. 10–22 × 2–5 cm), awn length (0.7–2 mm vs. 15–17 mm), presence of fusoid cells (in *C. lanceolata*).

Phenology. Flowering between October and January.

Distribution and Habitat. Known from the states of Rio de Janeiro, Paraná, Minas Gerais, Santa Catarina, Rio Grande do Sul, and São Paulo, Brazil, where it is found at margins of rivers and streams, on seasonally inundated soils, between sea level and 1300 m (Fig. 2).

Specimens Examined. BRAZIL. MINAS GERAIS: Catas Altas, Serra do Caraça (R.P.P.N.), *Longhi-Wagner et al. 9659* (ICN, SI). PARANÁ: Mallet, *Hatschbach 15371* (US); Mun. Arapoti, Rio das Cinzas, Barra do Perdizes, *Hatschbach 8491* (US), Guarapuava, Rio das Pedras, *Pereira 8004* (RB, US); Piraquara, ca. 22 km ao este de Curitiba, *Tessmann 3732* (US); estrada p/Porto Vitoria, *Hatschbach 14888* (US); Mun. Porto Vitoria, Prainha, *Hatschbach 28413* (US); Mun. S. Mateus do Sul, Foz do Rio Taquaral, *Hatschbach 3337* (US). RIO GRANDE DO SUL: Tupaceretan, *Pott & Valls s.n.* (SI), *Araujo 338* (US). RIO DE JANEIRO: Alto Macahe, *Glaziou 20976* (P, W); without locality, *Glaziou 4303* (BAA). SANTA CATARINA: Porto União, 6 km E of Porto União, *Smith & Klein 15729* (R, US); Campo do Areão, Santa Cecilia, 1100 m, *Reitz & Klein 14150* (US); Mun. Ireneópolis, Poço Preto, swamp 10 km east of Poço Preto, *Smith & Klein 15736* (US); Bom Retiro, banhado, 950 m, *Reitz & Klein 5500* (US); Valòes, *Klein 3706* (US), *Reitz & Klein 13571* (G, US); Morro do Campo Alegre, São Francisco do Sul, 1300 m, *Reitz & Klein 10062* (US); Porto União, *Reitz & Klein 13680* (US); Fazenda Frei Rogeiro, Porto União, *Reitz & Klein 13613* (US). SÃO PAULO: Mun. Salesópolis, Boraceia, margem do Rio Claro, *Kuhlmann 2774* (IBGE, SI, SP, US).

According to Döll (1877) the type of *Panicum aristellum* was collected ''In provincia Minarum a cl. Widgren lectum (herb. Holm.)''. When we studied the type material in P, R, and US all the specimens have the same label indication: ''Minas Gerais, Jardim, 29 Nov. 1845, *J.F. Widgren 924*''.

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Appendix 1. List of taxa used in the molecular analysis, voucher information of the new sequence, and GenBank accession numbers.

Subfamily Centothecoideae. *Chasmanthium laxum* (L.) H.O. Yates subsp. *sessiliflorum* (Poir.) L. G. Clark, U27296; *Danthoniopsis dinteri* (Pilg.) C.E. Hubb., AY029695; *Thysanolaena maxima* (Roxb.) Kuntze, U21984; *Zeugites pittieri* Hack., U21987.

Subfamily Panicoideae. Tribe Andropogoneae. *Andropogon gerardii* Vitman, AF117391, *Bothriochloa bladhii* (Retz.) S. T. Blake, AF117395; *Chionachne koenigii* (Spreng.) Thwaites, AF117397; *Cymbopogon flexuosus* (Nees ex Steud.) Will. Watson, AF117404; *Phacelurus digitatus* (Sibth. & Sm.) Griseb., AF117418; *Sorghum bicolor* (L.) Moench, U21981; *Zea mays* L., U21985. **Tribe Arundinelleae.** *Arundinella hirta* (Thunb.) Tanaka, AF117393. **Tribe Paniceae** (not *Panicum*). *Acroceras zizanioides* (Kunth) Dandy, AY029618; *Altoparadisium chapadense* Filg. et al., AY029619; *Anthaenantia lanata* (Kunth) Benth., AY029640; *Anthaenantiopsis rojasiana* Parodi, AY029620; *Arthropogon villosus* Nees; AY029622; *Axonopus anceps* (Mez) Hitchc., AY029623; *Canastra aristella* (Döll) Zuloaga & Morrone; Longhi 9659, DQ355988; *C. lanceolata* (Filg.) Morrone et al., AY029621; *Cenchrus ciliaris* L., AY029625; *Chaetium bromoides* (J. Presl) Benth. ex Hemsl., AY029626; *Dichanthelium clandestinum* (L.) Gould, AY188461; *D. cumbucana* (Renvoize) Zuloaga, AY188464; *D. koolauense* (H. St. John & Hosaka) C.A. Clark & Gould, AY029627, *D. sabulorum* (Lam.) Gould & C.A. Clark, AY029654; *Digitaria setigera* Roth ex Roem. & Schult., AY029629; *Echinochloa colona* (L.) Link, AY029631; *Echinolaena inflexa* (Poir.) Chase, AY029633; *Eriochloa punctata* (L.) Desv., AY029634; *Homolepis glutinosa* (Sw.) Zuloaga & Soderstr., AY029637; *Hymenachne donacifolia* (Raddi) Chase, AY029635; *H. grumosum* (Nees) Zuloaga, AY188468; *H. pernambucense* (Spreng.) Zuloaga; AY188478; *Ichnanthus pallens* (Sw.) Munro ex Benth., AY029638; *Lasiacis sorghoidea* (Desv.) Hitchc. & Chase, AY029639; *Melinis repens* (Willd.) Zizka, AY029675; *Megathyrsus maximus* (Jacq.) B.K. Simon & S.W.L. Jacobs, AY029649; *Mesosetum chaseae* Luces, AY029641; *Moorochloa eruciformis* (Sm.) Veldkamp., AY188452; *Ophiochloa hydrolithica* Filg. et al., AY029642; *Oplismenopsis najada* (Hack. & Arechav.) Parodi, AY188453; *Oplismenus hirtellus* (L.) P. Beauv., AY029644; *Otachyrium versicolor* (Döll) Henrard, AY029643; *Paspalidium geminatum* (Forssk.) Stapf, AY029662; *Paspalum arundinellum* Mez, AY029663; *Pennisetum alopecuroides* (L.) Spreng., AY029672; *Paspalum glaziovii* (A.G. urm.) S. Denham, AY029689; *Phanopyrum gymnocarpon* (Elliott) Nash, AY188469; *Plagiantha tenella* Renvoize, AY029674; *Pseudechinolaena polystachya* (Kunth) Stapf, AY029676; *Sacciolepis indica* (L.) Chase, AY029677; *Setaria palmifolia* (J. König) Stapf, AY029680; *Steinchisma decipiens* (Nees ex Trin.) W.V. Br., AY188499; *S. laxa* (Sw.) Zuloaga, AY029655; *Stenotaphrum secundatum* (Walter) Kuntze, AY029684; *Streptostachys asperifolia* Desv., AY029687; *S. ramosa* Zuloaga & Soderstr., AY029686; *Tatianyx arnacites* (Trin.) Zuloaga & Soderstr., AY029688; *Urochloa mutica* (Forssk.) T.Q. Nguyen; AY029691. ***Panicum*. Section *Dichotomiflora*** (Hitchc.) Honda. *Panicum aquaticum* Poir., AY029658; *P. dichotomiflorum* Michx., AY188466; *P. elephantipes* Nees ex Trin., AY029647; *P. gouinii* E. Fourn., AY188467; *P. pedersenii* Zuloaga, AY029646; *P. repens* L., AY029651. **Section *Panicum***. *P. bergii* Arechav., AY188457; *P. fauriei* Hitchc., AY029650; *P. miliaceum* L., AY188472; *P. nephelophilum* Gaudich., AY029645; *P. stramineum* Hitchc. & Chase, AY188489. **Section *Rudgeana*** (Hitchc.) Zuloaga. *P. cervicatum* Chase, AY188459; *P. rudgei* Roem. & Schult., AY029661. **Section *Urvilleana*** (Hitchc.) Pilg. *P. chloroleucum* Griseb., AY188460; *P. racemosum* (P. Beauv.) Spreng., AY188481. **Section *Virgata*** Hitchc. & Chase ex Pilg. *P. tricholaenoides* Steud., AY188493; *P. virgatum* L., U21986. **Ungrouped.** *P. mistasypus* Zuloaga & Morrone, AY188474; *P. olyroides* Kunth; AY188475. ***Panicum*** incertae sedis. **Section *Agrostoidea*** Hitchc. & Chase ex C.C. Hsu. *Panicum anceps* Michx., *AY188455*; *P. rigidulum* Bosc ex Nees, AY188482. **Section *Bulbosa*** Zuloaga. *P. bulbosum* Kunth; AY029648. **Section *Clavelligera*** Stapf. *P. adenophorum* K. Schum., AY188454; *P. claytonii* Renvoize, AY188462. **Section *Cordovensia*** Parodi. *P. cordovense* E. Fourn., AY188463; *P. missionum* Ekman, AY188473; *P. ovuliferum* Trin., AY029653; *P. penicillatum* Nees ex Trin., AY188477. **Section *Lorea*** Zuloaga. *P. euprepes* Renvoize, AY029657; *P. subtiramilosum* Renvoize & Zuloaga, AY188490. **Section *Megista*** Pilg. *P. mertensii* Roth, AY188471. **Section *Monticola*** Stapf. *P. millegrana* Poir., AY029660; *P. sellowii* Nees, AY188484. **Section *Obtusa*** Pilg. *P. obtusum* Kunth, AY029659. **Section *Parvifolia*** Hitchc. & Chase ex Pilg. *P. cyanescens* Nees ex Trin., AY188465, *P. parvifolium* Lam., AY188476; *P. schwackeanum* Mez, AY188483; *P. trichanthum* Nees, AY188492; *P. wettsteinii* Hack., AY188497; **Section *Prionitia*** Zuloaga. *P. petersonii* Hitchc. & Ekman, AY188479; *P. prionitis* Nees, AY029652. **Section *Stolonifera*** Hitchc. & Chase ex Pilg. *P. piauiense* Swallen, AY029656; *P. stoloniferum* Poir., AY188488; *P. chapadense* Swallen, AY188486. **Section *Tenera*** Hitchc. & Chase ex Pilg. *P. caricoides* Nees ex Trin., AY188458. *P. stenodes* Griseb., AY188487; *P. tenerum* Beyr. ex Trin., AY188491. **Section *Tuerckheimiana*** (Hitchc.) Zuloaga. *P. tuerckheimii* Hack., AY188494. **Section *Valida*** Zuloaga & Morrone. *P. validum* Mez, AY188495. **Section *Verrucosa*** Hitchc. & Chase ex C.C. Hsu. *P. verrucosum* Muhl., AY188496. **Ungrouped.** *P. antidotale* Retz., AY188456. *P. hylaeicum* Mez, AY188470; *P. pilosum* Sw., AY188480.