

Four New Species of *Paspalum* (Poaceae, Paniceae) from Central Brazil, and Resurrection of an Old One

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Abstract—Four new Brazilian species from the genus *Paspalum* are described and illustrated: *P. phaeotrichum*, *P. vexillarium*, *P. veredense*, and *P. clipeum*. *Paspalum phaeotrichum* is an annual with no obvious affinity to any known species of *Paspalum*, although it shares several characters with species of both *P.* subg. *Ceresia* and the 'Bertoniana' group. *Paspalum vexillarium* is presumably related to *P. ceresia*, with which it has been confused. *Paspalum veredense* shows affinities with both *P. ellipticum* and *P. erianthoides*. *Paspalum clipeum* is probably related to annual species of the 'Plicatula' group, although it lacks the dark brown upper florets typical of that group. Moreover, *P. spissum*, a species currently considered as a synonym under *P. carinatum*, is recognized on the basis of vegetative morphology, phenology and habitat. Keys to the treated species are provided when relevant, as well as a distribution map.

Resumo—Quatro novas espécies de *Paspalum* do Brasil são descritas e ilustradas: *P. phaeotrichum*, *P. vexillarium*, *P. veredense*, e *P. clipeum*. *Paspalum phaeotrichum* é uma espécie anual sem afinidades óbvias com outras espécies do gênero, embora compartilhe vários caracteres com *P.* subg. *Ceresia* e com o grupo 'Bertoniana'. *Paspalum vexillarium* é supostamente relacionada a *P. ceresia*, com a qual tem sido confundida. *Paspalum veredense* tem afinidades com *P. ellipticum* e *P. erianthoides*. *Paspalum clipeum* é provavelmente relacionada às espécies anuais do grupo 'Plicatula', embora não apresente os antécios superiores de cor marrom escura, típicos desse grupo. Além disso, *P. spissum*, uma espécie atualmente considerada como sinônimo de *P. carinatum*, é reabilitada com base na morfologia vegetativa, fenologia e habitat. São fornecidas chaves para as espécies tratadas, quando relevante, assim como um mapa de distribuição.

Keywords—Brazilian flora, Cerrado, grasses, Panicoideae, taxonomy.

Paspalum L. comprises about 350 species of grasses mostly distributed in tropical and warm-temperate areas of the Americas (Clayton and Renvoize 1986; Zuloaga and Morrone 2005; Denham 2005). They are recognized by their dorsiventral raceme-like partial inflorescences, by their plano-convex spikelets with the upper lemma adaxial, and, in most cases, by the lacking of the lower glume. Within the Panicoideae, the genus *Paspalum* belongs to a clade characterized by a basic chromosome number of $x = 10$ (Giussani et al. 2001) and is related to other genera having an NADP-ME photosynthetic pathway.

Species of *Paspalum* are, in large part, responsible for much of the biodiversity of grassland ecosystems in South America, which are strongly threatened by the expansion of agriculture. Among them, the Brazilian Cerrado is certainly a hotspot of grass diversity (Warming 1973; Mendonça et al. 1998). A number of new grass genera and species have been described from this region in recent years, including several species of *Paspalum* (Burman 1980; Davidse and Filgueiras 1993; Filgueiras and Davidse 1994; Filgueiras 1995; Davidse et al. 2001; Filgueiras et al. 2001, Morrone and Zuloaga 2003).

While identifying grasses collected in Cerrado areas of central Brazil, four new species of *Paspalum* were found. They are here described, illustrated, and compared with related species. Moreover, *P. spissum*, a species currently considered a synonym of *P. carinatum*, is recognized on the basis of vegetative morphology, phenology and habitat.

MATERIALS AND METHODS

Descriptions and illustrations were based on field collections and herbarium material (CEN, IBGE, UB). Andean material of *P. ceresia* (Kuntze)

Chase was examined at BAA and SI for comparison. Leaf samples for anatomical sections from herbarium specimens were rehydrated according to the method described by Voster (1990) with few modifications. Cross sections were obtained using a Ranvier microtome, stained with Alcian blue and safranin 1% and mounted using a synthetic resin (Paiva et al. 2006). Anatomical micrographs were obtained using a Zeiss Axioscop MC80DX microscope. Micrographs of the upper lemma surface were taken using a Zeiss DSM 962 scanning electron microscope (SEM).

TAXONOMIC TREATMENT

Paspalum phaeotrichum Valls, G. H. Rua, Graciano-Ribeiro, & R. C. Oliveira, sp. nov.—TYPE (here designated): BRAZIL. Bahia: Mun. Riachão das Neves, entrada de fazenda ca. 20 km N de Barreiras pela estrada antiga, 2 km N da ponte sobre o Rio Branco, 31 Mar 1983, J. F. M. Valls, A. Krapovickas, R. F. A. Veiga, & G. Pereira-Silva 7049 (holotype: CEN!; isotypes: BAA!, L!, RB!, SI!, US!).

A omnibus speciebus notis distincta, tamen *P. lilloi* Hack. flosculo molli, laminis foliorum costatis aliquantum similis, sed habitu annuo, omnibus partibus multo minoribus differt.

Annuals. Culms 18–28 cm tall, 0.8–0.9 mm diam, erect to decumbent, freely branching, some culms proximally creeping, with branches rooting at the base, the main axis coming to flower; internodes glabrous, the basalmost purple, otherwise pale; nodes glabrous, purple-tinged. Leaf sheaths keeled, striate, long-ciliate at the top of margins, otherwise glabrous, the proximal sheaths 1–1.5 cm long, purple-tinged, the distal sheaths up to 6 cm long. Ligules 0.5–0.7 mm long, membranous, acute, glabrous, erose, without a pseudoligule. Blades 4.5–5.5 cm long, ca. 2 mm wide, lanceolate-acuminate, flat, the base narrower than the leaf sheath, sharply ribbed

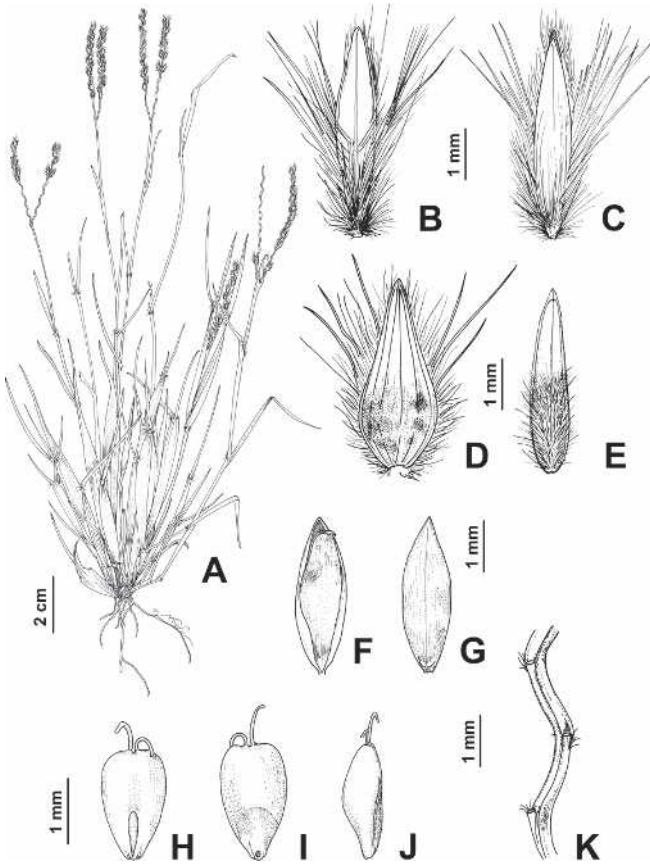


FIG. 1. *Paspalum phaeotrichum* (from Valls et al. 7049). A. Habit. B. Spikelet, adaxial view. C. Spikelet, abaxial view. D. Upper glume, adaxial view. E. Lower lemma, abaxial view. F. Upper floret, adaxial view. G. Upper floret, abaxial view. H. Caryopsis, hilum side. I. Caryopsis, embryo side. J. Caryopsis, lateral side. K. Portion of the rachis, abaxial view.

adaxially; the margins with a few proximal cilia, otherwise glabrous; cauline blades reduced, the most distal ca. 1 cm long. Peduncles 4.5–9 cm long, compressed, glabrous, pale to purple-tinged. Inflorescences exserted; main axis not prolonged above the racemes; ‘racemes’ 2–4 cm long, 2, conjugate, ascending to divaricate; pulvini hirsute; rachis of the racemes ca. 0.4 mm wide, glabrous, flexuous, triquetrous, narrowly 3-winged, ending in a terminal spikelet, the nerves green, otherwise pale; spikelets 4.0–4.1 mm long, 1.1–1.4 mm wide, narrowly ovate, solitary, sessile, loosely 2-seriate, deciduous at maturity, dorsiventrally compressed. Lower glumes lacking. Upper glumes as long as the spikelets, ca. 2.1 mm wide, ovate, membranous-hyaline, pale, 7-nerved, the two outer nerve pairs close to the margins, the proximal half convex, corrugate, densely pilose with pale hairs intermingled with longer and stiffer, golden-brown cilia up to 3 mm long; the distal half depressed, somewhat ornamented with longitudinal purple stripes, pilose along the lateral nerves, otherwise glabrous, the involute margins covering the margins of the lower lemma; the base widely attenuate, the apex acute but somewhat rounded at the very tip. Lower lemmas ca. 4 mm long, 1 mm wide, narrowly ovate, flat, acute at apex, 5-nerved, the lateral nerves close to the margins, densely pilose at the proximal portion. Upper florets 3.1–3.3 mm long, 1–1.1 mm wide, narrowly ellipsoidal, flattened, hyaline, pale, glabrous, the upper lemma faintly 5-nerved, slightly shorter than the palea and not enclosing the palea apex, so that the floret remains open, the palea with

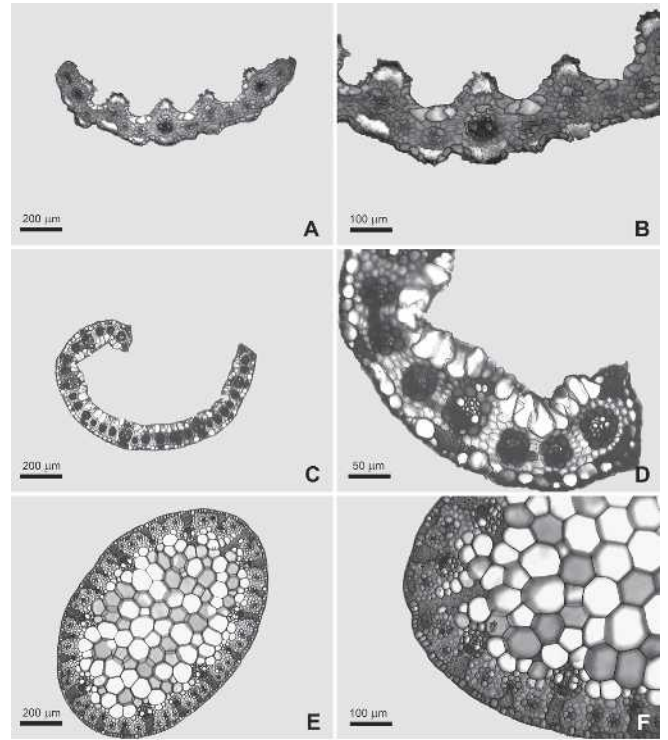


FIG. 2. Leaf blade anatomy in cross section, general view (left) and detail of a portion (right). A, B. *Paspalum phaeotrichum* (Valls et al. 7049). C, D. *Paspalum vexillarium* (Amaral et al. 28). E, F. *Paspalum veredense* (Rua et al. 695).

overlapping marginal flaps; lodicules 2; stamens 3, anthers 2.1–2.2 mm long, yellowish; stigmas 2, pale, plumose. Caryopsis 1.8 mm long, ca. 1 mm wide, plano-convex, obovate, slightly emarginate at apex, pale; hilum ca. 0.8 mm long, linear-elliptical. Figure 1.

Leaf Anatomy—(Fig. 2A, B). Leaf blade expanded in cross section, sharply ribbed/furrowed adaxially. Midrib inconspicuous, with a single first-order vascular bundle. Cuticle thin. Adaxial epidermis with typical epidermal cells, bicellular microhairs, 3–5 fan-shaped bulliform cells, stomata, and

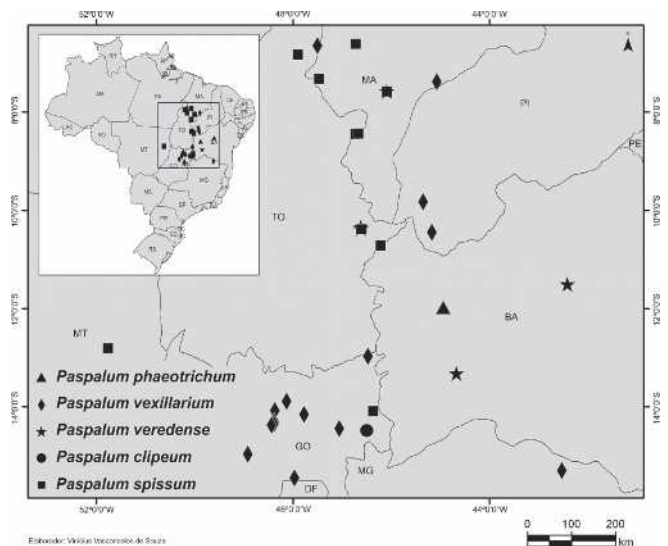


FIG. 3. Distribution map of *Paspalum phaeotrichum*, *P. vexillarium*, *P. veredense*, *P. clipeum*, and *P. spissum*.

silicified cells. Mesophyll consisting of radial chlorenchyma cells. Three orders of vascular bundles present, each surrounded by a single bundle sheath of relatively large, thin-walled parenchyma cells, the bundles separated by 1 or 2 parenchyma cells. Sclerenchyma both adaxial and abaxial girders along ribs, but only abaxially at intercostal regions.

Distribution and Habitat—(Fig. 3). The new species was found near Barreiras, in the state of Bahia, in areas of transition between Cerrado and Caatinga vegetation. *Paspalum phaeotrichum* is known only from the type collection.

Etymology—The specific epithet refers to the golden-brown setaceous cilia of the upper glume.

Observations—*Paspalum phaeotrichum* has no obvious af-

finity with any known species of *Paspalum*. Morphologically it seems allied to species of *P.* subg. *Ceresia* (Pers.) Rchb., because of its soft, distally gaping upper floret, and the hair pattern in the basal portion and margins of the upper glume. However, the rachis of the 'racemes' are slender, triquetrous, narrowly 3-winged, with the lateral margins not distinctly developed. The characteristics of open upper florets, that are shorter than the upper glumes and lower lemmas, the presence of linear-elliptical hilums, and leaf blades conspicuously ribbed suggest an affinity with *P. lilloi* Hack. and *P. bertonii* Hack., both from *Paspalum* 'Bertoniana' group.

The following key separates the new species from other putatively related groups in the genus *Paspalum*.

1. Apex of the upper palea enclosed by the inrolled borders of the upper lemma. *Paspalum* spp. (most species)
1. Apex of the upper palea free, not enclosed by the upper lemma 2
2. Rachis winged, 0.8–12 mm wide, the lateral margins conspicuously developed; hilum mostly punctiform to elliptical; adaxial surface of the leaf blades smooth *Paspalum* subg. *Ceresia* (Pers.) Rchb.
2. Rachis trichetrous to obscurely winged, 0.4–0.7 mm wide; hilum linear-elliptical; adaxial surface of the leaf blades with conspicuous ribs and furrows 3
3. Perennials; inflorescence branches separated by conspicuous internodes; upper glumes with whitish hairs only; upper florets membranaceous; plants from stony river banks *Paspalum* 'Bertoniana' group
3. Annuals; inflorescence branches conjugate; upper glumes with golden-brown cilia intermingled with whitish hairs; upper florets hyaline; plants from temporarily dry sites *P. phaeotrichum* nov. sp.

Paspalum vexillarium G. H. Rua, Valls, Graciano-Ribeiro, & R. C. Oliveira, sp. nov.—TYPE (here designated): BRAZIL. Distrito Federal: APA da Cafuringa, 15°27'27" S, 47°58'00" W, 22 Mar 2006, A. C. Amaral, E. S. G. Guarino, G. Pereira-Silva, & J. R. Santos 28 (holotype: CEN!; isotypes: BAA!, K!, L!, MO!, RB!, SI!, US!).

Paspalum membranaceum Lam. var. *inaequiglume* Döll, in Mart., Fl. Bras. 2(2): 94. 1877.—TYPE: BRAZIL. Goiás: campos between Natividade e Conceição, Feb 1840, G. Gardner 4029 (lectotype: designated by Denham et al. (2002), B-photograph!).

P. ceresia affine sed lemmate inferiore manifeste binervio, gluma superiori conspicue brevior, rhizomate cataphyllis nullis differt.

Caespitose perennials. Base of tillers U-shaped, composed of a variable number of short internodes, the first node with a brownish, scale-like prophyll, the next one bearing an additional cataphyll, the following nodes with foliage leaves, the dead sheaths of which remain covering the base of the tillers. Culms 60–75 cm tall, ca. 1 mm diam, erect, branched at the lowermost nodes; internodes 3–7, glabrous to faintly puberulous, reddish; nodes mostly bearded. Leaf sheaths up to 11 cm long, distally keeled, glabrous to distally hirsute, greenish, the outer surface striate in dry material, sometimes purple-tinged, the margins membranous. Ligules ca. 0.3 mm long, membranous, rounded to obtuse, hyaline, glabrous, erose, without pseudoligule. Blades up to 25 cm long, 3–5 mm wide at flowering, up to 10 mm wide in early regrowth, linear, ribbon-like, ascending, flat to folded and apparently filiform, the base continuing with the leaf sheath, acuminate at apex, somewhat glaucous, glabrous to coarsely hirsute on the adaxial surface, glabrous abaxially; the margins finely scabrous and ciliate along the proximal third; upper blades reduced. Peduncles 9–17 cm long, terete, puberulous, purplish. Inflorescences mostly exserted; main axis 2–6 cm long, truncate or ending in a short naked point; 'racemes' 2–6 cm long, (1)2–6, ascending, alternate along the inflorescence axis; pulvini pubescent; rachis of the racemes 5–12 mm wide, lon-

gitudinally folded, glabrous, conspicuously winged, ending in a naked point, the middle portion greenish to purple, the wings orange-ferruginous; pedicels minute, puberulous. Spikelets solitary, densely imbricate in 2 series, dorsiventrally compressed. Lower glumes lacking. Upper glumes 2–2.9 mm long, 1–1.3 mm wide, ovate, membranous, pale to

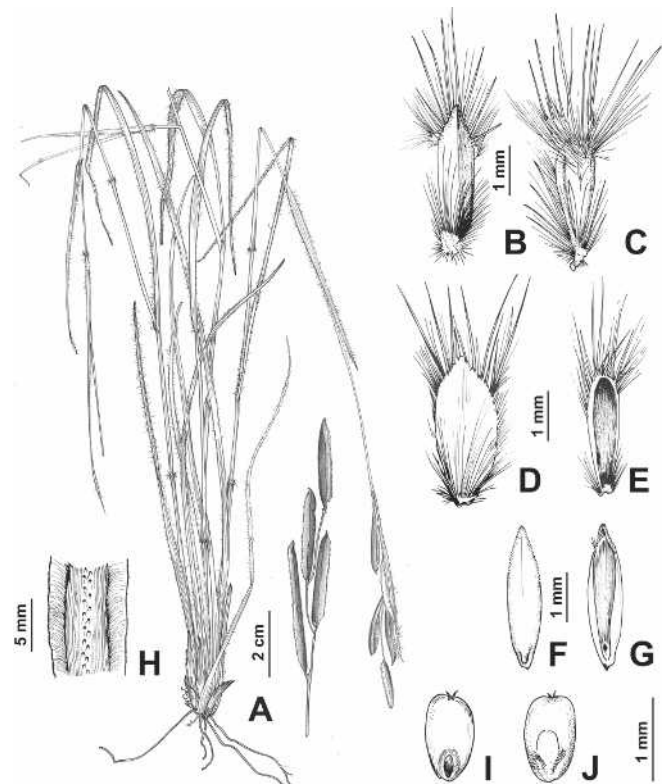


FIG. 4. *Paspalum vexillarium* (I and J from Rua et al. 642, otherwise from Amaral et al. 28). A. Habit and detail of the inflorescence. B. Spikelet, adaxial view. C. Spikelet, abaxial view. D. Upper glume, abaxial view. E. Lower lemma, abaxial view. F. Upper floret, adaxial view. G. Upper floret, abaxial view. H. Portion of the rachis, abaxial view. I. Caryopsis, hilum side. J. Caryopsis, embryo side.

ferruginous, 3-nerved, the nerves submarginal, densely silky-pilose at the base and along the margins, otherwise glabrous, the marginal hairs forming two conspicuous lateral tufts preceding a row of stouter, tubercle-based cilia up to 2.5 mm in the distal portion; the margins inrolled, the base attenuate, the apex acute and slightly recurved, glabrous. Lower lemmas 1.6–2.3 mm long, 0.4–0.5 mm wide, oblong-obovate, dorsally concave, obtuse to rounded at apex, strongly 2-nerved, indumentum as in the upper glume. Upper florets 2–2.1 mm long, 0.7–0.8 mm wide, narrowly ovate to ellipsoidal, shortly acuminate, deciduous at maturity, dorsiventrally compressed, membranous-hyaline, whitish, the upper lemma faintly 3-nerved, both lemma and palea shortly pubescent on the distal portion; lodicules lacking; stamens 3, anthers ca. 2.2 mm long, yellow with purple marks; stigmas 2, pale, plumose. Caryopses ca. 1.1 mm long, ca. 0.6 mm wide, obovate, dorsiventrally compressed, slightly emarginate at apex, stramineous; hilum ca. 0.3 mm long, narrowly elliptical. Figures 4, 5A.

Leaf Anatomy—(Fig. 2C, D). Leaf blade expanded in cross section. Cuticle somewhat thick. Adaxial epidermis with typical epidermal cells, bicellular microhairs, macrohairs, cushion hairs, inflated bulliform cells, stomata and silicified cells. Mesophyll consisting of radial chlorenchymatous cells. Two orders of vascular bundles present, all of them surrounded by a single bundle sheath of relatively large, thin-walled parenchyma cells; the bundles separated by 1 or 2 parenchyma cells. First order vascular bundles with abaxial and adaxial sclerenchyma extensions. Abaxial sclerenchyma caps associated with second order vascular bundles.

Distribution and Habitat—(Fig. 3). *P. vexillarium* is a common species found in pebbly or rocky soils in areas of Cerrado vegetation, comprising the Brazilian states of Pará, Maranhão, Piauí, Goiás, Minas Gerais, Tocantins, and Distrito Federal.

Chromosome Number—Chromosome counts in two paratypes (*Rua & Oliveira* 632 & 642) were $2n = 40$ (Pozzobon et al. in press, under *Paspalum* aff. *ceresia*).

Etymology—The specific epithet means ‘standard-bearer’, and refers to the flag-like appearance of the rachis.

Additional Material Examined—BRAZIL. Goiás: Mun. Alto Paraiso, Alto Paraiso-Colinas, próximo do Vale da Lua, a 6 km de São Jorge, 21 Jul 1994, *Boechat & Filgueiras* 101 (IBGE); Chapada dos Veadeiros, ca. 5 km SE of São Jorge, Vale da Lua, 14°09'39" S, 47°46'14" W, 898 m, 11 Jul 2005, *Rua & Oliveira* 642 (CEN); Mun. Barro Alto, Barro Alto, 8 Jul 1994, *Brina s.n.* (CEN); Mun. Campos Belos, estrada de chão para Pouso Alto, 12°58'33" S, 46°28'05" W, 740 m, 23 Apr 2001, *Pereira & Cardoso* 2552 (IBGE); Mun. Colinas do Sul, ca. 23 km da entrada Sul do canteiro da A.H.E. Serra da Mesa, 13°53'37" S, 48°07'39" W, 500 m, 12 Sep 1997, *Oliveira & al.* 805 (CEN); Mun. Flores de Goiás, Serra do Morcego, wooded valley, córrego Estrema, ca. 35 km NE of Formosa, 800 m, 22 Apr 1966, *Irwin et al.* 15248 (IBGE, UB); Mun. Niquelândia, Macedo, ca. 18 km N de Niquelândia, 13 Apr 1992, *Filgueiras* 2280 (IBGE, UB); loc. de Macedo, ca. 20 km de Niquelândia, 14°18' S, 48°23' W, 4 Aug 1992, *Filgueiras & Lopes* 2433 (IBGE); 2 km da estrada de chão para o Macedo Velho, 14°21'03" S, 48°24'52" W, 25 Apr 1995, *Oliveira et al.* 305 (IBGE); Companhia de Níquel Tocantins-CNT, ca. 1 km após a mina de níquel, descendo no lado esquerdo da estrada, 14°21'29" S, 48°23'11" W, 12 Apr 1996, *Oliveira et al.* 516 (IBGE); Macedo, ca. 1 km abaixo da mina de níquel, 14°21'29" S, 48°23'11" W, 29 May 1996, *Oliveira et al.* 598 (IBGE); ca. 4 km de Macedo Velho, próximo à bica, 14°21'34" S, 48°24'38" W, 30 May 1996, *da Silva & Nunes de Jesus* 3017 (IBGE); ca. 8 km do trevo de Niquelândia em direção à Companhia de Níquel Tocantins, 14°05' S, 48°22' W, 25 Oct 2000, *Oliveira & Moraes* 1435 (CEN); Estrada Niquelândia-Macedo, ca. 10 km N de

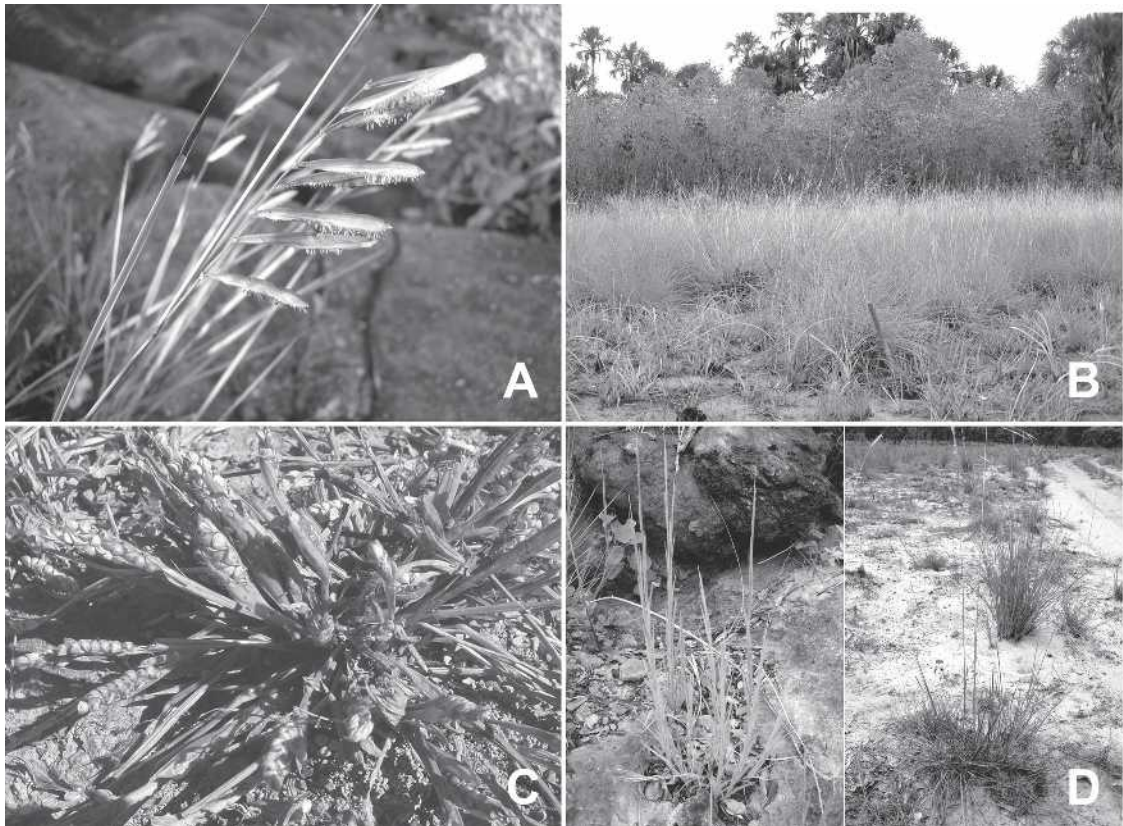


FIG. 5. Field photographs of *Paspalum* species. A. *Paspalum vexillarium* in Vale da Lua ('Moon Valley'), Mun. Alto Paraiso, Goiás, Brazil. B. A population of *Paspalum veredense* in a 'vereda' margin in the Jalapão region, Tocantins, Brazil. C. *Paspalum clipeum* in a deciduous forest ('mata-seca') area in Simolândia, Goiás, Brazil. D. *Paspalum spissum* (left) and *P. carinatum* (right) in Cerrado areas in the Jalapão region, Tocantins, Brazil.

Niquelândia, 14°22'32.5" S, 48°25'46.2" W, 863 m, 10 Jul 2005, *Rua & Oliveira* 632 (CEN); Maranhão: Mun. Loreto, Ilha de Balsas, region between the Balsas and Parnaíba rivers, 35 km S of Loreto, several hundred meters W of main house of Fazenda Morro along trail to "Gigante", 07°23' S, 45°04' W, 300–350 m, 25 Feb 1970, *Eiten & Eiten* 10789 (UB); Minas Gerais: Mun. Montezuma, Retiro, ca. 16 km da cidade em direção a Mato Verde, 15°18'23" S, 42°31'25" W, 900 m, 17 Mar 1994, *Souza et al.* 5548 (UB); Piauí: Mun. Corrente, 500 m ao sul da ponte sobre o rio Corrente na BR-135, 10°27' S, 45°10' W, 460 m, 3 Apr 1983, *Valls et al.* 7109 (CEN); Mun. Gilbués, Gilbués, 14 Mar 1979, *Delarco s.n.* (*Herb. G. Barroso* 363, CEN); Gilbués, area degradada em avançado processo de desertificação, 8 Mar 1988, *Filgueiras & Rodrigues* 1342, 1347, 1350 (IBGE); Tocantins: Mun. Tocantinópolis, estrada vicinal junto à Ferrovia Norte-Sul, km 18 no sentido Darcinópolis, 06°38'50" S, 47°29'56" W, 190 m, 21 Feb 2005, *Pereira-Silva et al.* 9457 (CEN).

Observations—*Paspalum vexillarium* has long been confused with *P. ceresia*, a species growing in Andean slopes of Ecuador, Peru, Bolivia and NW Argentina. Döll (1877) distinguished *P. vexillarium* and *P. ceresia* at the varietal level (under *P. membranaceum* var. *inaequiglume* Döll and var. *aequiglume* Döll, respectively), on the basis of the relative length of upper glumes and lower lemmas. Nevertheless, in the recent revision of *Paspalum* subg. *Ceresia* by Denham et al. (2002),

such a distinction was not made, because the authors felt it was based on "a variable character according to the degree of maturity of spikelets" (p. 363). Leaf shape and width was also disregarded as a valuable taxonomic character, because the authors felt they exhibited "a considerable variation," ranging from "filiform to linear and rigid," to "filiform and lanceolate in a single specimen," to lanceolate, up to 2 cm wide. Curiously, these authors overlooked the strong correlation between subequal vs. unequal upper glumes and lower lemmas, lanceolate vs. narrowly elliptical to lineal leaves, and geographical distribution. Indeed, all the specimens that they cited as having "filiform" leaves are from Brazil, as is all the material available to us and now included in the new species. The Döll's epithet *inaequiglume* cannot be used at the species level because the binomial *P. inaequiglume* Parodi already exists; hence the new epithet *vexillarium* is here proposed for this species.

The following key separates the new species from other *Paspalum* species in *P.* subg. *Ceresia* with membranous rachises more than 3.5 mm wide and solitary spikelets.

1. Spikelets awned 2
 2. Dwarf plants up to 40 cm tall; spikelets 1.1–2.2 mm long *P. longiaristatum* Davidse & Filg.
 2. Plants more than 70 cm tall; spikelets 3.8–4.5 long *P. biaristatum* Filg. & Davidse
1. Spikelets not awned 3
 3. Spikelets 5–7 mm long; upper florets conspicuously shorter than the spikelets 4
 4. Upper glumes winged, cordate at base; upper florets sessile *P. aspidiotes* Trin.
 4. Upper glumes not winged or cordate; upper floret stipitate *P. lanciflorum* Trin.
 3. Spikelets up to 4 mm long; upper florets as long as or slightly shorter than the spikelets 5
 5. Rachises 3.5–4 mm wide; spikelets occasionally paired; culms many-noded 6
 6. Plants caespitose; culms freely branched at the upper nodes after flowering of the main axis; spikelets 2.3–3 mm long, with an annular thickening at the base; a few marginal hairs longer than the rest; lower lemmas pilose only at the upper margins *P. heterotrichon* Trin.
 6. Plants rhizomatous; culms unbranched, at least at the upper nodes; spikelets 3.5–4.2 mm long, without an annular thickening at the base; marginal hairs ± uniform; lower lemmas pilose at the margins and the basal portion. *P. gracielae* Sulekic
 5. Rachises 5–10 mm wide; spikelets always solitary, without an annular thickening at the base; culms few-noded 7
 7. Inflorescences with 1 or 2 primary branches, if 2 conjugate; pedicels with a crown of hairs toward the apex; upper florets short-stipitate; lodicules 2; blades filiform, 0.1–0.3 cm wide *P. stellatum* Humb. & Bonpl. ex Flügge
 7. Inflorescences with (1)2–7 primary branches, alternate along the main axis; pedicels without a crown of hairs toward the apex; upper florets sessile; lodicules absent; blades linear-filiform to linear-lanceolate, 0.5–2 cm wide 8
 8. Spikelets 2.9–4.0 mm long., 1.2–1.4 mm wide; upper glumes flat; lower lemmas 93–97% as long as the upper glumes, ca. 1 mm wide, flat to slightly convex, acute, pilose throughout on the abaxial surface, nerves slightly prominent; proximal portion of the tillers shortly plagiotropic, covered with several cataphylls; culms freely branching; leaf blades 0.5–1(–2) cm wide, flat; Eastern Andean slopes in Ecuador, Perú, Bolivia and NW Argentina *P. ceresia* (Kuntze) Chase
 8. Spikelets 2.2–2.9 mm long., ca. 1 mm wide, upper glumes with inrolled margins and slightly recurved apex; lower lemmas 64–84% as long as the upper glumes, 0.4–0.5 mm wide, concave, obtuse, glabrous and glossy on the abaxial surface, lateral nerves very prominent; tillers orthotropic, covered with the old proximal leaf sheaths; culms unbranching or branching just at the lowermost nodes; leaf blades 0.3–0.5 cm wide, flat to involute; central Brazil *P. vexillarium* nov. sp.

Paspalum veredense G. H. Rua, R. C. Oliveira, Valls, & Graçiano-Ribeiro, sp. nov.—TYPE (here designated): BRAZIL. Tocantins: Mun. Mateiros, Região do Jalapão, estrada Mateiros-São Félix, ca. povoado da Mumbuca, vereda da Extrema, 10°21'13.4" S, 46°36'49.9" W, 442 m, 9 Dec 2005, *G. H. Rua, I. B. Figueiredo, J. M. de Rezende, R. F. Lima* 695 (holotype: CEN!; isotypes: BAA!, RB!, US!).

P. elliptico Döll affine sed foliis farctis teretibus, spiculis minoribus acutis vel acuminatis, lemmate inferiori transverse-plicato, flosculo lemmate inferiori brevior, inconspicue papilloso differt.

Caespitose perennials forming dense clumps. Base of tillers forming short, curved rhizomes bearing strong, thick roots 2–3 mm diam, composed of several short internodes, the first node with a brownish, scale-like prophyll, the next one or two nodes bearing cataphylls, the following ones with foliage

leaves. Culms 70–110 cm tall, ca. 2 mm diam, erect, unbranched; internodes 3 or 4, glabrous, terete, hollow, pale; nodes dark. Proximal leaf sheaths 7–12 cm long, the distal ones longer, slightly keeled, hirsute at the base and the apical margin, otherwise glabrous, striate in dry material. Ligules ca. 0.7 mm long, membranous, obtuse, hyaline, glabrous, without a pseudoligule. Blades 40–65 cm long, 1–1.5 mm wide, solid, elliptical in cross section, junciform, somewhat bending, the base continuing with the leaf sheath, slightly pungent at apex, glaucous, hirsute at the very base, otherwise glabrous; upper blades reduced. Peduncles 25–40 cm long, terete, glabrous, pale. Inflorescences long exserted; main axis up to ca. 2 cm long, prolonged into a terminal 'raceme' shorter than the lateral ones or, more rarely, ending in a short naked point; 'racemes' 2–6, the lowermost 4.5–11.5 cm long, erect, conjugate to subdigitate; pulvini hirsute; rachis of the

racemes 0.7–0.9 mm wide, scabrous, somewhat flexuous, ending in a spikelet, greenish, the midnerve striking, pale; pedicels 0.5–1 mm long, puberulous, narrowly winged; spikelets 3.8–4.8 mm long, 1.2–1.4 mm wide, solitary, imbricate in 2 series, plano-convex. Lower glumes lacking. Upper glumes as long as the spikelets, 1.3–1.5 mm wide, narrowly ovate, membranous, 5-nerved, nerves green, the lateral nerves close to the glume margins, region between nerves pale, glaucous, somewhat crumpled, the marginal hairs up to 2 mm long, whitish, otherwise glabrous, margins involute, covering the margins of the lower lemma, the base truncate, the apex acute to shortly acuminate. Lower lemmas 3.7–4.6 mm long, not as pilose as the glume, conspicuously wrinkled between nerves but otherwise similar to it. Upper florets 3.5–3.8 mm long, 1.2–1.5 mm wide, narrowly elliptical, slightly shorter than the lower lemmas, plano-convex, coriaceous, pale, glabrous, finely papillose with papillae 10–15 μm diam, acute but blunt at the very apex, the upper lemmas faintly 3-nerved, the cucullate apex of the lemma clasping the palea apex; lodicules 2; stamens 3, anthers ca. 1.8 mm long, purple; stigmas 2, purple, plumose. Caryopses not seen. Figure 6.

Leaf Anatomy—(Fig. 2E, F). Leaf blades elliptical in cross section, solid cuticle thickened. Epidermis with typical epidermal cells, bicellular microhairs, hooks, stomata and silicified cells. Mesophyll consisting of radial parenchyma cells. Three orders of vascular bundles present, all of them surrounded by a single bundle sheath of relatively large, thin-walled parenchymatous cells. First- and second-order vascu-

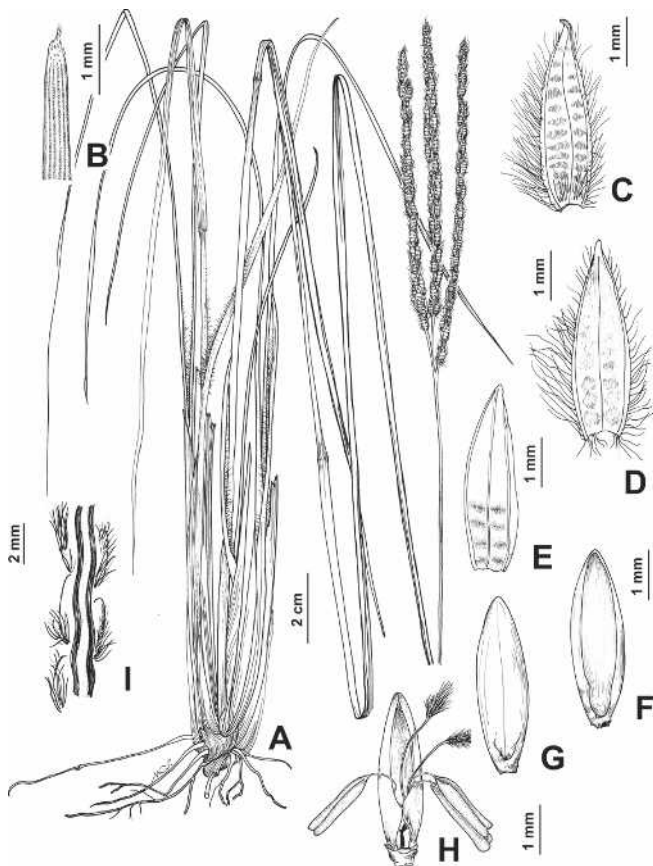


FIG. 6. *Paspalum veredense* (from Rua et al. 695). A. Habit. B. Leaf apex. C. Upper glume, abaxial view. D. Upper glume, adaxial view. E. Lower lemma, abaxial view. F. Upper floret, adaxial view. G. Upper floret, abaxial view. H. Flower. I. Portion of the rachis with spikelets, adaxial view.

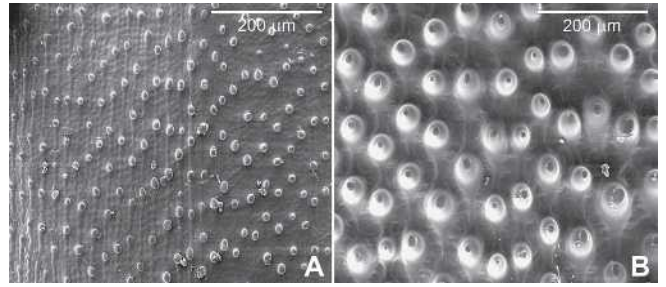


FIG. 7. Scanning electron micrographs of the upper lemma epidermis. A. *Paspalum veredense* (Rua et al. 695, CEN). B. *P. ellipticum* (Souza et al. 7414, CEN).

lar bundles with sclerenchyma extensions; the bundles separated by 1 or 2 parenchyma cells. Strands of sclerenchyma occur joining the margins. Parenchymatous medulla of very thin-walled cells.

Distribution and Habitat—(Figs. 3, 5B). This species forms monospecific stands in moist grasslands ('campo úmido') along the margins of permanent swamp areas characterized by the occurrence of the Buriti palm (*Mauritia flexuosa* L.f.), locally known as 'veredas', in the Brazilian states of Maranhão, Piauí, Goiás, and Tocantins.

Etymology—The epithet refers to the 'veredas', the Brazilian name for permanent swamp areas along small rivers and creeks, characterized by the occurrence of *Mauritia flexuosa*, in the margins of which the new species grows.

Additional Material Examined—BRAZIL. Bahia: Mun. Correntina, vereda do Alegre, proximo à cabeceira do córrego Alegre, 22 km de Correntina, 13°20' S, 44°40' W, 600 m, 1 Nov 1994, Oliveira & Werneck 277 (CEN); Maranhão: Mun. Balsas, Projeto Geral de Balsas, 07°35' S, 46°05' W, 300 m, 20 Nov 1995, Oliveira & Pereira-Silva 366 (CEN); Projeto Geral de Balsas, 07°35' S, 46°05' W, 300 m, 27 Nov 1997, Oliveira & Pereira-Silva 637 (IBGE); Geral de Balsas, campo úmido 06 (U6), 20 Mar 2000, Oliveira & al. 1401 (CEN); Tocantins: Mun. Dianópolis, nos arredores do acampamento, na margem direita do rio Limoeiro, confluência com o rio Palmeira, 11°31'00" S, 42°24'38" W, 630 m, 27 Sep 2003, Scariot et al. 879 (CEN); Mun. Mateiros, Região do Jalapão, estrada Mateiros-São Félix, ca. povoado da Mumbuca, vereda do Bebedouro, 10°22'29" S, 46°36'28" W, 444 m, 7 Dec 2005, Rua & al. 670 (CEN); Região do Jalapão, estrada Mateiros-São Félix, ca. povoado da Mumbuca, vereda do Velho, 10°23'06.6" S, 46°36'59.7" W, 479 m, 8 Dec 2005, Rua & al. 679 (CEN).

Observations—(Figs. 2E, 7). *Paspalum veredense* is presumably related to *P. ellipticum* Döll and to *P. erianthoides* Lindm. It has sometimes been confused with *P. ellipticum* in herbarium identifications, and the specimens Oliveira & Werneck 277 and Oliveira & Pereira-Silva 366 were cited earlier as reference material for this species (Oliveira and Valls 2002). The spikelets of *P. veredense* resemble those of *P. ellipticum*, from which they can be distinguished by being shorter, acute-acuminate, with plicate lower lemmas and upper florets shorter than lower lemmas, inconspicuously papillose in macroscopic observation (Fig. 7). *Paspalum veredense* is a robust plant forming dense tussocks, with strong, densely packed rhizomes, thick roots and very distinctive stout, junciform, and solid leaf blades (Fig. 2E) resembling those of *P. erianthoides*, whereas the leaf blades of *P. ellipticum* are filiform-conduplicate (Aliscioni 2000).

The following key separates the new species from other *Paspalum* species with pilose spikelets, inflorescences with two or more primary branches, and filiform to junciform leaves (groups 'Notata' and 'Eriantha' p.p.).

1. Spikelets paired; inflorescence primary branches scattered along the main axis, appressed *P. erianthoides* Lindm. 2
1. Spikelets solitary inflorescence primary branches conjugate or fasciculate 2
2. Leaf blades filiform-conduplicate to sublanceolate, v-shaped in cross section, 0.2–1.5 mm wide; spikelets elliptical, mostly 4.5–5 mm long., upper glumes and lower lemmas obtuse to short-apiculate, as long as the upper florets, lower lemmas smooth, the upper florets conspicuously papillose in macroscopic observation (papillae 20–40 μm diam); inflorescences with 2, rarely 3, primary branches *P. ellipticum* Döll
2. Leaf blades junciform, elliptical in cross section, solid, 1.5–2 mm wide; spikelets lanceolate, mostly 4 mm long., upper glumes and lower lemmas acute-acuminate, longer than the upper floret; lower lemmas wrinkled between nerves; upper florets inconspicuously papillose in macroscopic observation (papillae 10–15 μm diam); inflorescences with 2–7 primary branches *P. verdense* nov. sp.

Paspalum clipeum G. H. Rua, Valls, Graciano-Ribeiro, & R. C. Oliveira, sp. nov.—TYPE (here designated): BRAZIL. Goiás: Mun. Simolândia, pouco ao norte da estrada Simolândia-Jaciara, entrando a oeste da ponte sobre o córrego Salobro, 14°29'22.7" S, 46°29'42.3" W, 500 m, 28 May 2006, J. F. M. Valls, G. H. Rua, A. Custodio 15204 (holotype: CEN!; isotypes: BAA!, K!, L!, MO!, RB!, SI!, US!).

P. convexo Humb. & Bonpl. ex Flügge affine sed flosculo superiori stramineo differt.

Dwarf annuals. Culms 3–11 cm tall, 0.5–1.1 mm diam, erect to ascending, freely branching and flowering from the axils of proximal leaves, the successive branches arising from the axils of the prophylls forming cymose branching systems; internodes 3–4, glabrous, solid, the basalmost purple-tinged; nodes glabrous, purple-tinged. Leaf sheaths 2–6 cm long, distally keeled, striate, glabrous to distally hirsute. Ligule 0.7–0.9 mm long, membranous, truncate to rounded, glabrous, without a pseudoligule. Blades 3–5 cm long, ca. 5 mm wide, lanceolate-acuminate, flat, the base slightly broader than the leaf sheath; hirsute to glabrescent with hirsute margins; upper blades reduced. Peduncles 1.5–4 cm long, compressed,

glabrous. Inflorescences formed by 1 or 2 (if two, separated by an internode 0.8–1 cm long), erect racemes 1–2 cm long, partly enclosed within the uppermost foliage leaf, main axis up to ca. 1 cm long; pulvini pilose; rachis of the racemes 0.8–0.9 mm wide, glabrous, slightly flexuous, triquetrous, narrowly 3-winged, ending in a terminal spikelet, green; pedicels 1–1.2 mm long, glabrous to puberulous, terete. Spikelets 2.4–2.5 mm long, 1.8–2.3 mm wide, suborbicular to broadly obovate, paired, crowded, deciduous at maturity, sharply plano-convex (gibbous). Lower glumes lacking. Upper glumes as long as the spikelets, suborbicular to broadly obovate, cucullate, membranous, pale green, 5-nerved, nerves prominent, light green, the lateral ones close to the margins, region between nerves with a few short hairs in the middle portion, otherwise glabrous, the margins clasping the margins of the lower lemma, the base attenuate, the apex rounded. Lower lemmas as long as the upper glume, broadly obovate, flat, glabrous, the margins clasping the upper floret, rounded at apex, 5-nerved, the lateral nerves close to the margins. Upper florets broadly obovate to suborbicular, as long as the spikelet, sharply plano-convex (gibbous), stramineous, crustaceous, glabrous, the upper lemmas faintly 5-nerved, the thickened borders of the lemma clasping the palea borders, the paleas with overlapping marginal flaps, verrucose-reticulate at the internal surface; lodicules 2; stamens 3, anthers ca. 0.8 mm long, yellow, purple-tinged; stigmas 2, purple, plumose. Caryopsis ca. 1.6 mm long, 1.3 mm wide, plano-convex, broadly obovate, pale; hilum ca. 0.8 mm long, linear. Figures 5C, 8.

Leaf Anatomy—(Fig. 9A, B). Leaf blade V-shaped in cross section, with smooth margins. Midrib conspicuous, containing a single first order vascular bundle towards the abaxial surface. Cuticle thin. Upper epidermis with typical epider-

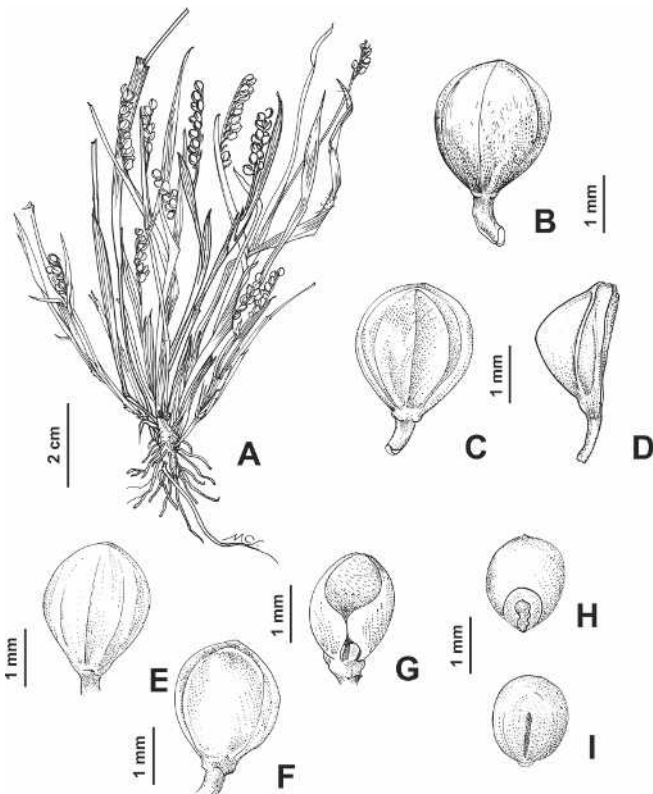


FIG. 8. *Paspalum clipeum* (from Valls et al. 15204). A. Habit. B. Spikelet, adaxial view. C. Spikelet, abaxial view. D. Spikelet, lateral view. E. Upper floret, abaxial view. F. Upper floret, adaxial view. G. Upper palea and lodicules. H. Caryopsis, embryo side. I. Caryopsis, hilum side.

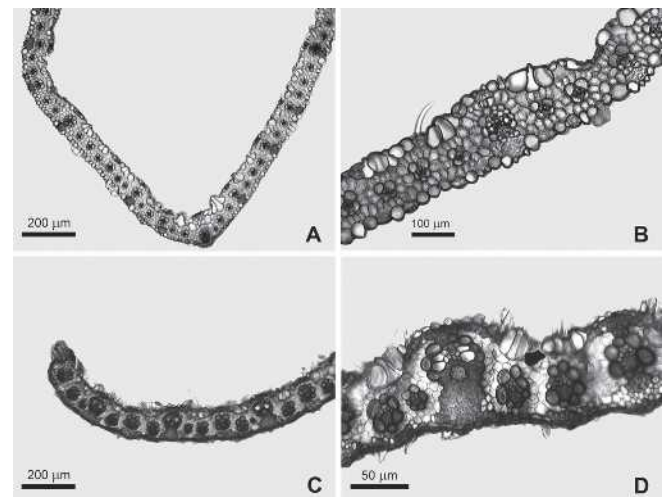


FIG. 9. Leaf blade anatomy in cross section, general view (left) and detail of a portion (right). A, B. *Paspalum clipeum* (Valls et al. 15204). C, D. *Paspalum spissum* (Rua et al. 798).

mal cells, bicellular microhairs, short macrohairs, cushion hairs, 3 fan-shaped bulliform cells, stomata, and silicified cells. Mesophyll consisting of radial chlorenchymatous cells. Three orders of vascular bundles present, all of them surrounded by a single bundle sheath of relatively large, thin-walled parenchyma cells. Bundles separated by 2 parenchyma cells. Abaxial and adaxial sclerenchyma caps associated with first-order vascular bundles.

Distribution and Habitat—The new species was found in the vicinity of Simolândia, in the state of Goiás, in grazed areas surrounding deciduous woodlands locally known as ‘matas secas’ (Fig. 3). *Paspalum clipeum* is known only from the type collection.

- | | |
|---|--|
| 1. Upper glume wanting or reduced, not more than half as long as the spikelet | 2 |
| 2. Upper glume 1/3 to half as long as the spikelet, clasping; upper floret nearly smooth, marmorate-speckled | <i>P. marmoratum</i> Kuhl. |
| 2. Upper glume wanting or reduced to a small scale; upper floret conspicuously papillose, uniformly colored | <i>Paspalum</i> ‘Gardneriana’ group |
| 1. Upper glume as long as the spikelet or nearly so | 3 |
| 3. Spikelets shield-shaped or provided of a broad notched margin | 4 |
| 4. Spikelets orbicular, with a broad notched margin | <i>P. fimbriatum</i> Kunth |
| 4. Spikelets shield-shaped, without a notched margin | <i>P. scutatum</i> Nees ex Trin. |
| 3. Spikelets variously shaped, but not shield-shaped or provided of a broad notched margin | 5 |
| 5. Upper floret dark brown | <i>Paspalum</i> ‘Plicatula’ group <i>p.p.</i> |
| 5. Upper floret stramineous | 6 |
| 6. Spikelets up to 1.5 mm long | 7 |
| 7. Racemes 6 or more. | <i>P. microstachyum</i> J. Presl |
| 7. Racemes 1–4. | <i>Paspalum</i> ‘Parviflora’ group <i>p.p.</i> |
| 6. Spikelets more than 1.9 mm long | 8 |
| 8. Leaf sheaths coarsely pilose. Spikelets ca. 2 mm long, upper glume and lower lemma purple-mottled | <i>P. expansum</i> Döll |
| 8. Leaf sheaths glabrous to distally hirsute. Spikelets ca. 2.5 mm long, upper glume and lower lemma uniformly pale green | <i>P. clipeum</i> nov. sp. |

PASPALUM SPISSUM Swallen, *Phytologia* 14: 358. 1967.—TYPE: BRAZIL. Maranhão: Carolina to San Antonio de Balsas, 20–25 Mar 1943, J. R. Swallen 4050 (holotype: US-1612651, photograph!).

Caespitose perennials forming loose clumps, the base of the tillers forming short, knotted, curved rhizomes sheltered by numerous cataphylls that are covered with very dense, villous to woolly, isabelline to tawny hairs on the outer surface. Culms 70–90 cm tall, 1.5–2 mm diam, erect; internodes 11–16, hollow, the basal internodes 4–5 cm long, the distal internodes up to ca. 15 cm long; nodes generally white-bearded. Leaves mostly cauline, appressed along the culms and covering them. Leaf sheaths 4–8 cm long, decreasing toward the middle portion of the culm, those of basal leaves soft hairy, those of cauline leaves apically hirsute, otherwise glabrous. Ligules 0.7–0.9 mm long, membranous, rounded, glabrous, erose, pseudoligule present. Blades up to ca. 15 cm long, decreasing toward apex, 3–4 mm wide, narrowly triangular, flat, the base continuing with the sheath, the apex long acuminate, coarsely tuberculate-hirsute on both surfaces. Peduncles 18–32 cm long, flattened, glabrous, pale. Inflorescences exerted or basally enclosed by the uppermost leaf sheath; main axis up to ca. 4 cm long, truncate, sometimes ending in a short membranous, scale-like appendix; ‘racemes’ 7–14 cm long, 1 or 2(–3), separated by filiform internodes 2–3 cm long, ascending; pulvini hirsute, frequently flanked by two lateral membranous scales; rachis of the racemes 2–2.2 mm wide, glabrous, laterally winged, ending in a spikelet, the mid portion flexuous, composed of a thick, pale-green midnerve flanked by 2 or 3 thin, dark-green lateral nerves, the wings ca. 0.8 mm wide, ferruginous, minutely scaberulous at margins; pedicels short, glabrous;

Etymology—The epithet means ‘medal-like’, and refers to the shape of the spikelet.

Observations—*Paspalum clipeum* is morphologically similar to *P. convexum* Humb. & Bonpl. ex Flügge and other annual species of the ‘Plicatula’ group (Oliveira 2004), with which it shares the gibbous, sharply indurate upper florets, and the caryopses with linear hilums. However, *P. clipeum* differs from other species in this group by having stramineous rather than dark brown upper florets.

The following key separates the new species from other annual South American *Paspalum* species with glabrous spikelets, inflorescences with rachis narrower than 2 mm wide, and upper florets closed at the summit.

spikelets 4.4–5.2 mm long, solitary, densely imbricate in 2 series, dorsiventrally compressed. Lower glumes lacking. Upper glumes as long as the spikelets, 1.5–1.7 mm wide, narrowly ovate, hyaline, pale, 3-nerved, the lateral nerves submarginal, densely silky-pilose on the basal third and along the margins, the hairs up to 4 mm long, otherwise glabrous, proximally convex, distally flattened, the proximal portion of the margins covering the margins of the lower lemma, the base truncate, the apex acute. Lower lemmas 3.9–4.9 mm long, 1.1–1.2 mm wide, narrowly ovate to narrowly elliptical, acute to rounded at apex, 3-nerved, flat, with folded margins, the indumentum as in the upper glume but the hairs shorter. Upper florets narrowly ovate, 3.3–3.8 mm long, 1.1–1.7 mm wide, plano-convex, distally flattened, acute to rounded at apex, cartilaginous, pale stramineous, faintly papillose, the upper lemmas pubescent at apex, the palea glabrous, the apex not enclosed by the lemma apex; lodicules 2; stamens 3, anthers 2.4–2.5 mm long, purple-tinged; stigmas 2, purple, plumose. Caryopses not seen. Figure 10.

Leaf Anatomy—(Fig. 9C, D). Leaf expanded in cross section. Midrib inconspicuous, containing a single first-order vascular bundle more lignified than the others. Cuticle very thick. Adaxial epidermis with typical epidermal cells, bicellular microhairs, prickles, hooks, short macrohairs with round apices and long macrohairs with acute apices, bulliform cells, stomata, and silicified cells; abaxial epidermis lacking macrohairs and bulliform cells. Mesophyll consisting of radial parenchyma cells. Three orders of vascular bundles present, all with a single bundle sheath of relatively large, thin-walled parenchyma cells. Bundles separated by 2 parenchymatous cells. Sclerenchyma extensions adaxial and abaxial in first-order vascular bundles, only abaxial in second-

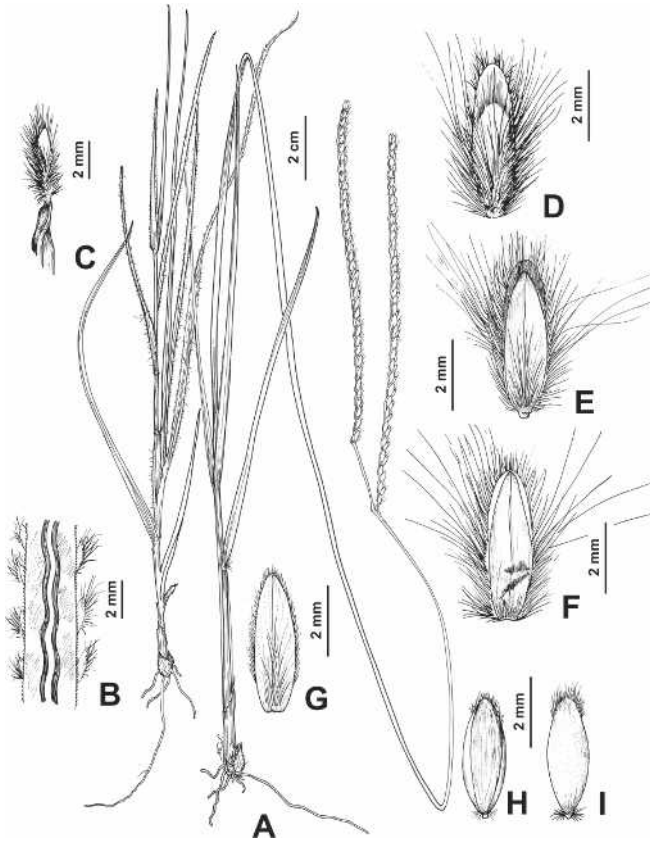


FIG. 10. *Paspalum spissum* (from Rua et al. 774). A. Habit. B. Portion of the rachis with spikelets, adaxial view. C. Spikelet ending the rachis. D. Spikelet, adaxial view. E. Spikelet, abaxial view. F. Upper glume, adaxial view. G. Lower lemma, abaxial view. H. Upper floret, adaxial view. I. Upper floret, abaxial view.

order vascular bundles. Adaxial sclerenchyma girders associated just with first order vascular bundles.

Distribution and Habitat—(Fig. 3). *Paspalum spissum* is a common species in sandy soils of Cerrado vegetation and is found in the Brazilian states of Goiás, Maranhão, Mato Grosso, and Tocantins.

Additional Material Examined—BRAZIL. Goiás: Mun. Posse, Serra Geral de Goiás, rio da Prata, ca. 6 km S of Posse, 800 m, 7 Apr 1966, Irwin et al. 14511 (IBGE); Maranhão: Mun. Balsas, Projeto Geral de Balsas, 07°35' S, 46°05' W, 300 m, 17 Nov 1997, Oliveira & Pereira-Silva 512 (IBGE); Condomínio Kissy lote 16, 06°36'57"S, 46°43'12" W, 470 m, 18 Mar 1999,

Pereira-Silva 4088 (CEN); Gerais de Balsas, estrada para Riachão, ca. 10.7 km de Gerais, 08°27'04" S, 46°43'27" W, 560 m, 20 Mar 2000, Oliveira et al. 1409 (CEN); Gerais de Balsas, ca. 16 km Gerais de Balsas-Riachão, 08°26'48" S, 46°40'11" W, 550 m, 20 Mar 2000, Oliveira et al. 1420 (CEN); Mato Grosso: Mun. Ribeirão Cascalheira, Royal Geographic Society Expedition, Base Camp., 12°49' S, 51°46' W, 1967–69, Smith L11 (UB); Tocantins: Mun. Aguiarnópolis, km 64 da BR-226 cerca de 7 km a nordeste de Vanderlândia, 06°50' S, 47°54' W, 16 Mar 1985, Valls et al. 8339 and 8340 (CEN); Mun. Mateiros, Estação biológica do Jalapão, atalho na estrada Cnia. Panambi-Mateiros, 16 km antes do encontro com a estrada principal, 170 km de Dianópolis, 10°43'35.8" S, 46°12'48.3" W, 686 m, 7 Mar 2006, Rua et al. 774 (CEN); Região do Jalapão, estrada Mumbuca-Boa Esperança, 2 km antes do posto da Naturatins, 10°23'21.5" S, 46°36'03.7" W, 547 m, 8 Mar 2006, Rua et al. 779 (CEN); Região do Jalapão, estrada Mumbuca-Boa Esperança, morrinho no sopé da Serra do Espírito Santo, 8,5 km do povoado da Mumbuca, 10°23'38.3" S, 46°36'45.7" W, 500–550 m, 9 Mar 2006, Rua et al. 798 (CEN).

Observations—In the comments of the original description, Swallen (1967) pointed out that *P. spissum* differs greatly from the related species *P. carinatum* Humb. & Bonpl. ex Flügge, because the former has "flat appressed blades completely covering the culm, conspicuously villous cataphylls, and very narrow margins on the racemes". Denham et al. (2002) considered *P. spissum* to be a synonym of *P. carinatum*, since width and pilosity of the leaf blade were thought to be highly variable characters across the collections examined. The occurrence of cauline leaves was attributed to the probable absence of periodic fires (Denham et al. 2002). Nevertheless, cauline papillose-hispid leaf blades 2–3 mm wide on a many-noded culm occur consistently in all specimens of *P. spissum* examined, as well as culms having a knotted base with villous cataphylls forming a rather loose clump. These characteristics were also observed during fieldwork by GHR in recently burned Cerrado where individuals of *P. carinatum* were growing a few meters away from individuals of *P. spissum*, generally associated with more disturbed habitats, such as roadside areas. Here, individuals of *P. carinatum* formed dense tufts that contrast sharply with those of *P. spissum*, primarily because the former species has basal filiform leaves and few-noded culms (Fig. 5D). In this locality, plants of *P. carinatum* flowered earlier than those of *P. spissum*. Even though both species apparently have identical spikelets, we think *P. spissum* should be maintained as a separate species, in agreement with Filgueiras (1993).

The following key separates *P. spissum* from other *Paspalum* species in *P.* subgen. *Ceresia* with solitary spikelets and rachises less than 3 mm wide.

1. Upper glumes winged, cordate at the base; inflorescence primary branches up to 11, conjugate or subdigitate. *Paspalum* sect. *Pectinata* Chase ex Rodr.-Rodr. (p.p.)
1. Upper glumes not winged nor cordate; inflorescence primary branches just 1–3, scattered along the main axis 2
2. Annuals; upper florets stipitate. *P. cachimboense* Davidse, Morrone & Zuloaga
2. Perennials; upper florets not stipitate 3
3. Tillers densely packed in dense clumps, without basal cataphylls; culms with 2–4-nodes; leaves basal with linear to filiform blades 4
4. Rachis of the racemes 1.8–2.5(–3.5) mm wide, straight to subfalcate; upper glumes densely pilose on the proximal third, otherwise scaberulous; upper glumes and lower lemmas flat in the upper portion; leaf blades filiform, recurved at maturity. *P. carinatum* Humb. & Bonpl. Ex Flügge
4. Rachis of the racemes 1–1.6 mm wide, straight; upper glumes densely pilose on the proximal half, otherwise glabrous; upper glumes and lower lemmas slightly convex; leaf blades linear, erect at maturity. *P. goyasense* Davidse, Morrone & Zuloaga
3. Tillers spreading, forming loose clumps, the knotted base covered with conspicuous villous cataphylls; culms with 11–16-nodes; leaves basal and cauline, appressed, covering the culm, with narrowly triangular-acuminate blades *P. spissum* Swallen

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LITERATURE CITED

- Aliscioni, S. S. 2000. Anatomía ecológica de algunas especies del género *Paspalum* (Poaceae, Panicoideae, Paniceae). *Darwiniana* 38: 187–207.
- Burman, A. G. 1980. A new species of *Paspalum* (Gramineae) from Brazil. *Kew Bulletin* 35: 297–298.
- Clayton, W. D. and S. A. Renvoize. 1986. Genera Graminum. *Kew Bulletin, Additional Series* 13: 1–389. London: Her Majesty's Stationery Office.
- Davidse, G. and T. S. Filgueiras. 1993. *Paspalum longiaristatum* (Poaceae: Paniceae), a new serpentine endemic from Goiás, and the first awned species in the genus. *Novon* 3: 129–132.
- Davidse, G., O. Morrone, and F. O. Zuloaga. 2001. Two new species of *Paspalum* (Poaceae: Panicoideae) from Brazil. *Novon* 11: 389–394.
- Denham, S. S. 2005. Revisión sistemática del subgénero *Harpostachys* de *Paspalum* (Poaceae, Panicoideae, Paniceae). *Annals of the Missouri Botanical Garden* 92: 463–532.
- Denham, S. S., F. O. Zuloaga, and O. Morrone. 2002. Systematic revision and phylogeny of *Paspalum* subgenus *Ceresia* (Poaceae: Panicoideae: Paniceae). *Annals of the Missouri Botanical Garden* 89: 337–399.
- Döll, J. C. 1877. Gramineae II. Pp. 39–119 in *Flora Brasiliensis* 2(2), eds. C. F. P. Martius & W. Eichler. München: F. Fleischer.
- Filgueiras, T. S. 1993. Nomenclatural and critical notes on some Brazilian species of *Paspalum* (Poaceae: Paniceae). *Acta Amazonica* 23: 147–161.
- Filgueiras, T. S. 1995. *Paspalum niquelandiae* (Poaceae: Paniceae), a new species from serpentine outcrops of central Brazil. *Novon* 5: 30–33.
- Filgueiras, T. S. and G. Davidse. 1994. *Paspalum biaristatum* (Poaceae: Paniceae), a new serpentine endemic from Goiás, Brazil, and the second awned species in the genus. *Novon* 4: 18–22.
- Filgueiras, T. S., O. Morrone, and F. O. Zuloaga. 2001. *Paspalum burmanii* (Poaceae: Paniceae), a new species from central Brazil. *Novon* 11: 36–39.
- Giussani, L. M., H. Cota-Sánchez, F. O. Zuloaga, and E. A. Kellogg. 2001. A molecular phylogeny of the grass subfamily Panicoideae (Poaceae) shows multiple origins of C₄ photosynthesis. *American Journal of Botany* 88: 1993–2012.
- Mendonça, R. C., J. M. Felfili, B. M. T. Walter, M. C. Silva-Júnior, A. V. Rezende, T. S. Filgueiras, and P. E. Nogueira. 1998. Flora vascular do Cerrado. Pp. 289–556 in *Cerrado: ambiente e flora*, eds. S. M. Sano & S. P. Almeida. Planaltina: EMBRAPA-CPAC.
- Morrone, O. and F. O. Zuloaga. 2003. New species of *Paspalum* (Poaceae: Panicoideae: Paniceae) from Brazil. *Systematic Botany* 28: 307–312.
- Oliveira, R. C. 2004. Estudo taxonômico das espécies de *Paspalum* L., grupo *Plicatula* (Poaceae-Panicoideae-Paniceae) no Brasil. Dr thesis, University of Campinas, Campinas, SP, Brazil.
- Oliveira, R. C. and J. F. M. Valls. 2002. Taxonomia de *Paspalum* L., grupo *Linearia* (Gramineae - Paniceae) do Brasil. *Revista Brasileira de Botânica* 25: 371–389.
- Paiva, J. G. A., S. M. Fank-de-Carvalho, M. P. Magalhães, and D. Graciano-Ribeiro. 2006. Verniz vitral incolor 500: uma alternativa de meio de montagem economicamente viável. *Acta Botânica Brasileira* 20: 257–264.
- Pozzobon, M. T., A. C. C. Machado, M. Vaio, J. F. M. Valls, A. P. S. Penáloza, S. dos Santos, A. L. Côrtes, and G. H. Rua. Cytogenetic studies in *Paspalum* (Gramineae) reveal new diploid species and accessions. *Ciência Rural* (in press).
- Swallen, J. R. 1967. New species of *Paspalum*. *Phytologia* 14: 358–389.
- Voster, P. 1990. Anatomy of the South African species of *Mariscus* (Cyperaceae), and its relation to environmental conditions. *Mitt. Inst. Allg. Bot. Hamburg* 23: 367–386.
- Warming, E. 1973. Lagoa Santa, contribuição para a geografia fitobiológica. Pp. 1–284 in *Lagoa Santa - A vegetação de cerrados brasileiros*, ed. M. G. Ferri. São Paulo: EDUSP [translation of the original publication in Danish, 1892].
- Zuloaga, F. O. and O. Morrone. 2005. Revisión de las especies de *Paspalum* para América del Sur austral (Argentina, Bolivia, sur Del Brasil, Chile, Paraguay y Uruguay). *Monographs in Systematic Botany from the Missouri Botanical Garden* 102: 1–297.