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Paspalum giuliettiae (Poaceae, Panicoideae), a New Grass from 'Campos Rupestres' of the Chapada Diamantina, Bahia, Brazil

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Abstract—A new grass species from Brazil, ***Paspalum giuliettiae,*** is herein described, illustrated, and compared with some congeners. This new species shares inflorescences with subconjugate primary branches and solitary glabrous spikelets with *P. pumilum,* but it differs in macromorphological characters and in leaf anatomy. *Paspalum giuliettiae* has been collected in the Chapada Diamantina, which is the northern portion of the Espinhaço Range, in the central region of the State of Bahia, Brazil. This new *Paspalum* grows in humid or swampy places in the 'campos rupestres' vegetation, above 1,000 m, and seems to be endemic to this region.

Keywords—Brazilian flora, Espinhaço Range, Gramineae, Paspaleae, *Paspalum pumilum*

Paspalum L. is a member of Poaceae subfamily Panicoideae, which comprises about 350 species mostly distributed in tropical and warm-temperate areas of the Americas (Clayton and Renvoize 1986; Zuloaga and Morrone 2005; Denham 2005). The genus was recently included in tribe Paspaleae (Morrone et al. 2012) and is recognized by dorsiventral raceme-like partial inflorescences, plano-convex spikelets with adaxial upper lemmas, lower glumes frequently lacking, obtuse indurate upper florets, and lemma margins inrolled, although one or more of these characters may not be present in some species (Chase 1929).

Species of *Paspalum* contribute amply to the biodiversity of grassland ecosystems in South America, which are strongly threatened by the expansion of agriculture. Valls and Oliveira (2012) cite 203 species of *Paspalum* to Brazil, 73 exclusive to the country and distributed in all of the native biomes. Renvoize (1984) lists 48 species for the state of Bahia in northeastern Brazil. Moreover, in a recent revision of the Brazilian flora, this number increased to 63 (Valls and Oliveira 2012) and this list is probably not exhaustive.

Five species of this genus are currently known to be endemic to the state of Bahia, two of them exclusive to the Atlantic Coast [*P. strigosum* Döll ex Chase, *P. restingense* Renv.], one to the 'Cerrados' from Western Bahia [*Paspalum phaeotrichum* Valls, G.H.Rua, Graciano-Ribeiro, & R.C.Oliveira] and two other species are cited as exclusive from the region known as 'Chapada Diamantina' [*P. madorense* Renv. and *P. rupium* Renv.].

The 'Chapada Diamantina' region corresponds to the northern portion of the Espinhaço Range, one of the most important mountain complexes of Brazil (Giulietti et al. 1997). This area comprises high altitudes (often up to 900 m and sometimes up to 2,000 m) and a heterogeneous vegetation displaying elements from the main Brazilian Biomes such as Cerrado, Atlantic Forest, and Caatinga, with the "campos rupestres" the main vegetation type (Rapini et al. 2008).

Poaceae is a characteristic component of the flora of the Espinhaço Range, especially the members of subfamily Panicoideae as indicated by Viana and Filgueiras (2008) who compiled 340 Poaceae species in the region, 49 of which are representatives of *Paspalum*, the most diverse grass group in that area.

More specifically in the Chapada Diamantina in the central region of Bahia State several new grass species have been described in last decades (e.g. Oliveira and Longhi-Wagner 2007; Rua et al. 2008; Salariato et al. 2011), with about 20 of them endemic to this region. Due to the scarce investment in field collections in many areas of that region and the doubtful identification of several materials previously collected, it is to be expected that potential new species await discovery.

Collections made in the northern and central portions of the Chapada Diamantina revealed a new species of *Paspalum*, which also seems to be endemic to this region. It is similar to *P. pumilum* Nees, a species widely distributed from the Caribbean to eastern Argentina (Zuloaga et al. 2004), including several Brazilian states (Valls and Oliveira 2012). This new species, which we named *P. giuliettiae*, is herein described, illustrated, and compared with *P. pumilum.*

Materials and Methods

This work was based on field collections and on a taxonomic review of the following herbaria: ALCB, BAA, CEPEC, HUEFS, ICN, IPA, SI, and PEUFR (acronyms by Thiers 2012). Additional information about *P. pumilum* was taken from published descriptions (Chase 1929; Oliveira and Valls 2001; Zuloaga et al. 2004; Zuloaga and Morrone 2005) and digital images of typus material were also examined at http://plants.jstor.org/.

Anatomical transverse sections were made on the second leaf blade below the inflorescence of *Paspalum giuliettiae* (*Oliveira et al. 1265* and *1322*, HUEFS) and *P. pumilum* (*Oliveira et al. 1360*, HUEFS). Leaf material was rehydrated with water and glycerol (50%) and mild detergent (0.5 ml). Transverse sections from the center of the leaf blade were cut by hand), dyed with an Astra Blue (1%) and Safranine (1%) aqueous solution (9:1) (Kraus and Arduin 1997) and mounted on semi-permanent slides with gelatin-glycerol. The observations and photographs were made on a Zeiss microscope at the Universidade Estadual de Feira de Santana (UEFS). The distribution map was created using Arcview GIS 3.2 (ESRI 2008).

Taxonomic Treatment

Paspalum giuliettiae Pimenta, G.H. Rua & R.P. Oliveira, sp. nov.—TYPE (here designated): BRAZIL. Bahia: Morro do

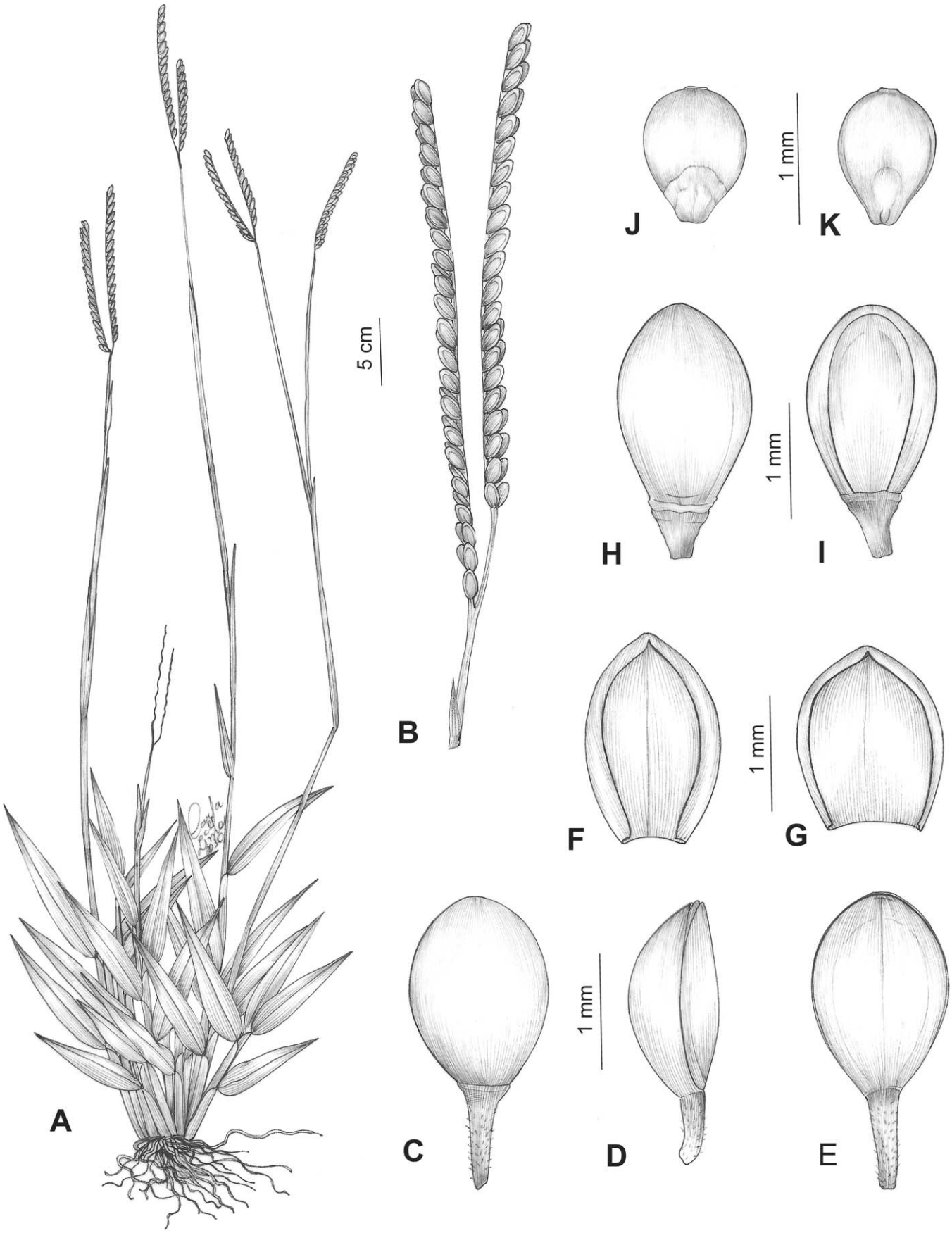

FIG. 1. *Paspalum giuliettiae.* A. Habit. B. Terminal inflorescence. C. Spikelet, upper glume view. D. Spikelet, lateral view. E. Spikelet, lower lemma view. F. Upper glume. G. Lower lemma. H. Upper floret, lemma view. I. Upper floret, palea view. J–K. Caryopsis (based on *Oliveira and Rua 1265).*

Chapéu, ca. 3.5 km na BA 052 para Mundo Novo, 11°30′25″S 41°20′24″W, 3 May 2007, *Oliveira & Rua 1265* (holotype: HUEFS!; isotype: BAA!).

Paspalum giuliettiae is similar to *P. pumilum*, but it differs by having a more erect habit, primary branches of the terminal inflorescence separate by an internode 0.6–1 cm long, an additional 1-racemed partial inflorescence axillary to the uppermost leaf sheath, and spikelets obtuse to rounded at apex.

Cespitose perennial, ca. 30 cm tall, with brief orthotropic rhizomes composed of short internodes; culms glabrous, 0.8–1.7 mm diam, erect. Leaf sheaths glabrous, striate when dry, margins distally ciliate; leaf blades 3–15 long × 4–6 mm wide, linear-lanceolate, apex acute, base attenuate to slightly cordate, glabrous in both surfaces, margins proximally ciliate, pseudoligule a ring of hairs up to 2 cm long, collar pilose; ligule a minute ring 0.25–0.5 mm long, membranaceous, glabrous, brown. Inflorescences terminal, composed of (1–)2 primary branches separate by an internode 0.6–1 cm long, usually accompanied by a long pedunculate, prophyllate partial inflorescence composed of a single raceme, borne at the axil of the uppermost leaf; peduncles 11–14 cm long, filiform; pulvinus at the base of primary branches puberulous; rachis 2–5 cm long, 0.7–0.8 mm wide, triquetrous, narrowly winged, sinuous, glabrous adaxially, scaberulous abaxially, margins smooth, ending in a spikelet. Spikelets 1.7–1.9 mm long, 1–1.2 mm wide, elliptical to obovate, obtuse to rounded at apex, plano-convex, solitary, pedicells ca. 0.6 mm long, scaberulous; lower glume lacking; upper glume and lower lemma as long as the spikelet, membranous, glabrous, 4–5–nerved, the nerves not convergent at apex, midvein present or lacking; lower lemma without an axillary flower; upper floret 1.6–1.7 mm long, plano-convex, elliptical to ovate, proximally constricted, crustaceous, glabrous, papillose, pale green when young, later stramineous; lodicules 0.25 mm long, truncate, hyaline. Caryopsis obovate, ca. 1 mm long. Figure 1.

Etymology—The name of the new species honors Dr. Ana Maria Giulietti, a Brazilian botanist who devoted her career to study the plants of the Chapada Diamantina.

Paratypes—BRAZIL. Bahia: Ibicoara, Gerais do Machombongo, 20 Set 2012, *Pimenta et al. 499* (HUEFS, CEPEC). Morro do Chapéu, trilha de acesso à cachoeira do Ferro Doido, 05 May 2007, *Oliveira et al. 1322* (HUEFS, BAA); 05 Oct 2007, *Dórea et al. 39* (HUEFS, BAA, CEN), 12 Feb 2012, *Pimenta & Oliveira 298* (HUEFS, CEPEC). Mucugê, by Rio Cumbuca ca. 3 km S of Mucugê, 04 Feb 1974, *Harley 15954A* (CEPEC); 2 Out 2012, *Pimenta & Silva 291* (HUEFS, CEPEC); trilha vale do Medonho, 20 Feb 2012, *Pimenta & Oliveira 327* (HUEFS, ALCB).

Distribution and Habitat—*Paspalum giuliettiae* was collected in the vicinity of Morro do Chapéu, a municipality located at the northern limits of the Chapada Diamantina, and also around the municipalities of Mucugê and Ibicoara in the central portions of this region, in the state of Bahia, Brazil (Fig. 2). On both areas, individuals of this new species were collected growing in humid and swampy places in the 'campos rupestres' vegetation (Fig. 3A , B), above 1,000 m altitude.

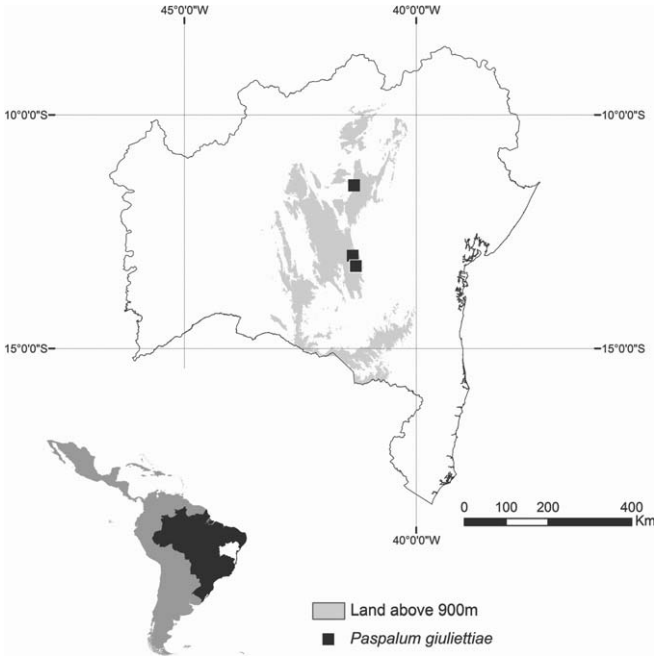

FIG. 2. Distribution map of *Paspalum giuliettiae.*

Morphological Comments—Collections of *Paspalum giuliettiae* were found misidentified in herbaria as *Paspalum pumilum*, and the specimen *Harley 15954A* was cited under this name by Renvoize (1984). These two species share a cespitose habit (Fig. 3C, E), leaves of similar size and shape, and inflorescences composed of two subconjugate racemes (Fig. 3D, F) with solitary and glabrous spikelets (Fig. 4). The new species can be differentiated by having an erect habit (Fig. 3C, vs. rounded clumps with somewhat lying culms in *P. pumilum*, Fig. 3E), obtuse to rounded spikelet apices (vs. acute in *P. pumilum*) (Fig. 4A-D), primary branches of the inflorescence separate by an internode more than 0.6 cm long (Fig. 3D, vs. less than 0.5 cm in *P. pumilum*, Fig. 3F), and the occurrence of a 1-racemed partial inflorescence axillary to the uppermost leaf sheath (Fig. 1A), lacking in *P. pumilum*. The last character is shared with other species from Bahia: *P. pilosum* Lam., *P. decumbens* Sw., *P. nutans* Lam., all of them belonging to *P.* subg. *Harpostachys* (Denham 2005), as well as with *P. arenarium* Schrad., a species currently ascribed to the informal group 'Setacea' (Zuloaga and Morrone 2005). However, all these species differ from *P. giuliettiae* in having paired spikelets.

Paspalum giuliettiae is herein considered as morphologically close to *P. pumilum*, which belongs to the Notata informal group. Three names are currently indicated as synonym of *P. pumilum*: *Paspalum nitidum* Swallen, *P. bicrurulum* Salzm. ex Steud. and *Paspalum campestre* Trin.; the last two were described based on collections made in the state of Bahia. The inspection of digital images of type material confirmed that all three names correspond to synonyms of *P. pumilum.*

Leaf Blade Anatomy—The leaf blade anatomy of *Paspalum giuliettiae* was compared with that of *P. pumilum* based on paradermic and transverse sections (Table 1; Fig. 5, 6). The anatomical characters are similar to those cited in the literature for different species elsewhere in *Paspalum* (Türpe 1966; Aliscioni 2000, 2002; Cialdella et al. 1995; Denham 2005; Denham et al. 2002; Morrone et al. 1995, 1996, 2000).

FIG. 3. Representatives of *Paspalum giuliettiae* and *P. pumilum* in the field. A. 'campo rupestre' vegetation in the vicinity of Morro do Chapéu, Chapada Diamantina, Bahia. B. Individual plant of *P.giuliettiae*, in a river Ferro Doido (*Pimenta and Oliveira 298*). C. Habit of *P. giuliettiae* (*Pimenta and Oliveira 298*). D. Detail of the inflorescence of *P. giuliettiae* (*Pimenta and Oliveira 298)*. E. Habit of *Paspalum pumilum Mota 183* (HUEFS). F. Detail of the inflorescence of *P. pumilum* (*Mota 183*).

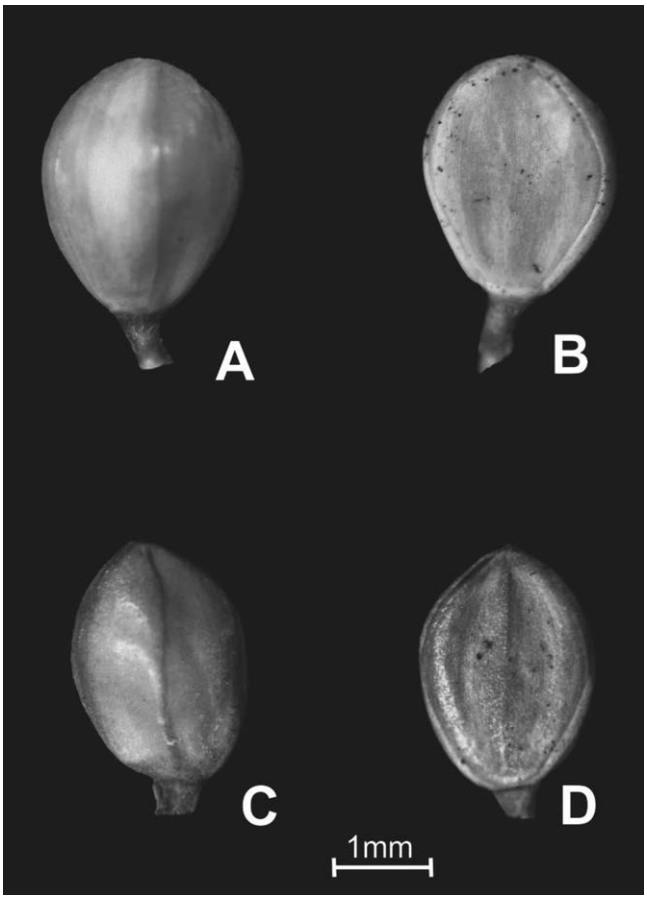

Fig. 4. Spikelets of *Paspalum giuliettiae* and *P. pumilum*. A–B: *P. giuliettiae*. A. Upper glume view. B. Lower lemma view (*Pimenta and Oliveira 327*). C–D. *Paspalum pumilum*. C. Upper glume view. D. Lower lemma view (*Pimenta and Silva 287*).

In surface view (Fig. 5A–G), the epidermis of these two species is organized into costal and intercostal zones, and on the costal zones both adaxial and abaxial surfaces alternate long and short cells (Fig. 5C). In this region, cells of *P. giuliettiae* (Fig. 5A–B) are longer than those of *P. pumilum* (Fig. 5G). In *P. giuliettiae*, adaxial anticlinal cell walls are straight (Fig. 5A) whereas abaxial ones are sinuous (Fig. 5B–D) differing from those of *P. pumilum*. Crenate siliceous cells occur on the intercostal zones (Fig. 5E).

We observed that *Paspalum giuliettiae* is amphistomatic, with the stomata distributed in ranks on each side of the costal zones (Fig. 5A–D), hence differing from *P. pumilum* which is hypostomatic (Fig. 5G), although Türpe (1966) also indicated this species as amphistomatic, based on material from another area. Two different trichome types were also found on the epidermis of these species: 1) short bicellular trichomes (Fig. 5F) in both species; and 2) long unicellular trichomes (Fig. 5G) only in *P. pumilum*.

In transverse sections, leaf blades of *Paspalum giuliettiae* and *P. pumilum* have a uniseriate epidermis on both surfaces, with groups of bulliform cells regularly spaced on the adaxial surface (Fig. 6). The midrib region is well defined in both species, with only a middle vascular bundle in a subcentral position, and ground parenchyma cells between the adaxial surface and the middle vascular bundle (Fig. 6A–B). Along the adaxial epidermis we observed three to five bulliform cell groups in *P. pumilum* (Fig. 6D) contrasting with six to eight groups in *P. giuliettiae* (Fig. 6C).

The leaf blade margin of *P. giuliettiae* ends with a bundle of sclerenchyma fibers (Fig. 6E), which is lacking in *P. pumilum* (Fig. 6F). On the other hand, *P. pumilum* has several papillae on the abaxial surface in this region (Fig. 6B, D, F), lacking in the new species.

Although *Paspalum giuliettiae* is a morphologically distinct member of this genus, additional studies including chromosome counting and molecular evidence should be conducted to assess its proper systematic position and phylogenetic relationships and to gain some insights on its reproductive behavior.

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Table 1. Morphological and leaf anatomical characters comparing *Paspalum giuliettiae* and *P. pumilum*.

Character	*Paspalum giuliettii*	*Paspalum pumilum*
Leaf blade indumentum	Glabrous	Densely pilose
Terminal inflorescence branches	(1–)2	2
Internode separating the inflorescence branches	6–10 mm long	Less than 5 mm long
Additional inflorescence on the axil of the uppermost leaf	Present	Absent
Spikelet Apex	Obtuse to rounded	Acute
Bulliform cells per group on the adaxial epidermis	6–8	3–5
Sclerenchyma bundle on leaf margins	Present	Absent
Papillae on leaf margins (abaxial surface)	Absent	Present

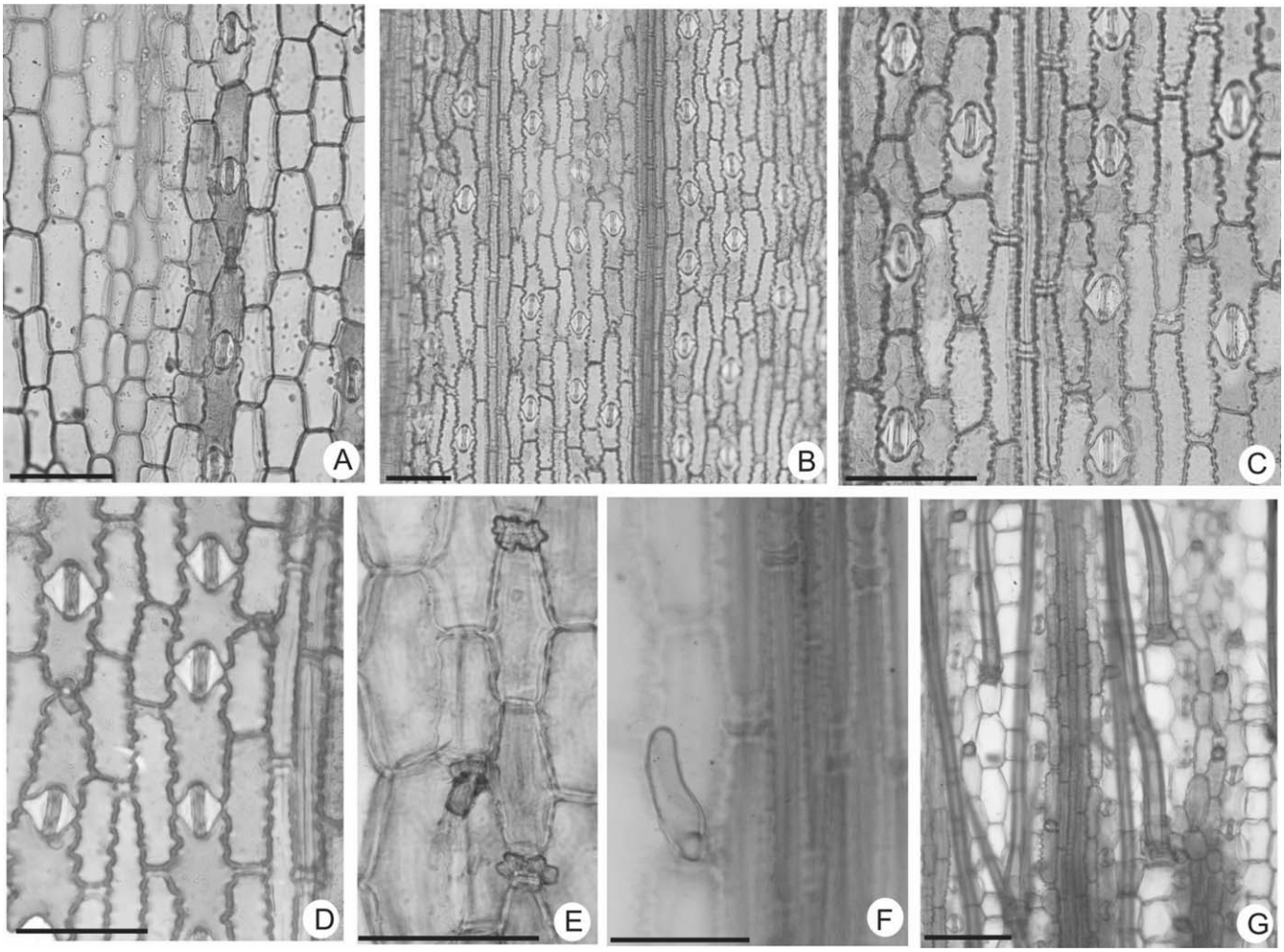

Fig. 5. Paradermal sections on the leaf blades of *Paspalum giuliettiae* (*Oliveira et al. 1322*) and *P. pumilum* (*Oliveira et al. 1360*). A–F: *Paspalum giuliettiae*. A. General view of the adaxial epidermis. B. General view of the abaxial epidermis. C. Detail of the abaxial epidermis with long and short cells. D. Adaxial epidermis with detail of the subsidiary cells of the stomata with triangular shape. E. Silicified crenate cells. F. Abaxial epidermis, showing bicellular trichomes. G. Abaxial epidermis of *P. pumilum*, showing long unicellular trichomes.

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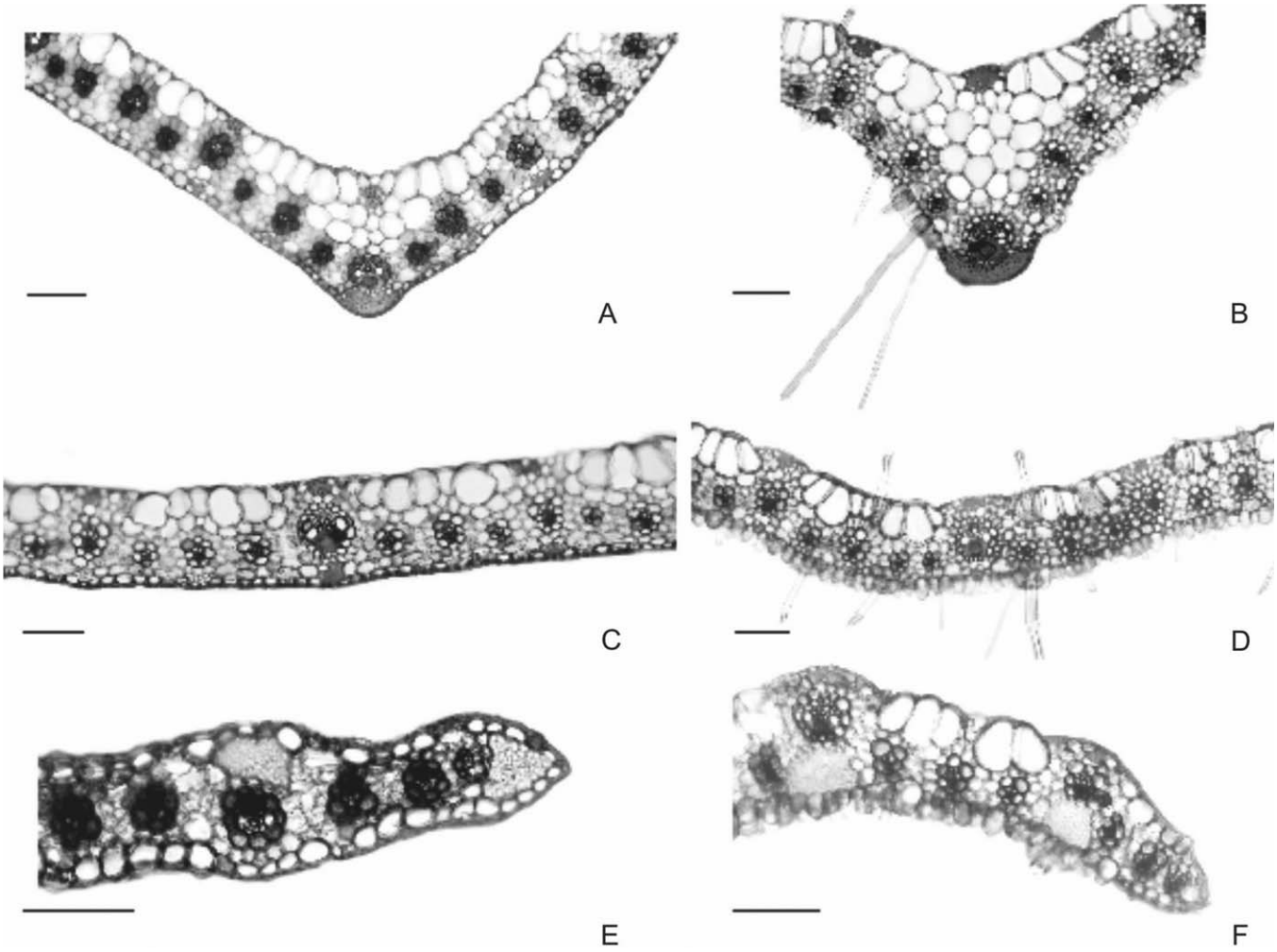

FIG. 6. Transverse sections on the leaf blades of *Paspalum giuliettiae* (*Oliveira et al. 1322*) and *P. pumilum* (*Oliveira et al. 1360*). A, C, E: P. *giuliettiae*. A. Midrib region showing vascular bundle in subcentral position. C. Mesophyll and bulliform cell groups regularly spaced on the epidermis. E. Leaf margin with a bundle of sclerenchyma fibers. B, D, F: *P. pumilum*. B. Midrib region with ground parenchyma. D. Mesophyll and bulliform cells groups on the epidermis. F. Leaf margin presented papillae on the abaxial surface.

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