
Panicum aquarum, a New South American Species of *Panicum* (Poaceae: Panicoideae: Paniceae)

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Previously unidentified specimens from Brazil, Colombia, and Venezuela are recognized as a new species of *Panicum*. This species is described and illustrated exomorphologically and anatomically and is compared with the putative most closely related species in subgenus *Panicum*. *Panicum aquarum* has a peculiar inflorescence pattern, with prophyllar branching occurring in several parts of the inflorescence. Prophyllar branching has not been cited up to the present in the genus *Panicum* and is an uncommon feature of the Poaceae.

MATERIALS AND METHODS

Segments taken from the middle third of the second leaf blade of a floriferous culm were used for anatomical studies. Specimens were treated with Contrad 70 (Schmid & Turner, 1977). The leaf material was desilicified, free-hand sectioned, stained with safranin and fast green, and mounted in glycerin jelly. Epidermis preparations were made following Metcalfe's (1960) method. Silica bodies, cork cells, and starch grains were identified with liquid phenol (Metcalfe, 1960), Sudan III (Sass, 1940), and I₂K (Sass, 1940) respectively. Drawings and observations were made using a Willd M20 microscope with camera-lucida. Upper antheria were studied with a JEOL, J.S.M. 25SII scanning electron microscope (SEM) of the Department of Odontology of the University of Buenos Aires, Argentina.

Panicum aquarum Zuloaga & Morrone, sp. nov.

TYPE: Venezuela. Guárico: Dpto. Infante, Parque Nacional Aguaro-Guariquito, Congriales de la Gorra, entre La Esperanza y Mesa de Cambao, ca. 9°12'–9°16'N y 67°48'–67°60'W, 60 m, Dec. 1981, *Delascio, Montes & Davidse 11206* (holotype, VEN; isotypes, MO, SI). Figures 1, 2.

Culmi 0.90–1.30 m alti, paniculis numerosis ex nodis superioribus nascentibus, spiculis elipsoideis 3–3.9 mm longis, gluma inferiore spiculae ½–¾ longitudinis aequante, gluma superiore ac lemma inferiore subaequalibus, anthoecio superiore indurato, glabro, brevi, paleae apice papilloso.

Annual?, 0.90–1.30 m high. Culms erect, root-

ing at the lower nodes, freely branching at the upper nodes; internodes 7–19 cm long, glabrous, striate, mottled, hollow; nodes glabrous, compressed, brownish. *Sheaths* 8–18 cm long, thin, delicate, glabrous, shiny on the inner surface and with air spaces, the margins membranous. *Ligules* ca. 1.2 mm long, short-membranous at the base and long-ciliate at the apex, adaxial surface pilose; collar glabrous. *Blades* linear, 11–18 cm long, 0.2–0.4 mm wide, the lower ones deciduous, glabrous, narrowed at base, the margins involute, scaberulous, the midnerve manifest toward the base. *Inflorescence* terminal with a peduncle up to 25 cm long, glabrous, scaberulous; *panicles* lax, pyramidal, multiflowered, 35–40 cm long, 12–20 cm wide; axillary panicles numerous, smaller and similar to the terminal one; *main axis* terete, glabrous, the pulvini glabrous; first-order branches alternate or subopposite, divergent, the axis of the branches triquetrous, scaberulous; second- and third-order branchlets alternate with scaberulous axis; spikelets congested on third-order branches; pedicels claviform, glabrous. *Spikelets* solitary, ellipsoid, 3–3.9 mm long, 1–1.2 mm wide, glabrous, stramineous or tinged with purple, gaping at maturity; upper glume and lower lemma subequal, acuminate, longer than the upper antherium. *Lower glume* ovate, abruptly acuminate, 1.7–2.7 mm long, ½–¾ the length of the spikelet, (3–)5-nerved, the midnerve scaberulous toward the upper portion; stipe conspicuous between the lower and upper glume. *Upper glume* 3–3.6 mm long, acuminate, (5–)7-nerved. *Lower lemma* glumiform, 3–3.2 mm long, (5–)7-nerved. *Lower palea* oblong-lanceolate, 1.7–2.1 mm long, 0.6–1 mm wide, glabrous, hyaline; lower flower absent. *Upper antherium* ellipsoid, 2.1 mm long, 1.2–1.3 mm wide, indurate, stramineous, with black spots at maturity, smooth and shiny, with a brown disc at its base at maturity; upper lemma 5-nerved, the margins involute; upper palea 2-nerved, papillose at the apex. *Caryopsis* broadly ellipsoid, 1.5 mm long, 1 mm wide, whitish; hilum subbasal, punctiform; embryo ⅓ or less the length of the caryopsis.

Paratypes. BRAZIL. AMAZONAS: Munic. Humaitá, 7°31'S, 63°10'W, campo a 15–17 km da cidade pela

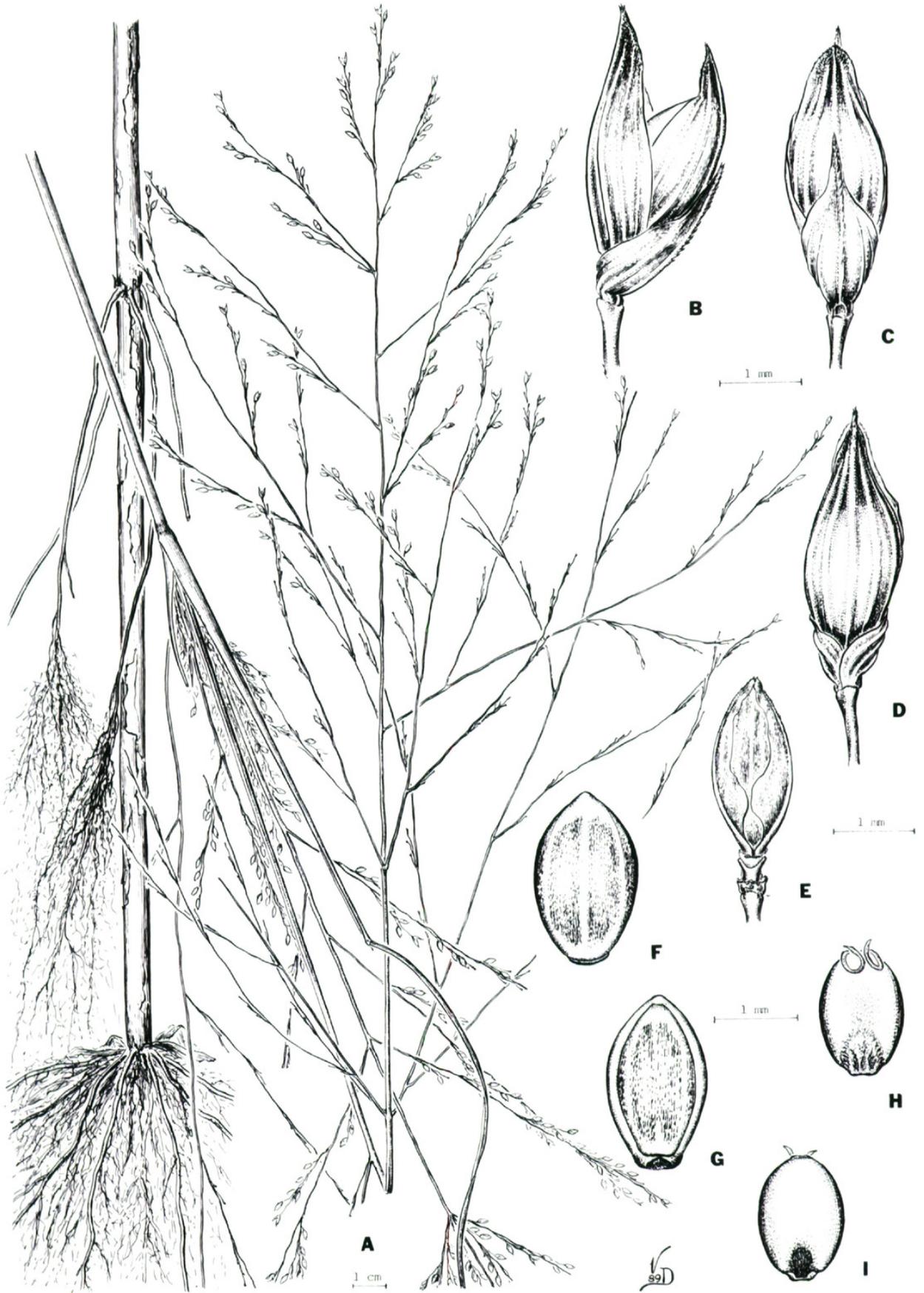


Figure 1. *Panicum aquarum* (Blydenstein 1846, COL). —A. Habit. —B. Spikelet, lateral view. —C. Spikelet, ventral view. —D. Spikelet, dorsal view. —E. Lower palea. —F. Upper antherium, dorsal view. —G. Upper antherium, ventral view. —H. Caryopsis, embryo side. —I. Caryopsis, hilum side.

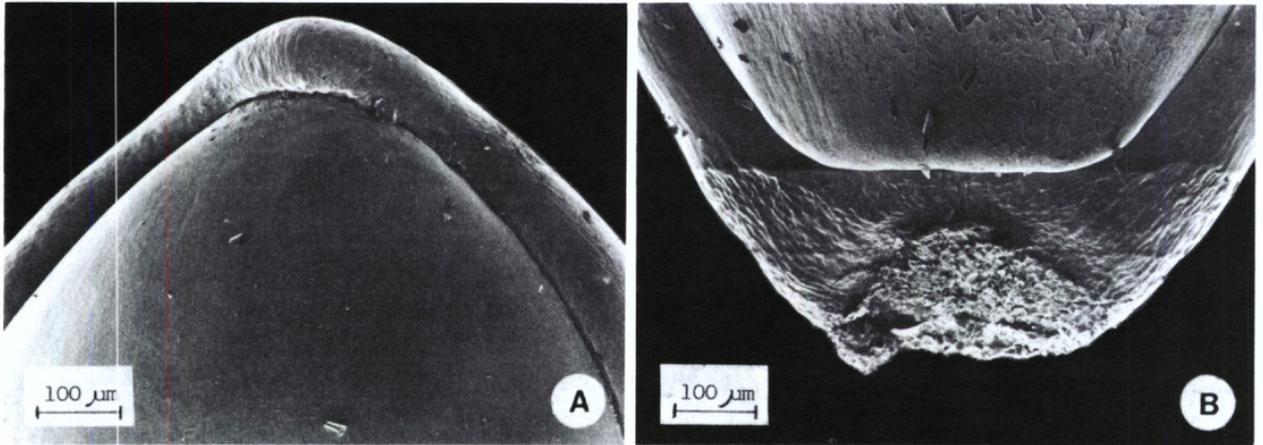


Figure 2. Photomicrographs of the upper anthercia of *Panicum aquarum* (Delascio et al. 11206, SI). —A. Upper portion of the lemma and palea, palea with papillae at the apex. —B. Lower portion of the upper anthercium.

estrada 319 ao norte da estrada, entre igarapés Retiro e Bom Futuro, 70 m, 11 May 1980, *Gemtchujnicov & Janssen 369* (IBGE, SP). PARA: Marajó, Camará River, Sep. 1902, *without collector* (US 1024781); ad Tocantins flumen inter Porto Imperial et Funil, *Burchell 8813* (K, W). COLOMBIA. META: Lago Carimagua, altillanura plana, bajo 30 cm de agua, 19 Nov. 1963, *Blydenstein 1846* (COL, G).

The specific epithet refers to the aquatic habitat of the species.

Burchell 8813 was included by Doell (1877) as a syntype of *P. virgatum* L. var. *glabrum*, together with *Vincent 3* from the United States. *Panicum virgatum* L. grows in the United States, Mexico, and the West Indies; it differs from *P. aquarum* in having conspicuous rootstocks and rigid culms with a single terminal inflorescence.

Panicum aquarum inhabits inundated areas of the "Provincia Amazonica" and "Provincia de la Sabana" (Cabrera & Willink, 1973), both provinces having a rainy season in which many areas are covered by water. The type specimen was collected, according to the label, under 1.30–1.80 m of water.

This species has conspicuous aerial roots from the lower nodes of the culms. Blades are usually missing in the lower portion of culms; the sheaths are delicate and spongy when young and the sheaths that remain are lacinate at maturity. Sheaths and the lower portion of blades have conspicuous lacunae between contiguous vascular bundles, and lacunae are also present in the roots.

The presence of lacunae in roots, sheaths, and blades indicates that these plants are adapted to aquatic or semiaquatic habitats with a low availability of oxygen.

Panicum aquarum has a complex system of floriferous culms (Fig. 3). The main culm develops in a terminal inflorescence on a long peduncle. At the base of the main inflorescence is a bud which de-

velops in a secondary inflorescence. This lateral floral branch has a 2-keeled prophyllum, with the keels embracing the new branch. Distal to the first node of the lateral branch, and separated by a clear internode, is another node that bears a completely developed sheath and blade. Successive axillary inflorescences continue the same pattern, and each branch ends in an inflorescence similar to the terminal one, except that it is smaller. A peculiar feature of *Panicum aquarum* is the presence of prophylls with a bud in their axil, which usually develops into a branch (Fig. 3). Thus, a prophyll is the first bract on each side branch, and this pattern is repeated throughout the entire inflorescence. This kind of branching pattern was called prophyllar branching by Meert & Goetghebeur (1979) and is, as these authors mentioned, a common feature in the Cyperaceae. However, the presence of prophyllar branching in the Poaceae is quite uncommon; prophyllar branching was described and illustrated by Cámara Hernández & Gambino (1990) in the genus *Zea*; also, a similar prophyllar branching was illustrated by Davidse & Ellis (1987) for the inflorescence of *Arundoclaytonia*.

LEAF BLADE ANATOMY (FIGURE 4)

LEAF IN TRANSVERSE SECTION

Outline: V-shaped, moniliform. *Ribs and furrows* conspicuous, leaf thickness 130–165 μm on ribs, 40–78 μm on furrows, adaxial ribs obtuse to flat-topped, abaxial ribs obtuse, adaxial furrows up to $\frac{1}{2}$ the width of the blade, the abaxial ones less pronounced; ribs associated with all vascular bundles. *Median vascular bundle*: no midrib or keel developed; median vascular bundle structurally indistinguishable from lateral first-order vascular bundles. *Vascular bundle arrangement*: 6–8 first-order

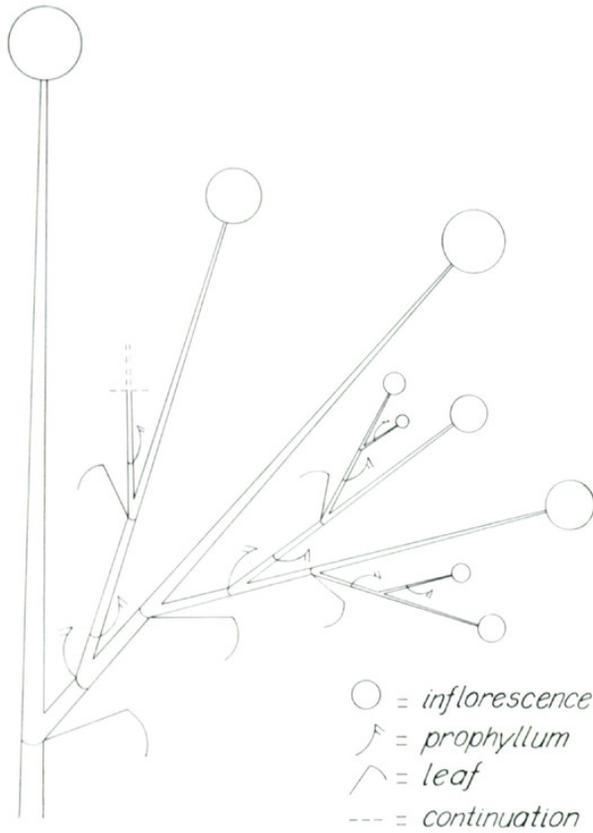


Figure 3. Diagrammatic illustration of a portion of the inflorescence of *Panicum aquarum*.

vascular bundles and 14–16 second-order vascular bundles per leaf section; 2 mesophyll cells between contiguous vascular bundles, with a distance of 110–170 μm between contiguous vascular bundles. *First-order* vascular bundles situated in center of blade, surrounded by an outer Kranz sheath subcircular in outline, regular, abaxially interrupted by sclerenchyma or colorless parenchyma girders; Kranz cells 8–13, the walls thickened, with their radial and inner tangential walls straight; specialized chloroplasts centripetal?; inner mestome sheath complete. Adaxial and abaxial sclerenchyma girders associated with all first-order vascular bundles. *Second-order* vascular bundles situated in center of blade, the Kranz outer sheath rounded in outline, with (5–)6–8 cells; inner mestome sheath present or absent, when present situated toward the abaxial surface and near the phloem. Adaxial and abaxial sclerenchyma girders or strand associated with second-order vascular bundles. *Mesophyll*: chlorenchyma radiate with a single layer of cells around the vascular bundles, continuous or interrupted above and below by sclerenchyma or colorless parenchyma girders; chlorenchyma cells tabular, rachimorphous, with a few intercellular air spaces. Groups of 2–3 fan-shaped *bulliform* cells present at bases of adaxial furrows. *Colorless parenchyma* cells present below

furrows, uniseriate and extending to the opposite epidermis. *Epidermal cells* thickened, with a thick cuticle 6.5–10 μm wide on both surfaces; papillose epidermal cells present, associated with ribs. Crystals absent. Kranz sheath with amyloplasts.

ABAXIAL EPIDERMIS

Costal zones with 3–5 files of cells. Silica bodies dumbbell-shaped, alternating with 1–2 square to rectangular cork cells, the latter with sinuous walls; prickles not observed. *Intercostal zones* narrow, 6–9 cells wide, long cells rectangular in shape, with sinuous walls, more than three times as long as wide, alternating with short cells; *short cells* in intercostal zones solitary or paired; *cork cells* square to rectangular in shape, with crenate walls; silica bodies irregular in outline. *Stomatal complex* dome-shaped, 32.5–36.4 μm long, 13–18.2 μm wide, in one row on both sides of the costal zones. *Microhairs* 2-celled, 50–58 μm long; walls of basal cell parallel, thicker than walls of distal cells, apex of distal cell obtuse. Hooks occasionally present. Macrohairs not seen. Papillae absent.

DISCUSSION AND CONCLUSIONS

The presence of two sheaths around the vascular bundles, the outer one with specialized chloroplasts, radiate chlorenchyma, and two cells between contiguous vascular bundles indicates that *P. aquarum* is a C_4 species (Ellis, 1977; Hattersley, 1987).

The chloroplast position on the outer Kranz sheath is dubious because it was not possible to study fresh material of the species. However, there is a tendency to a disposition toward the inner tangential wall.

According to Ellis (1977), *P. aquarum* is a C_4 species of the NAD anatomical subtype, because the outer Kranz sheath is regular in outline and the Kranz cells have straight inner tangential and radial walls.

The exomorphology and anatomy of *P. aquarum* indicate that the species belongs to subgenus *Panicum*; however, it does not have close relatives in this subgenus. It was not possible to assign the species to a section, because of the following reasons.

Panicum aquarum shares a similar habitat and habit with species of section *Dichotomisflora*, e.g., *P. dichotomisflorum* Michaux, *P. elephantipes* Nees ex Trin.; conspicuous air spaces are present in *P. elephantipes*, a common species of rivers or lakes from Mexico to Argentina. However, *P. aquarum* differs from species of section *Dichotomisflora* in having spikelets gaping at maturity, with the lower glume $\frac{1}{2}$ – $\frac{3}{4}$ the length of the spikelet. In contrast, in species of section *Dichotomisflora* the spikelets

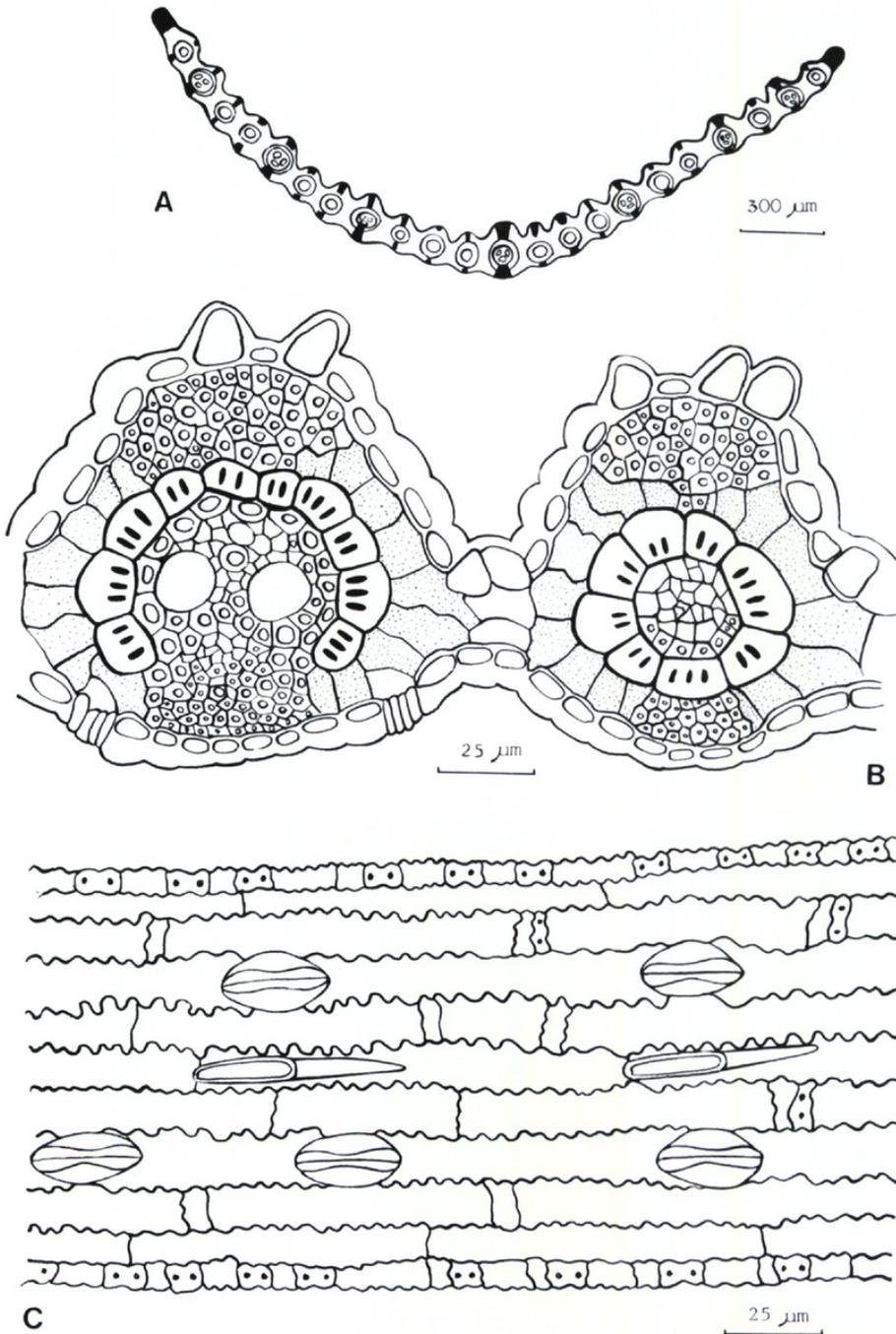


Figure 4. Leaf blade anatomy of *Panicum aquarum* (Blydenstein 1846, COL). —A. Outline showing absence of a keel. —B. Transverse section detail showing first- and second-order vascular bundles, bulliform cells with associated colorless cells. —C. Abaxial epidermis showing costal and intercostal zones.

do not gape at maturity and the lower glume is $\frac{1}{4}$ – $\frac{1}{3}$ the length of the spikelet. In addition, all species of this section have a PCK anatomical Kranz subtype (Ohsugi & Murata, 1986; Ohsugi et al., 1982; Zuloaga, 1937; Ellis, 1988), and also lack colorless parenchyma cells and conspicuous papillae on the epidermis.

Panicum aquarum is similar to species of sections *Repentia* and *Panicum* in its spikelets, which gape at maturity, and in the length of the lower glume.

It differs from species of both sections in its habit and habitat. Species of section *Repentia* are perennials with conspicuous rootstocks at the base, and the culms are erect and rigid; species of section *Panicum* are caespitose annuals or perennials of open and dry habitats.

Species of section *Urvilleana* grow in sand dunes and have rigid, infolded leaves, pilose spikelets, and an upper antherium with long macrohairs at the base of the lemma. Species of section *Rudgeana*

are caespitose, with the upper anthercium conspicuously stipitate at its base.

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