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Morphological variations of *Paspalum scrobiculatum* and *Paspalum distichum* in Kerala

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Abstract

Poaceae, formerly *Graminae*, is one of the most prominent families in Angiosperms. The family comprises over 12,000 species under 780 genera. *Paniceae* (*Poaceae*: *Panicoideae*) is one of the largest tribes in the grass family, consisting of 84 genera and ca 1500 species worldwide. *Paspalum* stands as one of the major genera within the *Paniceae* tribe. In the present communication, we have investigated the morphological differences within and between *P. scrobiculatum* and *P. distichum*, focusing on key characteristics such as the presence or absence of lower glume and the shape and pubescence of the upper glume. The morphological descriptions of taxa, a comparison table, and live photographs have also been included.

Keywords: *Poaceae, Paniceae*, *Paspalum*, Spikelet, Glume

Introduction

The grass family Poaceae is the fourth most prominent family of angiosperms, with over 12,000 species distributed across 780 genera (Christenhusz & Byng, 2016; Watson & Dallwitz, 1992; Clayton & Renvoize, 1986). On phylogenetic analysis, we can conclude that the grass family (Poaceae) is the most successful group of flowering plants. About 263 genera and 1291 species were reported in India (Karthikeyan et al., 1989). Grasses are considered one of the most prominent angiosperm families and adapt widely to different habitats. More than 1500 species are reported from the tribe Paniceae, distributed under 84 genera (Morrone &

Zuloaga 2003; Soreng et al., 2017). Seven species have been reported from Kerala (Sreekumar & Nair, 1991). The large genus *Paspalum* is found in the warm temperate tropics, primarily in the New World. In India and South Africa, *Paspalum scrobiculatum* was domesticated around 3000 years ago (De Wet et al., 1983). *Paspalum* Linnaeus (1759: 855) belongs to the tribe Paniceae and is the largest genus of the sub-family Panicoideae, with 330-350 species (Galdeano et al., 2016; Soreng et al., 2017). Different species of *Paspalum* can be identified morphologically by their plano-convex spikelets, with the margins of the upper lemma enrolled over the palea (Rua et al., 2010). Due to the high number of species and wide morphological variety of *Paspalum*, it has been divided into sub-genera, sections, and groups (Cialdella et al., 1995; Zuloago et al., 2004; Rua & Weberling, 1998). Here, we aim to conduct a morphological study of the inflorescence of two species of *P. distichum* and *P. scrobiculatum*. Morphologically, it is varied by spikelet and the floret structure of the species level.

Material and methods

A field exploration trip was conducted to the study area. Fresh plant materials were collected and examined using a Leica LZ 3E stereomicroscope and a digital camera. Field observations such as habitat, colour, and phenology were noted in the field book. The collected plants were processed to make a herbarium and deposited in JNTBGRI (TBGT) (Jain & Rao, 1997). Collected plant materials were identified with herbarium and regional floras (Gamble, 1935; Bor, 1960; Sreekumar & Nair, 1991; Kabeer & Nair, 2009). The acronyms of herbaria in Kerala are T N-TBGT, MH, CALI, STC, and MBGH (Thiers, 2017). Authors created the line drawings under a stereomicroscope.

Results

Taxonomic synopsis

Paspalum L.

Paspalum Linnaeus (1759: 855). Type: *Panicum dissectum* Linnaeus (1753: 57), INDIA. Kalm s.n. (lectotype LINN-HL79-1!, designated by Hitchcock (1908), probable isolectotype US-2855315 ex LINN). = *Paspalum dissectum* (Linnaeus) Linnaeus (1762: 81).

= *Paspalum dimidiatum* Linnaeus (1759: 855), nom. illeg. Super fl. Lectotype (designated by Chase 1911): -INDIA. P. Browne s.n. (LINN-HL79-2!). Linn.Syst. Nat.ed.02:855.1759; Hook.f.Fl.Brit. Ind.7:12.1896; Fischer in Gamble, Fl.Pres. Madr. 1770.1934 (repr.ed.3:1226.1957); Bor.Grass.Bur.Cey. Ind.Pak.334. 1960. Clayton & Renvoize, Gen.Gram.287.1986; Webster, Austr. Panic.169.1987; Sreekumar & V.J. Nair, Fl. Kerala-Grass.280.1991; Nayar et al., Flowering Plants of Kerala-A Handbook 820. 2006.

Paspalum distichum (Fig. 1, 3A,C,E)

Syst. Nat. Ed.102:855.1759; Hook. f Fl.Brit.Ind.7:12. 1896; Rama Rao Fl.Pl. Travancore 434.1914; Fischer in Gamble, Fl. Pres. Madr. 1770. 1934 (repr.ed. 3:1226.1957); Bor.Grass.Bur.Cey. Ind.Pak. 338. 1960. Clayton & Renvoize, Gen. Gram.287.1986; Sreekumar & V.J. Nair, Fl. Kerala-Grass.286.1991; Nayar et al., Flowering Plants of Kerala-A Handbook 820. 2006.

Annual or perennial; mat-formed structure; culms high; 7–60 cm long; Ligule eciliate, membranous. Leaves flat, acuminate or acute apex, convoluted; 3-15 cm long; inflorescence 2 to 3 digitate or

subdigitate to racemes; racemes 2-8 cm long; 2-3 paired; unilateral; Rachis 0.8-1.5 mm wide, narrowly winged; Spikelets regular, 2-rowed, subsessile, similar ovate to oblong, 2-3, 2 X0.9-1.2 mm, acute apex; pedicels 0.1-0.4 mm long, finely serrulate. Lower glume triangular or absent; lanceolate 0.3Xca.03 mm, acute apex, sparsely hairy; Upper glume acute-acuminate 2.2X1.3 mm, chartaceous five nerved, apex acute; spikelets contain one basal sterile floret and one fertile floret without rachilla extension; Floret 2, Lower floret epaleate.-Lower lemma ovate-acute, acuminate 2.6-1.2 mm 1-3 nerved, midnerve prominent, glabrous or minutely pubescent; Upper floret bisexual, paleate Upper lemma ovate-oblong, 2.3X1.2 mm, five nerved, subcoriaceous, faintly five nerved; Upper palea, elliptic, 2.1X1.3 acute to obtuse, two nerved, ovate-oblong, acute; Stamens 3, Ovary elliptic, anthers 1.1 mm long; Stigma plumose 0.7-1.2 reddish brown. Caryopsis is elliptic, 1-1 mm brownish, and acute (Fosberg, 1977).

Representative specimen examined: KERALA: ALAPPUZHA Dt., Mankombu, ±25 m, 14.6.1980, P.V.Sreekumar 67190; Palluthuruthy, ±20 m, 9.6.1980, P.V.Sreekumar 67165; KANNUR Dt.,Tellichery, ±50 m, 16.8.1980, V.S. Ramachandran 66987; KOLLAM Dt., Quilon, back waters, Sea level, 23.12.1979, C.N.Mohanan 65022; ERNAKULAM Dt., Cochin, ±2 m, 21.10.1980, P.V.Sreekumar, 67700;Cochin, ±25 m, 22.6.1980, P.V.Sreekumar 67712; KOTTAYAMDt., Kottayam, ±40 m, 23.6.1980, P.V.Sreekumar 67701; THIRUVANANTHAPURAM Dt., Kovalam, ±50 m, 16.11.1979, M. Mohanan 63884; Veli, ±30 m, 4.8.1978, M.Mohanan 58558; KASARGOD Dt., Payyannur, 100 m, 25.9.1982, R. Ansari 73994.

Fl. & Fr.: Apr-Oct.

Distribution: Widely distributed in tropical regions; Kerala: Alappuzha, Ernakulam, Idukki, Kottayam, Kollam, and Thiruvananthapuram.

Habitat: Common weed found along ditches and roadsides.

Local name: Theratta pullu (Malayalam)

Common name: Knotgrass

Uses: a valuable pasture grass found worldwide, particularly on shallow soils. Hay and silage are made using it on wet soil.

Paspalum scrobiculatum (Fig. 2, 3B,D,F) Linn. Mant.Pl. ; 29.1767; Hook. F. Fl. Brit. Ind.7: 10.1896; Rama rao, Fl. Pl. Travancore 434.1914; Fischer in Gamble, Fl. Pres. Madr. 1772. 1934 (repr. ed. 3: 1227.1957); Bor. Grass. Bur. Cey. Ind. Pak. 340.1960; Clayton & Renvoize, Gen. Gram. 287.1986; Sreekumar & V.J. Nair, Fl. Kerala-Grass. 287.1991; T.S Nayar et al. Flowering Plants of Kerala-A Handbook 821.2006.

Perennial; mat forming. Culms erect 10-75 cm long; band like nodes, glabrous, brownish; Leaf sheath keeled 3-15 cm long, shorter than the culm internode; Ligule eciliate membrane; Leaf blade open, filiform, lanceolate, apex serrulate margins, midrib sharp-edged, 1-2.5 mm wide, base rounded, acute to acuminate; Inflorescence 2-4, digitate to sub-digitate racemes, unilateral, 2-12X0.2-0.4 cm; Rachis winged, margins serrulate; Peduncle 4-16 cm long, smooth; Spikelet secund, abaxial regular, 2-rowed, acute to obtuse, alternate, subsessile 2.3-3.2X1.2-2 mm. Pedicels 0.3-0.6 mm long, oblong,

Figure 1. *Paspalum distichum*

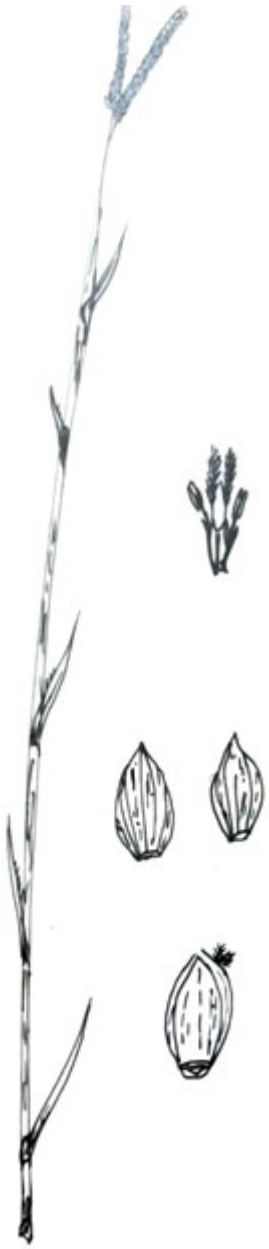

Figure 2. *Paspalum scrobiculatum*

stout; Lower glume absent, Upper glume orbicular, 2.7X2.2 mm, faintly 5-7 nerved, margins infolded, chartaceous; Florets 2; lower floret barren, upper floret bisexual; Lower lemma apex obtuse, chartaceous, 2.6-2 mm, 5-7 nerved, orbicular, margins infolded; Upper lemma elliptic, 1.9X1.7, apex, obtuse, coriaceous, 3-5 nerved, margins infolded; Upper palea elliptic, 2.2-1.4 mm, subcoriaceous, smooth margins inrolled; Lower oblong, orbicular, and inflexed; Stamens 3, anthers 0.8-1 mm long filaments 0.2-0.4ca, 0.2 mm, Ovary oblong 0.2ca, 0.6 mm yellow to brownish, long; stigma 1 mm long; red to brown; light purple colour; Caryopsis brown, oblong, apex truncate (Clayton, 1975).

Representative specimen examined: KERALA: ALAPPUZHA Dt., Pallana, 25.3.1980, P.V. Sreekumar 66793; ALAPPUZHA, ±125 m, 15.3.1980, P.V. Sreekumar 67031; KOTTAYAM Dt., Kidangare- Changanassery, 24.10.1984, V.T.Antony 897; Ponthanpuzha R.F., ±50 m, 17.5.1984,V.T.Antony 532; KANNUR Dt., Kannoth R.F., ±250, 28.02.1978, V.S. Ramachandran 61999; Kannoth R.F., ±150 m, 13.6.1979, V.S. Ramachandran 62604; KASARGOD Dt., Payyannur, 100 m, 25.9.1982, R. Ansari 73996; KOZHIKODE Dt., Kuttiyadi submergible area,190 m, 23.6.1965, B.D.Naithani 24178; THIRUVANANTHAPURAM Dt.,Vazhamoola, 150 m, 30.8.1975, J.Joseph 46548; Kottur R.F., 175 m, 4.4.1973, J.Joseph, 44033; Pulimath , ±125 m, 2.12.1977, M.Mohanan 52685; Way to Chemunji, ±1300, 18.5.1979, M.Mohanan 61815; THRISSUR Dt., Thunakadavu submergible area, 667 m, 28.10.1964, K.M.Sebastine 22357; Vazhani, 125 m, 5.9.1976, K.Ramamurthy 47638; KOLLAM Dt., Aranamudi, ±1025 m, 7.7.1981, P.V. Sreekumar, 70436; Adoor, 125 m, 21.7.1979, C.N.Mohanan 63417.

Fl.& Fr.: Throughout the year

Distribution: All District in Kerala

Habitat: Ponds, Marshy places, wetlands, and waterlogged areas.

Local names: Varagu (Telugu)

Common name: Kodo millet

Uses: A small grain crop which substituted for rice. It contains more proteins, minerals, vitamins, and carbohydrates and is known as Varagu. Santals use fresh root decoction mixed with black pepper paste, and a pinch of salt is given twice a day before lunch or dinner as the tonic for typhoid fever; also, the grain is fermented for the preparation of country liquor in the tribal people of West Bengal (Thapa & Tamang, 2004).

Discussion

Plano-convex spikelets with the outermost portion of the upper lemma folded over the palea are physical characteristics of the *Paspalum* species (Rua et al., 2010). *Paspalum*'s vast range of morphological variation and diversity of species has led to its division into subgenera, parts, and groupings by Morrone et al. (1995) and Zuloaga et al. (2004). In *P. distichum*, the lower glume is typically present as a little triangular scale or limited to a thin edge, whereas in *P. scrobiculatum,* the lower glume is usually absent. Moreover, *Paspalum distichum* is a glabrous, diverse species with polymorphism and a minutely pubescent upper glume. It also demonstrates the differences in their habitat and habits, making it very difficult

Figure 3. Plant and floret specimens of *Paspalum scrobiculatum* (A, C, E); *Paspalum distichum* (B, D, F)

Table 1. Morphological differences

Character	*Paspalum distchum*	*Paspalum scrobiculatum*
Lower glume	Present, lanceolate, subulate scale	Absent
Upper glume	Sparsely pubescent on the back, broadly ovate to elliptic	Obovate to orbicular-elliptic, boat shaped, chartaceous, white green
Ligule	Acute to truncate, membranous with few hairs	Truncate, membranous, hyaline, from back hairy
Spikelet shape	Subsessile, broadly ovate, greenish yellow	Secund, subsessile, compact, whitish green
Rachis	Broad, flat to triquetrous, slightly wavy	Flat, finely serrulate, hairy at base at times
Nerves of lower and upper lemma	Prominent, lateral nerves near margins	Faintly, coriaceous, joined near apex
Caryopsis	Broadly elliptic	Oblong

to separate *P. scrobiculatum*, *P. orbiculare, and P. auriculatum*. So, these species consolidate into *P. scrobiculatum*. Further, it is difficult to differentiate these species due to their lesser lemmas, diversities, and abundance of midway types. At maturity, the *Paspalum* exhibits a distinctive inflorescence behaviour in which the spikelets or complete florets may be lost, leaving the inflorescence axes intact, spikes' panicles, where the sessile spikelets are seated immediately on the central axis, similar to the *Paspalum* to a lesser degree. Sometimes, the spikelet's orientation concerning the axis is regarded as having taxonomic significance. The important feature of *Paspalum* is its abaxial orientation. *Paspalum* is ornamented with smooth, reflective, fruitful flowers. The species' epidermal pattern displays the star-shaped silica cells in *Paspalum distichum* and *Panicum repens*. The genus *Paspalum* has been found to include pluricellular microhairs (Turpe, 1996).

Conclusions

Based on Chase (1911, 1929), *Paspalum* is distinguished by its racemose inflorescence, plano-convex or somewhat concavo-convex spikelets, which are typically arranged abaxially (with the opposite side of the fertile lemma facing the rachis); as a result, the obtuse indurated fertile floret and the typically flat sterile lemma are the most visible features. Genus *Paspalum* is intently connected with the genus *Panicum*. It is generally accepted that the varied genus *Paspalum* is closely linked to the genus *Panicum*. The primary general characteristic that Linnaeus initially utilized to differentiate *Paspalum* was the lack of the lower glume. According to Chase (1911), the characteristics are unreliable, as it is a taxonomic member of the *Paspalum* genus, though it is occasionally more or less developed in *Paspalum distichum*. The authors of Flora of Kerala and Tamil Nadu Grasses mentioned *P. scrobiculatum* as a highly

variable species like *P. commersonii* Lam., *P. orbiculare* G. Forst., etc., exhibits a high degree of variability and similarities, as shown by the original form of this species.

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