

Ligules as aid to Identification of Grasses

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Abstract

Foliar ligules in Poaceae are taxonomically very significant and differ structurally from species to species. Many key recognizing characters are present in the collar region, the junction of the leaf blade and leaf sheath, where the ligule resides. The paper aims to determine the type, shape, structure and pattern of the ligules in 10 species of grasses, assessing their value in species identification, in absence of other vegetative or floral characters.

Key words: Identification, ligules, Poaceae.

INTRODUCTION

Grass leaf consists of three principle parts, the blade or lamina, the leaf sheath and the leaf ligule. Ligule, derived from a Latin word “*ligula*” meaning a strap-like structure, variant of “*lingual*”, from “*lingua*” meaning tongue. It is a thin membrane-like structure or row of flimsy hairs at the junction of the leaf sheath and blade, formed entirely by an upgrowth of the ventral epidermis of the leaf, typically found in grasses and sedges (Philipson 1935). The ligule is a continuance of the leaf sheath that encircles or clasps the stem. It may be present adaxially or abaxially at the collar region, the junction of the blade and leaf sheath, depending on the species. Moreover, in some species, leaves comprise auricles, which are minute appendages found on either side of the blade’s base. The ligule attaches resolutely and prevents the admission of water, dirt and harmful spores. However, ultrastructural and cytochemical studies revealed that the ligules play more active role in the life of grasses as a secretory tissue (Chaffey 2000). Again, according to Moreno *et al* (1997) and Korzun *et al* (1997) grasses with ligules have superior fitness.

The morphology of ligule is imperative for identification of grass species, especially when the shoots are in the vegetative state (Zuloaga *et al* 1998; Judziewicz & Clark 1993; Fuente & Ortunez 2001). They can provide information on the evolutionary relationships among certain species, contributing to a more natural taxonomic system because it is comparatively constant (Chaffey 1994). Ligule character is also vital for identifying individual species living in non-optimal environments (Neumann 1938). The present study aims to establish the type, shape, structure and pattern of ligules in 10 species of grasses, assessing their value in species identification, in the absence of other vegetative or floral characters.

MATERIALS AND METHODS

Fresh materials were collected during the monsoon (July 2011 to September 2012) from different sectors of Acharya Jagadish Chandra Bose Indian Botanic Garden, Howrah, West Bengal and also from CAL (Table 1). The materials were selected as they grow successfully and dominantly in the mentioned area. For the study, the leaves from the middle segment of the culms (3rd and 5th leaf from the base) of at least 5 duplicates of each were used throughout the preparation. All major characters as length, type, shape, and pattern of ligule have been considered; mean and standard deviation has been ascertained (Table 2). Collected plants were preserved and mounted on the herbarium sheets, submitted to CAL. Grasses were identified using authentic taxonomic literatures and matching at CAL.

Table 1. Information of the Investigated Taxa (Bor 1960).

Name of Investigated Taxa	Group	Tribe
<i>Brachiaria ramosa</i> (Linnaeus) Stapf	Panicoideae	Paniceae
<i>Digitaria ciliaris</i> (Retzius) Koeler	Panicoideae	Paniceae
<i>Centotheca lappacea</i> (Linnaeus) Desvaux	Pooideae	Centothecae
<i>Echinochloa colona</i> (Linnaeus) Link	Panicoideae	Paniceae
<i>Isachne albens</i> Trinius	Pooideae	Isachneae
<i>Paspalidium flavidum</i> (Retzius) A. Camus	Panicoideae	Paniceae
<i>Paspalum conjugatum</i> P.J. Bergius	Panicoideae	Paniceae
<i>Pennisetum polystachyon</i> Schultes	Panicoideae	Paniceae
<i>Poa annua</i> Linnaeus	Pooideae	Paniceae
<i>Sporobolus fertilis</i> (Steudel) Clayton	Pooideae	Sporoboleae

RESULT AND DISCUSSION

Brachiaria ramosa, having ligule in the form of a rim of dense, white, silky row of unequal hairs, ca 1 – 1.4 mm long. In *Digitaria ciliaris* the ligule is moderately thin, membranous, emarginated, greenish-brown, apex uneven, notched, ca 0.9 – 1 mm long. *Echinochloa colona* is eligulate, only having a white, silvery band or patch at the junction of lamina and leaf-sheath. In *Paspalidium flavidum* the ligule is thin, papery, shiny white, fragile membranous, apex slightly dentate, ca 0.6 mm long. *Paspalum conjugatum* having brown, herbaceous ligule, apex truncate, ca 0.6 – 0.8 mm long, mouth densely ciliate. *Pennisetum polystachyon* consisting of dense, white, fringe of lanate equal hairs, ca 1 – 1.3 mm long. In *Poa annua* the ligule is triangular, white, translucent, membranous, ca 2.1 – 3 mm long, margin serrated, apex apiculate-cuspidate. In *Sporobolus fertilis* ligule is represented by a minute, fringe of white hairs, ca 0.2 mm long, difficult to see with naked eye. In *Centotheca lappacea*, ligule is membranous, whitish-green, ca 1 – 1.2 mm long, margin fimbriate. In *Isachne albens* ligule is chartaceous, tough, lacerate, ca 0.6 – 0.7 mm long. [Plate I]

Key to the Species

1. Ligule absent *Echinochloa colona*
1. Ligule present 2
2. Ligule membranous 3
2. Ligule herbaceous or chartaceous 6

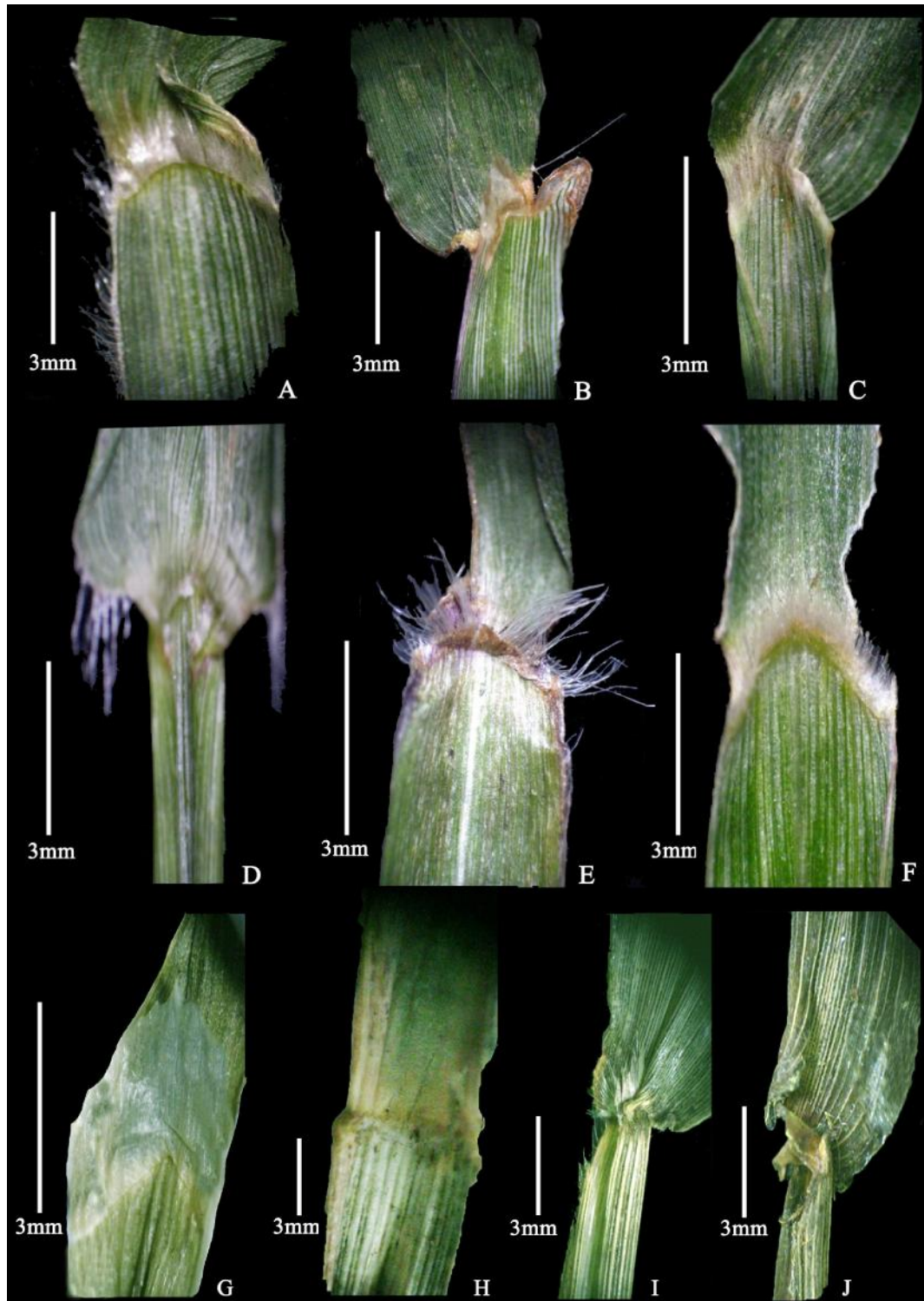


PLATE I. Showing comparison of leaf ligules. **A:** *Brachiaria ramosa*; **B:** *Digitaria ciliaris*; **C:** *Echinochloa colona*; **D:** *Paspalidium flavidum*; **E:** *Paspalum conjugatum*; **F:** *Pennisetum polystachion*; **G:** *Poa annua*; **H:** *Sporobolus fertilis*; **I:** *Centotheca lappacea*; **J:** *Isachne albens*

3. Ligule triangular, translucent; apex apiculate-cuspidate *Poa annua*
 3. Ligule neither triangular nor translucent; apex not apiculate-cuspidate 4
 4. Ligule 0.6 – 1 mm 5
 4. Ligule longer than 1 mm *Centotheca lappacea*
 5. Apex slightly dentate; shiny white *Paspalidium flavidum*
 5. Apex notched; greenish-brown *Digitaria ciliaris*
 6. Ligule other than white 7
 6. Ligule white 8
 7. Yellowish; chartaceous; tough *Isachne albens*
 7. Brown; herbaceous; fragile *Paspalum conjugatum*
 8. Ligule in the form of fringe of white hairs, more or less equal in length 9
 8. Ligule in the form of dense, white, silky row of hairs; unequally long, ca 1 – 1.4 mm
 *Brachiaria ramosa*
 9. Ligule 0.2 mm, hard to see with naked eye *Sporobolus fertilis*
 9. Ligule ca 1 – 1.3 mm; dense, lanate hairs *Pennisetum polystachyon*

Table 2. Calculation of Standard Deviation of the Investigated Taxa.

SL. NO.	INVESTIGATED TAXA	LENGTH OF LIGULE [mm]	MEAN [μ]	STANDARD DEVIATION		$\sigma = \sqrt{\frac{1}{N} \sum_{i=1}^N (x_i - \mu)^2}$
				$(x_i - \mu)^2$	MEAN	
1.	<i>Brachiaria ramosa</i>	1.0	1.2	0.04	0.14	0.16
2.		1.0		0.04		
3.		1.4		0.04		
4.		1.3		0.01		
5.		1.2		0.01		
1.	<i>Digitaria ciliaris</i>	1.0	1.0	0	0.02	0.06
2.		1.0		0		
3.		0.9		0.01		
4.		1.0		0		
5.		0.9		0.01		
1.	<i>Centotheca lappacea</i>	1.2	1.1	0.01	0.04	0.08
2.		1.2		0.01		
3.		1.1		0		
4.		1.0		0.01		
5.		1.0		0.01		
	<i>Echinochloa colona</i>	Ligule absent				
1.	<i>Isachne albens</i>	0.6	0.64	0.0016	0.0012	0.0489
2.		0.7		0.0036		
3.		0.6		0.0016		
4.		0.6		0.0016		
5.		0.7		0.0036		
1.	<i>Paspalidium flavidum</i>	0.6	0.54	0.0036	0.320	0.08
2.		0.4		0.0196		
3.		0.5		0.0016		
4.		0.6		0.0036		
5.		0.6		0.0036		

SL. NO.	INVESTIGATED TAXA	LENGTH OF LIGULE [mm]	MEAN [μ]	STANDARD DEVIATION		$\sigma = \sqrt{\frac{1}{N} \sum_{i=1}^N (x_i - \mu)^2}$
				$(x_i - \mu)^2$	MEAN	
1.	<i>Paspalum conjugatum</i>	0.6	0.66	0.0036	0.320	0.08
2.		0.6		0.0036		
3.		0.8		0.0196		
4.		0.7		0.0196		
5.		0.6		0.0036		
1.	<i>Pennisetum polystachyon</i>	1.0	1.18	0.0324	0.068	0.116
2.		1.2		0.0004		
3.		1.1		0.0064		
4.		1.3		0.0144		
5.		1.3		0.0144		
1.	<i>Poa annua</i>	3.0	2.58	0.1764	0.48	0.312
2.		2.1		0.2304		
3.		2.6		0.0004		
4.		2.4		0.0324		
5.		2.8		0.0484		
1.	<i>Sporobolus fertilis</i>	0.2	0.14	0.0036	0.0579	0.107
2.		0.1		0.0169		
3.		0.1		0.0169		
4.		0.1		0.0169		
5.		0.2		0.0036		

CONCLUSION

This study vividly describes the morphological characters of the foliar ligule of the selected grass species, which are relatively vital to demarcate the different taxa in terms of phylogeny and taxonomy. The ligule trait applied here has successfully alienated intimately related species, belonging to same tribe. In addition, this study is thriving to correlate between taxa and closely associated genera facilitating the identification of the species and its derivatives, in absence of other reproductive characters. We suggest the exercise of this attribute to be considered to determine taxonomic as well as phylogenetic position of intimately related and difficult species.

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