



MORPHOLOGICAL STUDIES ON THE ACHENES OF RHYNCHOSPORA Vahl AND SCHOENOPLECTUS (Reichb.) Palla (CYPERACEAE) IN GOA, INDIA

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ABSTRACT: Rhynchospora comprises about 250 species over the world, mostly in tropical and subtropical regions of South America. 10 species in India; 1 in Goa. While Schoenoplectus is represented by about 77 species throughout the world; 15 in India; 5 in Goa. In the present *Rhynchospora wightiana* (Nees) Steud., *Schoenoplectus articulatus* (L.) Palla, *S. juncooides* (Roxb.) Palla and *S. lateriflorus* (J.F. Gmel.) Lye were studied under light and scanning electron microscope (SEM). Achene shape, size and epidermal patterns were found distinctive and consistent for each species. Number and nature of perianth bristles and variation in the epidermal cells with respect to size of the cell, nature of periclinal wall, the number, thickness and sinuosity of anticlinal walls per cell and presence or absence of silica bodies was found to be useful determining the taxonomic relationship, identification and delimitation of different taxa of Schoenoplectus at species level. In the present study characteristics of epidermal cells are correlated with other morphological characters as well. The micro morphological characters of achene surface were found to be different in dissimilar taxa. However, there is close similarity of these characters in closely related taxa.

Key words: - Scanning electron microscope, Anticlinal wall, Rhynchospora, Schoenoplectus, Goa

INTRODUCTION :

The family Cyperaceae is one of the ten largest families of flowering plants and is the third largest of monocotyledons after Orchidaceae and Poaceae. Bruhl (1995) estimated approximately 5,000 species in about 80 genera and Goetghebeur (1998) included same number of species under 104 genera. But according to Mabberley (2009) there are 92 genera and 4450 species, and as per the WCSP (2015) there are 97 accepted genera and 5486 species of Cyperaceae. Singh and Prasad (2001) estimated about 570 species of 39 genera in India and the present number is estimated to be about 580 species belonging to 32 genera. In Goa it is represented by 11 taxa, 100 species, 3 subspecies and 8 varieties belonging to 16 genera.

The first basic study on epidermal silica bodies of the achenes was accomplished by Schuyler (1971) on two species of *Scirpus* L. and

Eriophorum L. that lead to the development of a new set of characters that could re-evaluate the systematics of Cyperaceae. Varma *et al.* (1989) studied the epidermal surface patterns of the achenes in *Eleocharis*, Govindrajalu (1990) studied SEM images of *Pycreus* sect. *Muricati*. and Wujek *et al.* (1992) did the achene micromorphology of some Indian species of *Cyperus*, *Fimbristylis*, *Pycreus*, *Scirpus* and *Scleria*. Also, Menapace *et al.* (2003) did the achene micromorphology of some Indian species as a possible systematic aid to the taxonomic recognition of different sections in *Fimbristylis*. Recently Patil and Prasad (2016, 2016a) revealed the micromorphology of the achenes of the genera *Fimbristylis* and *Eleocharis* found in Goa. Genus *Rhynchospora* in this family are usually perennials or annuals, with tufted (rarely solitary) culms. Leaves linear, rarely lanceolate, basal and/or cauline, flat or canaliculate; ligule absent; sheaths of cauline leaves long and

closed. Inflorescence terminal and lateral anthelas, sometimes with few to many heads disposed in anthela, spike or panicle, often whole inflorescence reduced to a single terminal head. Bracts leafy. Spikelets solitary or in clusters, sessile or peduncled, terete or laterally compressed, lanceolate or oblong-lanceolate, ovate or elliptic, usually few-flowered. Rachilla straight. Glumes 5-9 (rarely many), spiral or subdistichous, imbricate, 1-nerved, brown or white; the lower 3 or 4 glumes empty and much smaller. Flowers all bisexual with upper ones not maturing fruit, or the lower 1 to few bisexual and fertile, upper ones staminate or sterile, or flowers unisexual with lowest female and upper ones male. Hypogynous bristles 0 to 6, rarely more than 6, antrorsely or retrorsely scabrous, rarely smooth. Stamens (1-) 2-3; filaments ligulate; anther linear, with a shortly produced connective. Style slender, articulated with the ovary, almost undivided or deeply bifid into 2-stigmas, dark brown, dilated at base; style-base persistent on the achene. Achene sessile or shortly stipitate, 2-sided, obovate, elliptic or oblong, smooth or transversely rugulose.

Schoenoplectus are annuals or perennials, sometimes with decumbent or long-creeping rhizome. Culms trigonous or terete, naked, rarely with 1 or 2 nodes above base, solid or rarely transversely septate. Leaves reduced to bladeless sheaths surrounding the culm base, sometimes with a short blade. Inflorescence pseudolateral, anthelate or crowded in a head, bearing few to many spikelets. Involucral bract usually 1, looks like continuation of the culm, sometimes reflexed, more or less sheathing at base, shorter or longer than culm proper. Spikelets usually ovoid, oblong-ovoid or oblong-ellipsoid, many-flowered. Glumes spiral, usually membranous or thinly herbaceous, keeled towards apex. Flower bisexual, with or without hypogynous bristles. Bristles 3-6, antrorsely or retrorsely scabrous. Stamens 3; anther

connective crested. Stigmas usually 3, rarely 2. Achene trigonous or biconvex, smooth, sometimes slightly or strongly transversely wrinkled, brown to black when mature.

MATERIALS AND METHODS :

Achene samples were collected from the plant samples collected from different localities in Goa. The specimens collected were identified utilizing available facilities in Botanical Survey of India, Pune and the herbarium in Goa University. The herbarium specimens from which achene samples were taken are deposited in BSI. For better result, fully matured specimens were selected to study the morphology of achene by conventional method using stereo microscope and by the advanced method of interpreting the Scanning Electron Microscope (SEM) images. The shape and size of the achenes of each species were recorded and the micro structure of the achene surface was studied using SEM images. For this, achenes were extracted from the spikelets and mounted on glass slides with sticky tape, mounted on SEM stubs and then sputter coated with platinum and examined under JOEL JSM6360 Scanning Electron Microscope. The images were then photographed at different magnifications. The SEM images of achenes of different species thus obtained were then interpreted with the help of relevant literature. Achene shape, size, its ornamentations and micro-epidermal structures such as nature of perianth bristles, nature of periclinal walls, anticlinal walls and silica bodies were studied to find out the similarities or dissimilarities.

RESULTS AND DISCUSSION :

In Goa the genus *Rhynchospora* is represented by single species *R. wightiana*. Achene in this species is very distinct from other taxa of Cyperaceae. It is strongly dorsiventrally compressed, oblong-obovate and with a compressed conical beak. Shape of the epidermal cells is not clear, with indistinct

anticlinal wall. Periclinal wall of the epidermal cell possesses nodular silica bodies dispersed on entire surface. Whole surface of the achene is papillose-tuberculate in between silica bodies. Also, there are antrosely barbed perianth bristles that are longer than the achene in this species.

Table 1 provides a brief account of the important findings and the SEM images of the achenes are shown in plate 1.

Achene in the species of *Schoenoplectus* is trigonous or biconvex, smooth or sometimes slightly or strongly transversely wrinkled. Achene is triquetrous in *S. articulatus* and *S. corymbosus*, trigonous in *S. lateriflorus*, and biconvex in *S. juncooides* and *S. subalulatus*. Achene is obovate in outline in *S. articulatus*, *S. juncooides* and *S. lateriflorus*, but broadly elliptic to obovate in *S. corymbosus* and *S. subalulatus*. Achene in *S. articulatus* is the largest (1.8-2.15 x 1.5-1.92 mm) and *S. lateriflorus* is the smallest (1-1.39 x 0.9-1.16 mm). Achene surface is strongly transversely wrinkled *S. lateriflorus* and faintly transversely wrinkled in *S. juncooides*. But in *S. corymbosus* and *S. subalulatus* achene surface is smooth. However, in *S. articulatus* it is faintly transversely wavy-ridged when young, but ultimately smooth. The colour of achenes in different species varies from stramineous to shining blackish brown.

Perianth bristles are present in *S. juncooides* and *S. subalulatus* while absent in *S. articulatus* and *S. lateriflorus*. In *S. corymbosus* perianth bristles are usually absent, if present bristles are very short. Unlike in other species of *Schoenoplectus* perianth bristles in *S. subalulatus* are linear-spathulate, plumosely fringed in the upper part with moniliform antrorse hairs, papulose near the base and rust-brown in colour.

Out of the five species of *Schoenoplectus* found in Goa, achenes of 3 species were studied under SEM for comparison. Epidermal pattern was found to be different in these three species.

Epidermal cells in all these species are inconspicuous without differentiation of anticlinal and periclinal wall. In *S. articulatus* achene surface has numerous strong longitudinal parallel striations forming ridges and furrows, while in *S. juncooides* a closely allied species, these striations are weak. Achene in *S. lateriflorus* shows a different epidermal pattern than the other two species. In this achene surface has transversally arranged prominent wavy ridges with parallel striations in between the ridges. The present study proved that achene morphology including size, shape and micro epidermal structures of the achene is useful for identification and delimitation of *Rhynchospora* and *Schoenoplectus* species.

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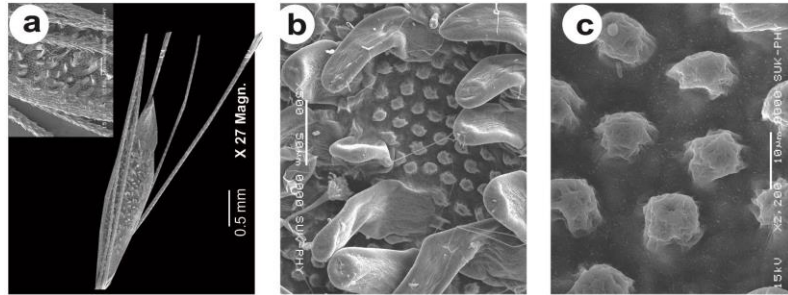
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Table 1. Macro- and micro-morphology of achenes in the genus *Rhynchospora* & *Schoenoplectus*

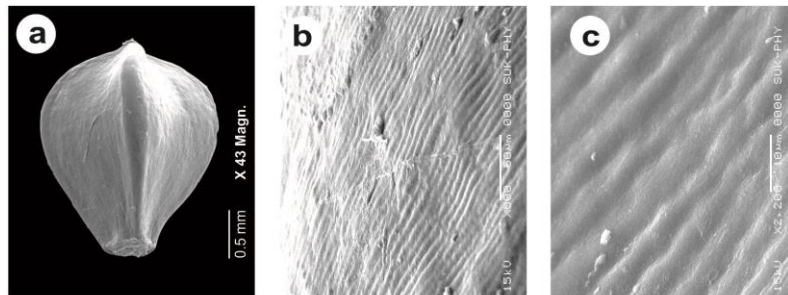
Sr. No.	Plant name and voucher specimen	Macromorphology	Micromorphology (SEM)
1.	<i>Rhynchospora wightiana</i> (Nees) Steud. Valpoi, Sattari Taluk, North Goa, 22.9.2007, R.T. Patil 192664, (BSI). PLATE 1	Strongly dorsiventrally compressed, oblong or oblong-obovate, obtuse at apex below the compressed-conical and nearly white beak, 2.87 x 0.51 mm. Perianth bristles 6, two to four times as long as the achene, antrorsely scabrous.	Epidermal cell shape not clear; anticlinal wall indistinct; periclinal wall with nodular warty silica bodies dispersed on entire surface. Buttresses present. Whole achene surface papillose-tuberculate in between silica bodies.
2.	<i>Schoenoplectus articulatus</i> (L.)	Acutely triquetrous, obovate,	Epidermal cells

	<p>Palla</p> <p>Margao-Colva beach road, Salcete Taluk, South Goa, 3.12.2006, R.T. Patil 192529, (BSI).</p> <p>PLATE 1</p>	<p>with slightly concave sides, apiculate at apex, narrowed towards base 2.15 x 1.92 mm.</p> <p>Perianth bristles absent.</p>	<p>inconspicuous, without differentiation of anticlinal wall and periclinal wall; with numerous strong, longitudinally parallel striations developing ridges and furrows on whole achene surface.</p>
3.	<p><i>Schoenoplectus juncooides</i> (Roxb.) Palla</p> <p>Corgao, Dewoolwada, Pernem Taluk, North Goa, 27.4.2008, R.T. Patil 3011 (BSI).</p> <p>PLATE 1</p>	<p>Unequally biconvex, broadly obovate, mucronate at the obtuse apex, 2.06 x 1.46 mm. Perianth bristles half the length of achene, minutely retrorsely barbed except at basal region.</p>	<p>Epidermal cells inconspicuous, without differentiation of anticlinal wall and periclinal wall; with numerous weak, longitudinally parallel striations developing ridges and furrows on whole achene surface. Pits present.</p>
4.	<p><i>Schoenoplectus lateriflorus</i> (J.F.Gmel.) Lye</p> <p>Bastora, Ucassaim, Bardez Taluk, North Goa, 20.9.2007, R.T. Patil 192646 (BSI).</p> <p>PLATE 1</p>	<p>Unequally trigonous, broadly obovate, shortly apiculate at apex, suddenly narrowed at both ends, 1.39 x 1.16 mm. Perianth bristles absent.</p>	<p>Epidermal cells inconspicuous, without differentiation of anticlinal wall and periclinal wall; with many reticulate, transversely arranged prominent wavy ridges on the achene surface and with transverse parallel striations in between wavy ridges.</p>

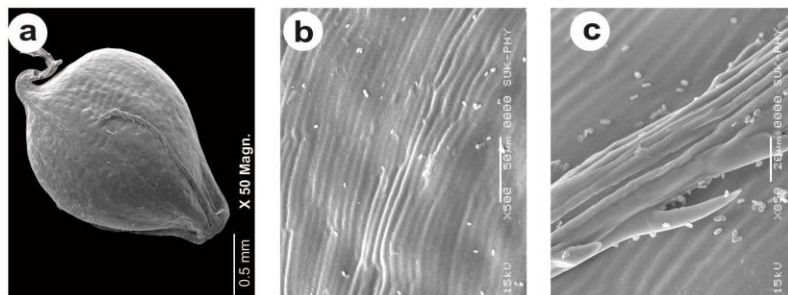
**SEM MICROGRAPHS OF RHYNCHOSPORA Vahl &
SCHOENOPLECTUS (Reichb.) Palla ACHENES**
PLATE 1



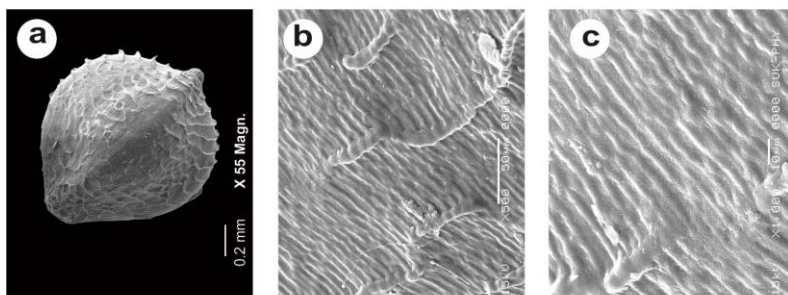
Rhynchospora wightiana (Nees) Steud. - a. Achene with perianth bristles, b & c. Achene surface with prominent silica bodies



Schoenoplectus articulatus (L.) Palla - a. Achene, b & c. Achene surface



Schoenoplectus juncooides (Roxb.) Palla - a. Achene, b. Achene surface, c. Perianth bristle



Schoenoplectus lateriflorus (J. F. Gmel.) Lye - a. Achene, b & c. Wavy ridges on achene surface