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ACHENE MORPHOLOGY AND ITS TAXONOMIC SIGNIFICANCE IN CYPERACEAE OF GOA, INDIA: 2. GENUS ELEOCHARIS

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ABSTRACT

Achene morphology of five species of *Eleocharis* in Goa, namely *E. acutangula* (Roxb.) Schult., *E. atropurpurea* (Retz.) J. Presl & C. Presl, *E. dulcis* (Burm.f.) Trin. ex Hensch., *E. geniculata* (L.) Roem. & Schult. and *E. spiralis* (Rottb.) Roem. & Schult. is elucidated by examining the achenes under light microscope and by interpreting the Scanning Electron Microscope (SEM) images. The shape, size and epidermal patterns of achenes were found distinctive and consistent for each species. Achenes in *Eleocharis* are biconvex or trigonous, obovate in outline and with smooth or pitted surface. Epidermal cells are hexagonal, vertically or transversely oblong, arranged in rows or irregularly placed. Style base persistent on the achene, which is conical or depressed conical and more or less spongy. Number and nature of the perianth bristles, variation in the epidermal cells with respect to size of the cell, nature of periclinal walls, the number, thickness and sinuosity of anticlinal walls were found to be useful in determining the taxonomic relationships, identification and delimitation of different taxa of *Eleocharis* at species level.

Keywords: *Eleocharis*, Goa, Achene Morphology, SEM Images

INTRODUCTION

The genus *Eleocharis* is characterized by the leaves reduced to bladeless sheaths, inflorescence of single terminal spike (rarely proliferous) not subtended by leafy bracts. The most distinctive character of the genus is the ovary with the style articulated to it and the achene beaked by the persistent style base, but separated from the achene proper by a distinct constriction. The plants are annuals or perennials with rhizomes or slender stolons.

Culms usually tufted, erect or arcuate, terete or triangular, solid or hollow with transverse septa inside, naked, but enclosed at the base only with few sheaths. Spikelets cylindrical or angular, rarely compressed, few to many-flowered, sessile, subtended by a scale-like bract. Rachilla continuous, persistent. Glumes membranous to subcoriaceous, spirally imbricate (at times distichous), usually ovate to elliptic, rarely cuneate or oblong, keeled or obtuse on back, lowest 1 or 2 mostly empty. Flowers bisexual. Perianth formed of 4–10 hypogynous bristles. Stamens 1–3; anthers with connective produced into a small subulate appendage. Style base persistent, more or less spongy; stigmas 2 or 3. Achene trigonous or biconvex, mostly obovate, with smooth or pitted surface; epidermal cells hexagonal, vertically or transversely oblong, arranged in rows or irregularly placed.

The genus is widely distributed from tropical to temperate regions of both the hemispheres with c. 200 species (Mabberley, 2009). There are c. 22 species in India and 5 in Goa. In the present study, achene morphology of all the five species in Goa has been studied and interpreted for their similarities and dissimilarities.

General information about the achene morphology in family Cyperaceae and its taxonomic importance is discussed in the first part of this article (Patil & Prasad, 2016).

MATERIALS AND METHODS

Achene samples were collected from the plant samples collected from different localities in Goa. The specimens collected were identified utilising available facilities in Botanical Survey of India, Pune and

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the herbarium in Goa University. The herbarium specimens from which achene samples were taken are deposited in BSI, except 1 in the Goa University Herbarium.

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, periclinal walls, anticlinal walls and silica bodies were studied to find out the similarities or dissimilarities.

RESULTS AND DISCUSSION

As mentioned earlier, the persistent style base at the apex of the achene is an important diagnostic feature of the genus.

It is conical or depressed conical and more or less spongy. Achene is compressed trigonous in *E. acutangula*, biconvex in *E. atropurpurea*, *E. dulcis* and *E. geniculata* and all are obovate in outline. Largest achene in the genus was found in *E. dulcis* ($1.7\text{--}2.8 \times 1.16\text{--}1.8$ mm), while the smallest in *E. atropurpurea* ($0.7\text{--}0.81 \times \leq 0.5$ mm). Size of the achene is significant in the identification of species of *Eleocharis*.

Also these species show difference in the shape and size of the persistent style base. In *E. acutangula*, it is prominent, dorsiventrally compressed and triangular-deltate; in *E. atropurpurea* it is minute and depressed conical; like a triangular beak in *E. dulcis*; conically much depressed in *E. geniculata* and in *E. spiralis* it is a compressed conical beak.

So, all the five species of *Eleocharis* in Goa can be segregated based on combination of morphological characters of the achenes.

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

The SEM studies of achenes of all the five species of *Eleocharis* in Goa revealed that the epidermal cells are conspicuous in *E. acutangula* and inconspicuous in all other species.

Shape of the epidermal cells is hexagonal in *E. dulcis*, subquadrate in *E. geniculata* and transversely oblong in *E. acutangula*.

Silica bodies are absent in the epidermal cells of the achenes in all the species. Nature of the anticlinal and periclinal walls is more or less similar but with minor differences.

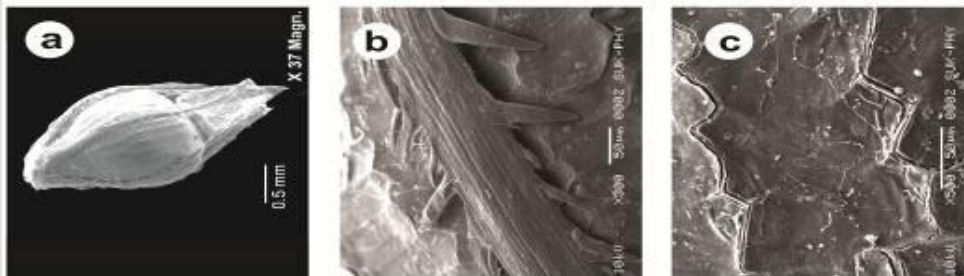
In *E. acutangula*, anticlinal wall is thin, straight and hardly raised; in *E. atropurpurea* it is slender, straight and slightly depressed; in *E. dulcis* slender, straight and slightly raised, and in *E. geniculata* and *E. spiralis* it is straight but indistinct.

Periclinal walls of the epidermal cells in all the species are smooth and flat, slightly convex in *E. atropurpurea*.

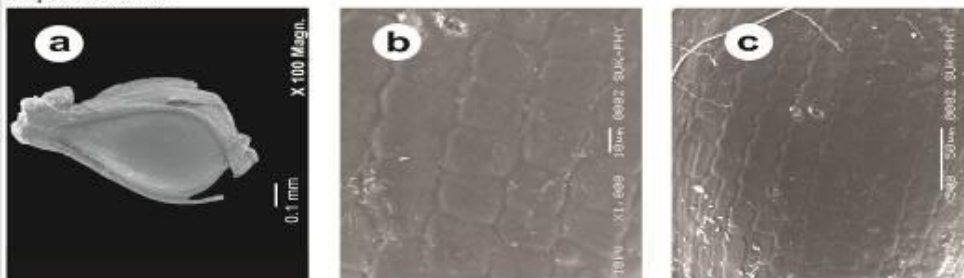
Perianth bristles in all species are retrorsely spinulose-scabrous from apex to nearly base. In *E. dulcis* and *E. geniculata*, the perianth bristles are slightly longer than the achene while in others they are smaller or equal to the achene.

From the above discussion it is clear that the achenes in *Eleocharis* show variations in their gross morphology and micro-epidermal morphology at species level, and such variations are of taxonomic significance.

SEM images of the achenes in *Eleocharis* R. Br.
PLATE 1



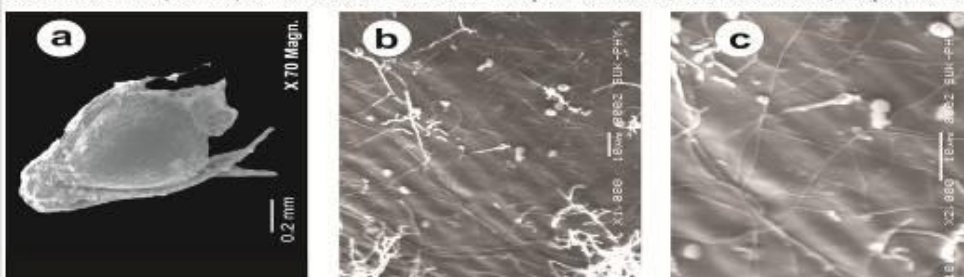
Eleocharis acutangula (Roxb.) Schult. - a. Achene with perianth bristles, b. Surface with perianth bristle, c. Epidermal cells



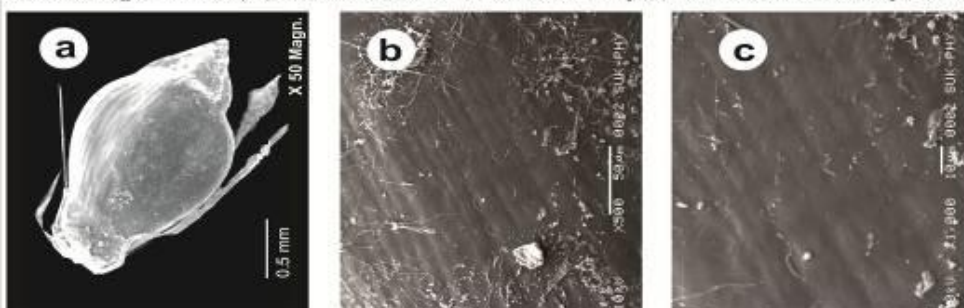
Eleocharis atropurpurea (Retz.) J. Presl. & C. Presl - a. Achene with perianth bristles, b & c. Epidermal cells



Eleocharis dulcis (Burm.f.) Trin.ex Hensch. - a. Achene with perianth bristles, b. Perianth bristle, c. Epidermal cells



Eleocharis geniculata (L.) Roem. & Schult. - a. Achene with perianth bristles, b. & c. Epidermal cells



Eleocharis spiralis (Rottb.) Roem. & Schult. - a. Achene with perianth bristles, b & c. Epidermal cells

Table 1: Macro and Micro-Morphology of Achenes in the Genus *Eleocharis*

Sr. No.	Plant Name and Voucher Specimen	Macromorphology	Micromorphology (SEM)
1.	<i>Eleocharis acutangula</i> (Roxb.) Schult. Nirancarachi Rai, Sattari Taluk, North Goa, s. die, V. Joshi & Rajkumar 1182 (Herbarium, University). PLATE 1	Sub-compressed biconvex, obpyriform, 2.69 × 1.35 mm. Summit of the achene distinctly constricted below the apex into a neck-like region but annulus indistinct. Style base prominent, persistent, dorsiventrally compressed, triangular-deltate. Perianth bristles arising from a basal spherical ring, stiff, strap-shaped, ascending and extending beyond summit of the achene; coarsely retrosely spinulose-scabrous from apex to nearly base.	Epidermal cells transversally oblong, reniform, in vertical rows; anticlinal walls 6, thin, straight, faintly raised; periclinal walls smooth, without silica bodies.
2.	<i>Eleocharis atropurpurea</i> (Retz.) J. Presl & C. Presl Paroda, Salcete Taluk, South Goa, 22.4.2007, R.T. Patil 192567 (BSI) PLATE 1	Biconvex, obovate, 0.81 × 0.51 mm. Style base persistent depressed conical. Perianth bristles minutely scabrid, extending up to apex of the achene.	Epidermal cells transversally oblong, hexagonal, inconspicuous; anticlinal walls slender, straight, slightly depressed; periclinal walls slightly convex, with smooth platform, without silica bodies.
3.	<i>Eleocharis dulcis</i> (Burm.f.) Trin. ex Hensch.	Biconvex with obtuse edges, obovate; 2.8 × 1.16 mm. Summit of the achene not conspicuously constricted at apex, enters directly	Epidermal cells transversally oblong hexagonal, inconspicuous; anticlinal walls slender, straight, slightly raised;



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	into annulus and terminates into a triangular beak.	periclinal walls flat, smooth, without silica bodies.
Chodan Island, after Raibandar ferry cross, Tiswadi Taluk, North Goa, 24.11.2007, R.T. Patil 192699 (BSI).	Perianth bristles 6, unequal, broader at base, stiff, strap-shaped, ascending and extending well above summit of the achene and the persistent style base, coarsely retrosely spinulose from apex to nearly base.	
PLATE 1		
4. <i>Eleocharis geniculata</i> (L.) Roem. & Schult.	Biconvex, broadly obovate, suddenly contracted to rounded apex, 1.03 × 0.63 mm. Style base spongy, conically much depressed.	Epidermal cells subquadrate but obscure; anticlinal walls not raised; periclinal walls smooth, without silica bodies.
Tonca, after the bridge, Tiswadi Taluk, North Goa, 16.2.2007, R.T. Patil 192545 (BSI).	Perianth bristles retrosely spinulose, slightly longer than the achene.	
PLATE 1		
5. <i>Eleocharis spiralis</i> (Rottb.) Roem. & Schult.	Turgidly biconvex, obovate to orbicular obovate, 2.15 × 1.13 mm. Summit of the achene with less abrupt constriction, prolonged, gradually tapered into a compressed conical beak, merging into a short persistent style base.	Epidermal cells inconspicuous, transversally linear-oblong in vertical rows; anticlinal walls straight, indistinct; periclinal walls smooth, flat, without silica bodies.
Chodan, Tiswadi Taluk, North Goa, 24.11.2007, R.T. Patil 192696 (BSI).	Perianth bristles 4–6, slender, shorter than to equaling the achene, minutely and retrosely scabrid.	
PLATE 1		

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