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Research Article

Comparative Foliar Epidermal Studies of Twelve species in the Family Cyperaceae

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Abstract: The study investigated the leaf foliar epidermal characters of twelve species in the family Cyperaceae. This was with a view to finding additional characters of diagnostic or taxonomic importance. The epidermal peels were obtained by standard methods. The twelve species studied were *Cyperus dilatatus* Schum. & Thonn.; *Cyperus difformis* Linn.; *Cyperus haspan* Linn.; *Cyperus distans* Linn. (F.) Retz.; *Cyperus imbricatus* Linn.; *Cyperus compressus* Linn.; *Kyllinga erecta* Schumacher.; *Kyllinga pumila* Michx.; *Kyllinga nemoralis* (Forst.) Dandy ex Hutch.; *Mariscus alternifolius* Vahl.; *Mariscus flabelliformis* Kunth.; *Rhynchospora corymbosa* (Linn.) Britton.
Foliar epidermal peels were obtained by standard methods. Characters that were taxonomically important in delimiting the twelve species include presence or absence of prickle hair, trichomes, idioblasts, prismatic crystals and contiguous stomata on both abaxial and adaxial surfaces and *Rhynchospora corymbosa* was distinctly separated from the other species studied because it was the only hypostomatic species, while the others were amphistomatic, it was the only species with 1-5 rows of stomata per band and it had the highest stomata number. The distinct foliar epidermal separation of *R. corymbosa* validated its placement in the tribe Schoeneae with the other species studied in the tribe Cypereae.
C. distans was unique in having non–glandular, tripod-shaped, T–shaped, tricellular and three-arm shaped trichomes on the abaxial epidermal surface. The presence of prismatic crystals was also unique on the adaxial surface of *C. distans* and *C. imbricatus*. Big sized circular papillae on the intercoastal zone of *C. haspan* delimited it from all the other species studied. Out of the three *Kyllinga* species studied, idioblast was found on both abaxial and adaxial surfaces of *K. erecta* and *K. pumila* but absent in *K. nemoralis*.

Keywords: Foliar, Epidermal, Taxonomic, Prickles, Papillae.

1. Introduction

Cyperaceae is a family of monocotyledonous graminoid flowering plants known as sedges, which superficially resemble grasses or rushes. It is the third family among the 10 largest families of monocotyledonous flowering plants. The family is large, with some 5,500 species described in about 109 genera (Govaerts *et al.*, 2007). In Nigeria, about 230 species belonging to 23 genera have been recorded. About four-fifths of the species grow in damp or wet places (including a few submerged aquatics), while one-fifth is found in drier situations such as savanna grassland, and sandy places including sand-dunes (Lowe, 1974).

The family has considerable economic importance; many members are serious agricultural weeds, whereas others provide food, fuel, and medicines together with construction, weaving, and perfumery materials (Simpson and Inglis, 2001). They also have importance in conservation as dominant components of many wetland ecosystems and are reliable indicators of habitat deterioration in such systems (Simpson and Inglis, 2001).

Sedges have featured in literature since antiquity. The family is well circumscribed and uncontroversial. Spikelet and inflorescence structure, together with other evidence, form the basis for classification within the family. Because the spikelet is very small and the inflorescence structure very complex, interpretation is difficult and there is still controversy over recognition of subfamilies, tribes, and genera.

The foliar epidermis is one of the most significant taxonomic characters from the biosystematics point of view and the taxonomic studies of a number of families

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are made on the basis of leaf epidermis (Bhatia, 1984; Jones, 1986; Adedeji, 2004; Adedeji & Jewoola, 2008).

The sedge family (Cyperaceae) constitutes a taxonomically difficult family (Metcalfe, 1971). Anatomical data are frequently used in characterizing species or species complexes within a genus and in determining evolutionary relationships (Stant, 1973; Forbes, 1980). Stace (1984) described the leaf of vascular plants as possessing characters which are second to those of flowers and fruits in their value and use in taxonomic studies.

The specific objective of this work is to investigate the foliar epidermal characters of the species of the family Cyperaceae under study in order to find additional characters of taxonomic importance.

2. Materials and Methods

For the purpose of this study, twelve species in the family Cyperaceae belonging to 4 genera and 2 tribes were collected from different locations in Ile–Ife. The altitudes and geographical coordinates of the localities were taken using a GPS device and the species studied were as listed in Table 1.

Sizeable portions of the matured leaves of the species were obtained from the median part of well-expanded leaves. For epidermal peels preparations, Metcalfe (1960) scrape method was used. Epidermal peels of both adaxial and abaxial surfaces were made by placing the desired epidermal surface face down on a glass slide; scraping off with a sandpaper and a sharp razor blade all tissues above the desired epidermis and washing the scraped parts off with water until the required epidermis was reached. The epidermal peels were stained with toluidine blue and mounted in 25% glycerol solution. Quantitatively, measurements were made for length and breadth of long and short cells, stomata, inter stomata cells and idioblasts and their area was calculated by multiplying the length and breadth of each character. Qualitatively, observations and descriptions of the stomata, subsidiary cells, trichomes, prickle hair, papillae, and idioblasts were noted. All microscopic measurements were taken with the aid of an ocular micrometer inserted in the eyepiece of the microscope. These measurements were later multiplied by an ocular constant with respect to the power under which they were taken. Statistical analysis includes Analysis of Variance (ANOVA) and Duncan Multiple Range Test (DMRT). Photomicrographs of the epidermal surfaces were taken under X10 and X40 objectives. Total magnification of the photomicrographs taken were calculated using objectives of the microscope multiplied by the eyepiece of the microscope used.

Table 1. Twelve species in the family Cyperaceae and the geographical location of sites of the collection.

Species	Location	Coordinates
Cyperus dilatatus Schum. & Thonn.	Olonade Street, Road 7 Area, Ile-Ife.	N 07^0 30.582, E 004^0 32.773, 282m
Cyperus dilatatus Schum. & Thonn.	Behind Civil Engineering Department, O.A.U. Ile-Ife.	N 07^0 31.248, E 004^0 31.593, 287m
Cyperus haspan Linn.	Road 7 Area, Ile-Ife.	N 07^0 30.794, E 004^0 32.913, 253m
Cyperus difformis Linn.	White House car park, O.A.U. Ile-Ife.	N 07^0 31.141, E 004^0 31.289, 285m
Cyperus difformis Linn.	Behind Conference Centre, O.A.U. Ile-Ife.	N 07^0 31.420, E 004^0 31.836, 269m
Cyperus distans Linn. (F.) Retz.	Behind Conference Centre, O.A.U. Ile-Ife.	N 07^0 31.421, E 004^0 31.835, 271m
Cyperus distans Linn. (F.) Retz.	Front of Zoological Garden, O.A.U. Ile-Ife.	N 07^0 31.292, E 004^0 31.375, 291m
Cyperus imbricatus Linn.	Farm along Road 7 gate area, O.A.U. Ile-Ife.	N 07^0 30.790, E 004^0 32.922, 259m
Cyperus imbricatus Linn.	Bridge after Ilesa garage, Ile-Ife.	N 07^0 29.885, E 004^0 34.181, 258m
Cyperus compressus Linn.	Along First Bank after bus stop, O.A.U. Ile-Ife.	N 07^0 30.993, E 004^0 31.367, 263m
Cyperus compressus Linn.	White House Car Park, O.A.U. Ile-Ife.	N 07^0 31.141, E 004^0 31.289, 285m
Kyllinga pumila Michx.	Farm along Road 7 gate area, O.A.U. Ile-Ife.	N 07^0 30.789, E 004^0 32.923, 251m
Kyllinga pumila Michx.	Behind Chemical Engineering Dept. O.A.U, Ile-Ife.	N 07^0 31.151, E 004^0 31.693, 274m
Kyllinga erecta Schumacher.	Along Road 7, Olonade street, Ile-Ife.	N 07^0 31.145, E 004^0 31.643, 275m
Kyllinga erecta Schumacher.	Farm along Road 7 gate area, O.A.U. Ile-Ife.	N 07^0 30.790, E 004^0 32.922, 259m
Kyllinga nemoralis (Forst.) Dandy ex Hutch.	After the signpost of the Dept. of Food Science and Technology, O.A.U. Ile-ife.	N 07^0 31.190, E 004^0 31.608, 276m
Kyllinga nemoralis (Forst.) Dandy ex Hutch.	Back of Botany Dept. O.A.U. Ile-Ife.	N 07^0 31.249, E 004^0 31.562, 273m
Mariscus flabelliformis (Kunth.)	Along Road 7, Olonade street, Ile-Ife.	N 07^0 30.582, E 004^0 32.788, 279m
Mariscus flabelliformis (Kunth.)	Behind Chemical Engineering Dept. O.A.U, Ile-Ife.	N 07^0 31.151, E 004^0 31.693, 274m
Mariscus alternifolius Vahl.	Behind Chemical Engineering Dept. O.A.U, Ile-Ife.	N 07^0 31.151, E 004^0 31.693, 274m
Mariscus alternifolius Vahl.	Parks and Garden, O.A.U. Ile-Ife.	N 07^0 31.404, E 004^0 31.823, 263m
Rhynchospora corymbosa (Linn.) Britton	Farm along Road 7 gate area, O.A.U. Ile-Ife.	N 07^0 30.811, E 004^0 32.915, 255m
Rhynchospora corymbosa (Linn.) Britton	Along the stream to Conference Centre, O.A.U. Ile-Ife.	N 07^0 31.420, E 004^0 31.836, 269m

3. Results

3.1 Epidermal surfaces of the Cyperaceae species studied

3.1.1 *Cyperus compressus* Linn.

The epidermal cells are variable in size, ranging from rectangular to, linear and parallel in shape on both surfaces. The long cells are many times longer than broad with width more or less uniform, anticlinal cell wall wavy on both surfaces. End walls straight, perpendicular and occasionally convex on abaxial but only perpendicular on the adaxial. Short cells are present, but not abundant, with end walls convex on abaxial while there are no short cells on the adaxial. Paracytic stomata are present and are abundant on the abaxial surface than the adaxial surface. The stomata are of 2 bands per intercoastal zone, 1-2 rows per band,

but occasionally 3 at the middle on the abaxial but 1 band with 1-2 rows on the upper and lower intercoastal zones towards the leaf blade only. Subsidiary cells are low-dome to triangular on both surfaces. There are 1-4 rows of cells per coastal zones on the abaxial while there are 1-3 rows of cells per coastal zones on the adaxial with small sized circular papillae on coastal zones on both surfaces. The epidermal cells in the upper and lower intercoastal zones towards the edge/margin have a smaller width than others. Their anticlinal cell walls are straight to wavy with end walls mostly perpendicular, straight and occasionally convex on the adaxial.

3.2.2 *Cyperus imbricatus* Linn.

The epidermal cells are rectangular in shape; orientation is linear and parallel, long cells are many times longer than broad with width more or less uniform on both surfaces. Anticlinal walls wavy to sinuous, end walls mostly oblique, perpendicular, straight and occasionally convex on the abaxial but the anticlinal walls straight to wavy, end walls straight, perpendicular and occasionally concave on the adaxial. The short cells are few to many in a continuous row, 1-2 times longer than broad, width not uniform, anticlinal walls wavy, end walls mostly oblique, perpendicular and occasionally convex on the abaxial only. Paracytic stomata are on both surfaces, subsidiary cells few, low dome to mostly triangular with 1-3 bands of stomata per intercoastal zone, occasionally 4 bands at the centre, 1-2 rows of stomata per band, 1 row of stomata is commonly observed towards the last intercoastal zone and each row is spaced from each other, the subsidiary cells are low dome, mostly 1 band of stomata, 1-2 rows of stomata per band on the adaxial. Inter stomata cells are observed on the abaxial only. Small sized circular papillae are present on the coastal zones. Prickle hair with pointed apex, swollen and large base is present at the edges of the leaf while prickle hair with flattened base and sharp apex is observed on the intercoastal zone and on the coastal zone prickle hair with almost circular base and apex that is not sharp is present on the abaxial while prickle hairs with pointed apex, swollen and flattened bases are present in both coastal and intercoastal zones but prickle hairs with swollen base and pointed apex are abundant at the margins i.e. marginal prickles. Prismatic crystals are present only on the adaxial surface.

3.2.3 *Cyperus dilatatus* Schum. and Thonn.

The epidermal cells are rectangular in shape on the abaxial while polygonal (ranging from rectangular to hexagonal but mostly rectangular) on the adaxial; orientation is linear and parallel, long cells are many times longer than broad with width more or less uniform on both surfaces. Anticlinal walls wavy to sinuous on both surfaces. End walls mostly oblique, perpendicular, straight and occasionally concave on the abaxial surface, but mostly convex, oblique and occasionally straight on adaxial surface. Short cells are present on both surfaces, width not uniform, anticlinal walls wavy to sinuous on both surfaces, end walls mostly concave, convex and occasionally oblique on the abaxial while mostly straight and convex on the adaxial. Paracytic stomata are abundant on the abaxial but are observed towards the edges, but very scarce on the adaxial, contiguous stomata are present on both surfaces, 2-3 bands of stomata per intercoastal zone, occasionally 4 bands at the centre, 1-2 rows of stomata per band occurring normally even after a small coastal zone and each row is spaced from each other on the abaxial surface while there is only 1 band of stomata at the upper and lower end, 1-3 rows of stomata per band. Subsidiary cells mostly low dome to triangular on abaxial but only low dome on adaxial. Small sized circular papillae are present on the coastal zones of both surfaces.

3.2.4 *Cyperus distans* Linn. (F.) Retz.

The epidermal cells are rectangular in shape on the abaxial surface while polygonal (ranging from rectangular to hexagonal but mostly rectangular) on the adaxial surface; orientation is linear and parallel to both surfaces. Long-cells are many times longer than broad with width more or less uniform on both surfaces; anticlinal walls wavy to sinuous on abaxial but undulating to sinuous on adaxial, end walls mostly oblique, perpendicular, concave and occasionally straight on abaxial while they are mostly concave, oblique and occasionally perpendicular and straight on adaxial surface. The short cells are rectangular, few to many in a continuous row on the abaxial surface, but are rectangular to pentagonal in shape on the adaxial surface, width not uniform on both surfaces, anticlinal walls wavy on abaxial while sinuous on adaxial, end walls mostly concave, oblique, perpendicular and occasionally straight on abaxial but mostly straight, oblique and perpendicular on adaxial. Paracytic stomata are abundant with 1-3 bands of stomata per intercoastal zone, 1-2 rows of stomata per band, 1 row of stomata is commonly observed towards the last intercoastal zone and each row is spaced from each other on the abaxial surface, but only observed towards the edges on the adaxial with 1 band of stomata on the last intercoastal zone, 1 row of stomata per band. Subsidiary cells mostly triangular on abaxial while low dome on the adaxial. There is the presence of contiguous stomata and inter stomata cells on the abaxial surface. Small sized circular papillae are present on both surfaces on the coastal zones. Prismatic crystals are present only on the adaxial surface. Tripod shaped, three – armed, T - shaped and tricellular non-glandular trichomes are present only on the abaxial surface. Prickle hair with sharp, pointed apex, swollen and large base are present at the edges of the leaf on abaxial surface while prickle hair with sharp, pointed apex, swollen and large base is present at the edges of the leaf while flattened base and blunt apex prickle hair is present in the coastal zone on the adaxial surface.

3.2.5 *Cyperus difformis* Linn.

The epidermal cells are rectangular in shape on the abaxial surface while they are polygonal in shape on the adaxial (ranging from rectangular to hexagonal but mostly rectangular), orientation is linear and parallel to each other on both surfaces, long cells are many times longer than broad with width more or less uniform on both surfaces; anticlinal walls wavy to sinuous on the abaxial surface while undulating to sinuous on adaxial surface, end walls mostly convex, oblique and occasionally perpendicular on abaxial but mostly concave, oblique occasionally perpendicular and straight on adaxial surface. The short cells are few to many in a continuous row, mostly solitary and occasionally paired, rectangular, polygonal or almost circular on the abaxial surface while they are rectangular to pentagonal in shape on the adaxial surface. Anticlinal walls wavy to sinuous on abaxial while sinuous on adaxial, end walls mostly convex, oblique and occasionally concave while they are mostly straight, oblique and perpendicular on the adaxial. Paracytic stomata are abundant with 1-3 bands of stomata per intercoastal zone, 1-3 rows of stomata per band on the abaxial but are observed towards the edges with 1 band of stomata on the last intercoastal zone, 1-2 rows of stomata per band on the adaxial, subsidiary cells mostly low dome to triangular on abaxial while low dome on adaxial. There is presence of contiguous stomata on the abaxial. Inter stomata cells are observed on both surfaces. Small sized circular papillae are present on the coastal zones of both surfaces. Prickle hair with sharp, pointed apex, swollen and large base is present at the edges of the leaf while flattened base and blunt apex prickle hair is observed on the last intercoastal zone on the abaxial surface, prickle hair with swollen base and blunt apex are present at the edges of the leaf on the adaxial surface while flattened base and blunt apex prickle hair is present in the coastal zone on the same surface.

3.2.6 *Cyperus haspan* Linn.

The epidermal cells are polygonal in shape (ranging from rectangular to hexagonal but mostly hexagonal), orientation of cells is linear and parallel to each other on both surfaces. Long-cells are many times longer than broad with width more or less uniform on both surfaces; anticlinal walls straight to slightly wavy on abaxial surface while they are straight on adaxial, end walls mostly straight, oblique and occasionally perpendicular on both surfaces. The short cells are few, not many times longer than broad, width not uniform, anticlinal walls straight to slightly wavy, end walls mostly straight and oblique occasionally convex and concave on both surfaces. Paracytic stomata are abundant but not as much as those in other species on the abaxial but sparsely distributed on the intercoastal zone, often solitary on the adaxial, subsidiary cells low dome to triangular with 1 band of stomata per intercoastal zone, 1-2 rows of stomata per band on the abaxial while they are generally low dome but occasionally triangular, no band of stomata per intercoastal zone, 1 row of stomata is present with many inter stomata cells separating them from each other on the adaxial. There are 1-4 rows of cells per coastal zones on both surfaces. Big sized circular papillae are more conspicuous on the cells on the intercoastal zones on the abaxial surface. No prickle hairs are observed.

3.2.7 *Kyllinga erecta* Schumacher.

The epidermal cells are rectangular in shape on the abaxial surface while they are polygonal in shape (ranging from rectangular to hexagonal but mostly rectangular) and varying in size on the adaxial surface, orientation of cells is linear and parallel to each other on both surfaces. Long-cells are many times longer than broad with width more or less uniform on both surfaces; anticlinal cell wall wavy, end walls mostly straight, perpendicular, oblique and occasionally convex on abaxial but mostly straight and occasionally oblique, perpendicular and convex on adaxial. The short cells are rectangular to almost circular in shape on abaxial while they are scarce, rectangular in shape on the adaxial, not many times longer than broad, width not uniform on both surfaces, anticlinal cell walls wavy on both surfaces, end walls convex, straight and perpendicular on abaxial but oblique, straight and convex on adaxial. The cells in the coastal zones are smaller than those on the intercoastal zones. The epidermal cells on the last intercoastal zone are smaller in width than those on the other intercoastal zones on adaxial surface. Paracytic stomata are abundant on abaxial but are observed towards the edges only on the adaxial, subsidiary cells low dome to mostly triangular on both surfaces, mostly 1-2 bands of stomata per intercoastal zone, 1-2 rows of stomata per band; but 1 row of stomata is mostly observed occurring normally even after a small coastal zone and inter stomata cells are observed on abaxial while 1 band of stomata at the upper and lower end, 1-3 rows of stomata per band are observed on adaxial surface. Small sized circular papillae are present on the coastal zones of both surfaces. Prickle hair with a swollen base and sharp apex are observed at the edges of the leaf on abaxial while Prickle hairs with a swollen base and long, sharply pointed apex are present at the edges of the leaf blade on adaxial. Idioblast (a shining substance with hairs surrounding it) of different sizes and shapes such as ovoid, circular and rectangular are present on both surfaces but was more abundant on the abaxial than the adaxial.

3.2.8 *Kyllinga pumila* Michx.

The epidermal cells are rectangular in shape on abaxial but are polygonal in shape (ranging from rectangular to hexagonal but mostly rectangular) on adaxial; orientation of cells is linear and parallel to each other on both surfaces, long cells are many times longer than broad with width more or less uniform on the abaxial than the adaxial; anticlinal walls are wavy on

both surfaces, end walls are mostly oblique, perpendicular, straight and occasionally convex on abaxial while they are mostly straight and concave occasionally oblique on adaxial. The short cells are rectangular in shape on both surfaces but are scarce on the adaxial, not many times longer than broad, width not uniform on both surfaces, anticlinal walls are wavy on both surfaces, end walls mostly oblique and perpendicular, occasionally convex and straight on abaxial but are oblique and straight on adaxial surface. Paracytic stomata are abundant on abaxial but are observed towards the edges only on the adaxial, subsidiary cells low dome to triangular on abaxial but mostly low dome on adaxial. Mostly 1-2 bands of stomata per intercoastal zone with 1-2 rows of stomata per band; but 1 row of stomata is mostly observed occurring normally even after a small coastal zone on abaxial surface while 1 band of stomata are observed at the upper and lower end with 1-2 rows of stomata per band on the adaxial. Inter stomata cells are observed on both surfaces. Small sized circular papillae are present on the coastal zones of both surfaces. Prickle hair with swollen base and pointed apex are observed at the edges of the leaf on abaxial while prickle hairs with swollen base and short, sharply pointed apex are present at the edges of the leaf blade. Idioblasts of different sizes, of ovoid, circular and rectangular shapes are present but not as much as those observed on the abaxial surface of *K. erecta*. They are also present on the adaxial surface but not as much as those present on the abaxial surface.

3.2.9 *Kyllinga nemoralis* (Forst.) Dandy ex Hutch.

The epidermal cells are rectangular in shape on abaxial surface but they vary in size, polygonal in shape (ranging from rectangular to hexagonal but mostly rectangular) on adaxial; orientation of cells is linear and parallel to each other, long cells are many times longer than broad with width more or less uniform on both surfaces; anticlinal cell wall wavy to undulating on abaxial but are wavy on adaxial, end walls mostly straight, perpendicular, oblique and occasionally convex on abaxial but are oblique, straight and concave on adaxial. The short cells are few on abaxial surface while they are scarce on the adaxial, not many times longer than broad, width not uniform on both surfaces, anticlinal walls wavy on both surfaces, end walls convex, straight and perpendicular on abaxial while oblique, straight and convex on adaxial. Paracytic stomata are abundant on abaxial but are observed towards the edges only on adaxial, subsidiary cells triangular on abaxial while low dome on adaxial, mostly 1-2 bands of stomata per intercoastal zone, occasionally 5 bands after a big coastal zone, 1-2 rows of stomata per band; but 1 row of stomata is mostly observed occurring normally even after a small coastal zone on the abaxial surface while 1 band of stomata are observed at the upper and lower end with 1-2 rows of stomata per band on adaxial. Inter stomata cells are present on both surfaces. Small sized circular papillae are present on the coastal zones of both surfaces. Prickle hair with flattened base and short sharp apex are observed on the intercoastal zone towards the leaf margin while prickle hairs with swollen, large base and sharp apex are present at the edges on abaxial surface. Swollen base, apex sharply pointed prickle hairs are present at the edges of the leaf blade while swollen base with short sharp apex and prickle hairs are found on the intercoastal zone, the apex is raised differently (downwards, horizontally and upwards) on adaxial.

3.2.10 *Mariscus alternifolius* Vahl.

Epidermal cells are rectangular in shape on abaxial but they vary in size, polygonal in shape (ranging from rectangular to hexagonal but mostly rectangular) on adaxial; the cell arrangement is linear to parallel, long cells are many times longer than broad, width more or less uniform on both surfaces, anticlinal walls wavy on abaxial but straight to wavy on adaxial, end walls mostly straight and oblique, occasionally convex on abaxial but are mostly convex, straight and oblique on adaxial. Short cells are present; usually rectangular to almost circular in shape found mostly between stomata cells i.e. inter stomata cells on abaxial but not many times longer than broad on both surfaces, anticlinal walls wavy on both surfaces, end walls mostly convex, occasionally oblique on abaxial while they are mostly convex, occasionally oblique, straight and perpendicular on adaxial. Paracytic stomata are abundant on abaxial while they are only observed towards the edges but not as much as those present in the other species on adaxial, subsidiary cells mostly triangular to low dome on both surfaces; 1 band of stomata per intercoastal zone, 1-3 rows of stomata per band are present on abaxial while 1 band of stomata is present at the last intercoastal zone with 1 row of stomata per band on adaxial. Contiguous stomata are present on adaxial surface. Small sized circular papillae are found on the epidermal cells on the coastal zones on both surfaces. Prickle hairs with swollen base and short pointed apex are present at the edges of the leaf blade after a big coastal zone on abaxial while prickle hairs with swollen base and long, pointed apex are present at the edges of the leaf blade while those with flat base and sharply pointed apex are present on the coastal and intercoastal zone on adaxial.

3.2.11 *Mariscus flabelliformis* Kunth.

Epidermal cells are rectangular in shape on abaxial but are polygonal in shape (ranging from rectangular to hexagonal but mostly rectangular) on adaxial; the cell arrangement is linear to parallel on both surfaces, the long cells are many times longer than broad, width more or less uniform on both surfaces, anticlinal walls wavy on abaxial but straight to wavy on adaxial, end walls mostly convex and straight, occasionally oblique on abaxial but mostly convex and occasionally straight on adaxial. Short cells are present on both surfaces; usually rectangular to almost circular in shape found mostly between stomata cells i.e. inter

stomata cells on abaxial, anticlinal walls wavy, end walls mostly convex, occasionally oblique on abaxial but mostly concave, occasionally straight on adaxial. Paracytic stomata are present in a continuous row on abaxial while few are present towards the edges after the last coastal zone on adaxial, subsidiary cells mostly triangular to low dome on abaxial while low dome on adaxial; 1-3 bands of stomata per intercoastal zone with 1-2 rows of stomata per band are present on abaxial while mostly 1 band of stomata with 1-2 rows of stomata per band are present on adaxial. Small sized circular papillae are found on the epidermal cells on the coastal zones on both surfaces. Prickle hairs with rhomboid shape are found towards the edges of the leaf blade after a big coastal zone on the intercoastal zone and prickle hairs with swollen base with sharply pointed apex are observed on the edges on abaxial while prickle hairs with swollen, large base, raised with sharply pointed apex, are present in both coastal and intercoastal zones but are abundant at the margins i.e. marginal prickles. The prickle hairs on the coastal and intercoastal zones are almost circular at the base with the apex pointing upwards or downwards on the adaxial surface.

3.2.12 *Rhynchospora corymbosa* (Linn.) Britton

The epidermal cells are rectangular in shape on abaxial but vary in size, polygonal in shape (ranging from rectangular to hexagonal but mostly rectangular), orientation of cells is linear and parallel to each other; the long cells are many times longer than broad with width more or less uniform on both surfaces, anticlinal walls wavy on both surfaces, end walls mostly concave, oblique, perpendicular on abaxial while mostly convex, oblique and perpendicular on adaxial. Short cells are abundant, occasionally paired and are found mostly as inter stomata cells, which are rectangular to almost circular in shape, not many times longer than broad, width not uniform on both surfaces but not many times longer than broad on adaxial surface, anticlinal walls wavy, end walls mostly concave, oblique, perpendicular on abaxial but are mostly oblique, perpendicular and straight on adaxial. Paracytic stomata are abundant, subsidiary cells markedly low dome to triangular; mostly 2 bands of stomata per intercoastal zone, occasionally 5 bands after a big coastal zone. 1-5 rows per band on abaxial surface. Stomata are absent, papillae are absent and no coastal zone is observed on the adaxial epidermis.

Table 2. Summary of Qualitative Foliar Epidermal Characters (Abaxial surface) of the Species of the Family Cyperaceae Studied.

Species	Long cells	Short cells	Cell shape	Anticlinal wall	Stomata type	Papillae	Prickle hair	Idioblast cells	Trichome	Contiguous stomata	PHE	PHI	PHC
C. compressus	+	+	Rectangular	Wavy	Paracytic	Szp	-	-	-	-	-	-	-
C. dilatatus	+	+	Rectangular	Wavy-Sinuous	Paracytic	Szp	-	-	-	+	-	-	-
C. imbricatus	+	+	Rectangular	Wavy	Paracytic	Szp	+	-	-	-	+	+	+
C. distans	+	+	Rectangular	Wavy-Sinuous	Paracytic	Szp	+	-	+	-	+	-	-
C. difformis	+	+	Rectangular	Wavy-Sinuous	Paracytic	Szp	+	-	-	+	+	+	-
C. haspan	+	+	Polygonal (R-H)	Straight-Slightly wavy	Paracytic	Bzp	-	-	-	-	-	-	-
K. erecta	+	+	Rectangular	Wavy	Paracytic	Szp	+	+	-	-	+	-	-
K. pumila	+	+	Rectangular	Wavy	Paracytic	Szp	+	+	-	-	+	-	-
K. nemoralis	+	+	Rectangular	Wavy-undulating	Paracytic	Szp	+	-	-	-	+	+	-
M. alternifolius	+	+	Rectangular	Wavy	Paracytic	Szp	+	-	-	-	+	-	-
M. flabelliformis	+	+	Rectangular	Wavy	Paracytic	Szp	+	-	-	-	+	+	-
R. corymbosa	+	+	Rectangular	Wavy	Paracytic	Szp	-	-	-	+	-	-	-

+ Present, R-H – Rectangular to Hexagonal, Bzp - Big size papillae, Szp – Small size papillae,
- Absent, PHE – Prickle hair at the edge/margin, PHI -Prickle hair on intercoastal zone, PHC - Prickle hair on coastal zone.

Table 3. Summary of Qualitative Foliar Epidermal Characters (Adaxial surface) of the Species of the Family Cyperaceae Studied.

Species	Long cells	Short cells	Cell shape	Anticlinal wall	Stomata type	Papillae	Prickle hair	Idioblast cells	Prismatic crystals	Contiguous stomata	PHE	PHI	PHC
C. compressus	+	+	Rectangular	Wavy	Paracytic	Szp	-	-	-	-	-	-	-
C. dilatatus	+	+	Polygonal (MR-H)	Wavy-Sinuous	Paracytic	Szp	-	-	-	+	-	-	-
C. imbricatus	+	+	Rectangular	Straight–Wavy	Paracytic	-	+	-	+	-	+	+	+
C. distans	+	+	Polygonal (MR-H)	Undulating-Sinuous	Paracytic	Szp	+	-	+	-	+	-	+
C. difformis	+	+	Polygonal (MR-H)	Undulating-Sinuous	Paracytic	Szp	+	-	-	-	+	-	+
C. haspan	+	+	Polygonal (MR-H)	Straight	Paracytic	-	-	-	-	-	-	-	-
K. erecta	+	+	Polygonal (MR-H)	Wavy	Paracytic	Szp	+	+	-	-	+	-	-
K. pumila	+	+	Polygonal (MR-H)	Wavy	Paracytic	Szp	+	+	-	-	+	-	-
K. nemoralis	+	+	Polygonal (MR-H)	Wavy	Paracytic	-	-	-	-	-	+	+	-
M. alternifolius	+	+	Polygonal (MR-H)	Straight–Wavy	Paracytic	-	+	-	-	+	+	+	-
M. flabelliformis	+	+	Polygonal (MR-H)	Straight–Wavy	Paracytic	Szp	+	-	-	-	+	+	+
R. corymbosa	+	+	Polygonal (MR-H)	Wavy	Paracytic	-	-	-	-	-	-	-	-

+ Present, MR-H – Mostly Rectangular to Hexagonal, Szp – Small size papillae,
- Absent, PHE – Prickle hair at the edge/margin, PHI -Prickle hair on intercoastal zone, PHC - Prickle hair on coastal zone.

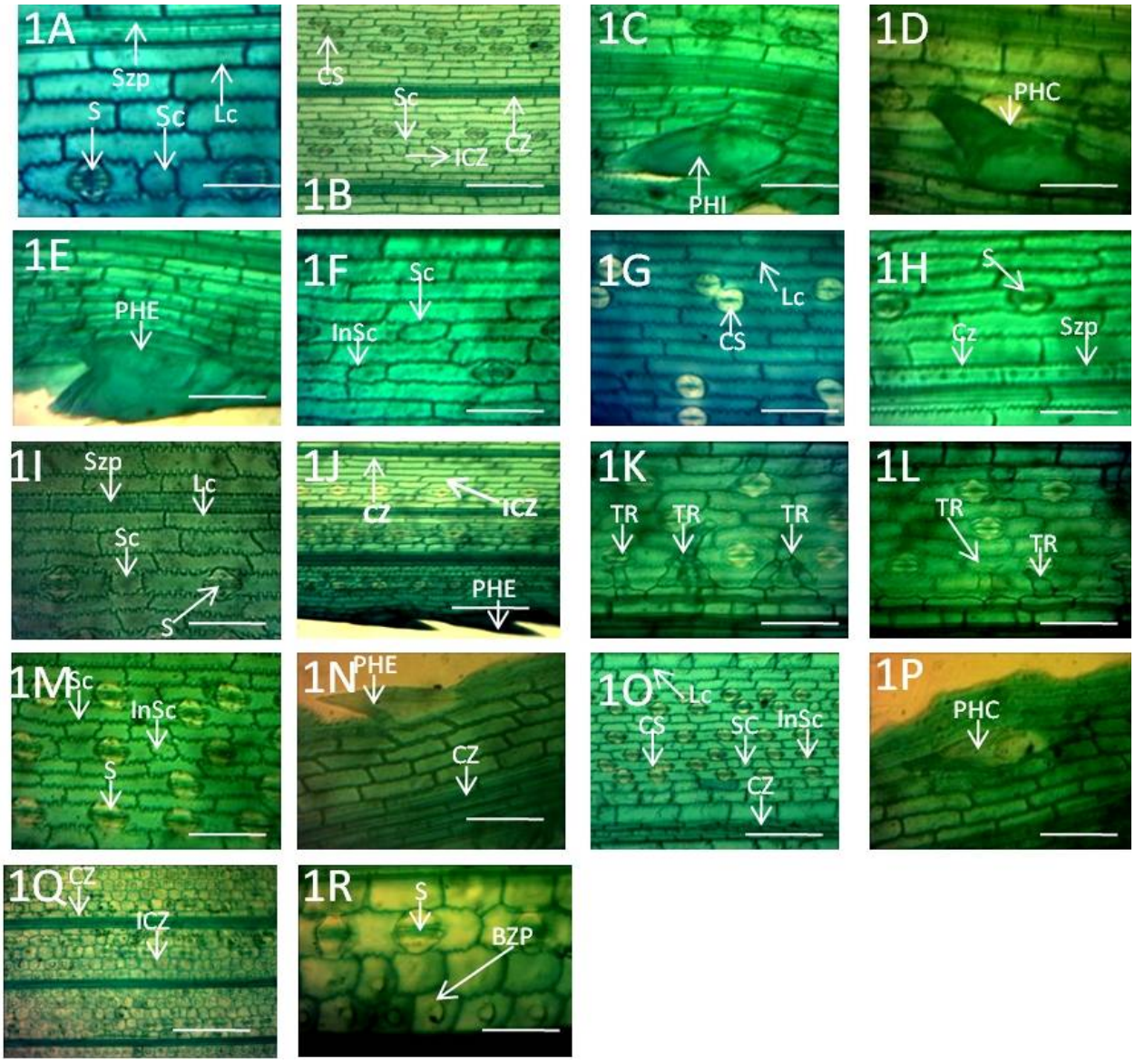

Plate 1. Abaxial surfaces of the *Cyperaceae* species studied (PLATES: A – *Cyperus compressus* Linn., B-E – *Cyperus imbricatus* Linn., F-H – *Cyperus dilatatus* Schum. & Thonn., I-L – *Cyperus distans* Linn. (F.) Retz**.**, M-P – *Cyperus difformis* Linn., Q-R – *Cyperus haspan* Linn.)**.**
Legends: S – Stomata, CS – Contiguous stomata, InSc – Interstomatal cell, Sc – Short cell, Lc – Long cell, Szp – Small size circular papillae, BZP – Big size circular papillae, IDB – Idioblast, CZ – Coastal zone, ICZ – Intercoastal zone, TR – Trichome, PHE – Prickle hair at the edge, PHC – Prickle hair on the coastal zone, PHI – Prickle hair on the intercoastal zone.
Magnification: X400: Plate 1 A, C, D, E, F, G, H, K, L, N, P, R; X100: Plate 1 B, I, M, O; X40: Plate 1 J, Q.

Table 4. Species grouping from Duncan's Multiple Range Test based on Leaf Epidermal Characters on Adaxial Surface (Means with the same letter are not significantly different).

	Long cells			Short cells			Long cells			Short cells			Stomata			Interstomatal cells		
	L (µm)	B (µm)	A (µm)	L (µm)	B (µm)	A (µm)	L (µm)	B (µm)	A (µm)	L (µm)	B (µm)	A (µm)	L (µm)	B (µm)	A (µm)	L (µm)	B (µm)	A (µm)
C. compressus	15.4^{e}	111.3^{a}	0.1718^{ef}	0^{g}	0^{d}	0^{d}	42.9^{b}	149.7^{b}	0.6391^{b}	15.0^{f}	30.1^{g}	0.0454^{f}	24.8^{a}	30.5^{d}	0.0757^{b}	13.8^{ef}	70.5^{bcd}	0.098^{cde}
C. dilatatus	14.4^{e}	107.6^{a}	0.1556^{f}	10232^{c}	54.3^{a}	58.79^{c}	35.6^{c}	118.4^{cd}	0.4243^{c}	14.7^{f}	37.4^{f}	0.0542^{f}	13.9^{g}	16.8^{g}	0.023375^{g}	$12.7f^{g}$	61.8^{d}	0.0789^{ef}
C. imbricatus	19.8^{d}	84.8^{c}	0.1664^{ef}	12756^{de}	41.1^{e}	53.41^{c}	10.0^{h}	110.1^{de}	0.1101^{h}	0^{g}	0^{h}	0^{g}	17.8^{ef}	32.6^{c}	0.058675^{d}	11.5^{g}	101.6^{a}	0.1181^{bc}
C. distans	16.1^{e}	89.0^{c}	0.1429^{f}	10188^{e}	47.5^{cd}	53.79^{c}	23.9^{e}	88.4^{f}	0.212^{fg}	19.4^{e}	46.8^{e}	0.0927^{e}	16.6^{f}	27.1^{e}	0.044825^{e}	13.6^{ef}	44.1^{e}	0.0598^{f}
C. difformis	10.4^{f}	87.2^{c}	0.0900^{g}	49880^{f}	23.3^{f}	11.95^{d}	14.5^{g}	98.5^{ef}	0.1431^{gh}	13.8^{f}	35.9^{f}	0.0495^{f}	19.6^{cd}	37.8^{b}	0.074075^{b}	14.4^{e}	63.1^{cd}	0.0870^{e}
C. haspan	30.8^{a}	105.7^{a}	0.3263^{a}	25476^{a}	52.2^{ab}	38.91^{e}	33.7^{c}	99.8^{ef}	0.3412^{d}	29.9^{c}	52.0^{d}	0.1581^{d}	14.2^{g}	25.0^{f}	0.035575^{f}	26.6^{a}	64.8^{bcd}	0.1763^{a}
K. erecta	21.0^{d}	104.5^{a}	0.2286^{bcd}	14052^{d}	47.0^{cd}	70.39^{bc}	20.7^{ef}	114.1^{d}	0.2356^{ef}	23.1^{de}	39.3^{f}	0.0921^{c}	22.0^{b}	41.3^{a}	0.091175^{a}	16.9^{c}	78.1^{b}	0.1273^{b}
K. pumila	25.6^{b}	85.8^{c}	0.2161^{cd}	18624^{c}	44.1^{de}	83.53^{b}	37.9^{c}	108.4^{de}	0.4107^{c}	31.8^{c}	47.7^{de}	0.1528^{d}	18.8^{de}	32.1^{cd}	0.066775^{c}	16.8^{c}	69.6^{bcd}	0.1169^{bc}
K. nemoralis	22.1^{cd}	90.1^{bc}	0.1988^{de}	18492^{c}	46.9^{cd}	88.22^{b}	29.4^{d}	95.2^{f}	0.2857^{de}	42.3^{b}	49.3^{de}	0.2108^{c}	20.8^{bc}	27.8^{e}	0.52475^{d}	16.1^{cd}	57.9^{d}	0.0925^{de}
M. alternifolius	26.1^{b}	92.3^{c}	0.2477^{bc}	22512^{b}	51.4^{abc}	124.74^{a}	13.5^{gh}	98.3^{ef}	0.1326^{h}	45.7^{b}	65.4^{b}	0.3014^{b}	21.6^{b}	26.4^{ef}	0.05765^{d}	15.0^{de}	75.6^{bc}	0.1144^{bcd}
M. flabelliformis	24.5^{bc}	101.6^{ab}	0.2617^{b}	21908^{b}	53.7^{a}	119.22^{a}	16.7^{fg}	126.9^{c}	0.2131^{fg}	25.5^{d}	56.9^{c}	0.1461^{d}	22.0^{b}	30.5^{d}	0.67175^{c}	18.5^{b}	66.3^{bcd}	0.1235^{b}
R. corymbosa	0^{g}	0^{d}	0^{h}	0^{g}	0^{g}	0^{d}	172.2^{a}	57.8^{a}	0.9933^{a}	69.5^{a}	98.5^{a}	0.5385^{a}	0^{h}	0^{h}	0^{h}	0^{h}	0^{f}	0^{g}

KEY: L = Length, B = Breadth, A = Area

Table 5. Species grouping from Duncan's Multiple Range Test based on Leaf Epidermal Characters on Abaxial Surface (Means with the same letter are not significantly different).

Species	Coastal Zone Adaxial																Intercoastal Zone Adaxial						
	Long cells			Short cells			Long cells			Short cells			Stomata		Interstomatal cells		Idioblast cells						
	L (µm)	B (µm)	A (µm)	L (µm)	B (µm)	A (µm)	L (µm)	B (µm)	A (µm)	L (µm)	B (µm)	A (µm)	L (µm)	B (µm)	A (µm)	L (µm)	B (µm)	A (µm)	L (µm)	B (µm)	A (µm)	
C. compressus	15.7^{def}	135.6^{a}	0.21^{bc}	14.20^{fg}	39.1^{cd}	0.056^{cde}	24.7^{c}	145.1^{a}	0.35^{b}	24.7^{c}	54.6^{a}	0.135^{b}	39.7^{a}	39.20^{ab}	0.155^{a}	28.50^{b}	108.4^{a}	0.30^{a}	0^{c}	0^{c}	0^{b}		
C. dilatatus	19.2^{b}	124.3^{b}	0.24^{a}	11.50^{h}	52.1^{a}	0.060^{cd}	18.6^{e}	124.0^{b}	0.21^{d}	18.6^{e}	40.2^{bcd}	0.073^{d}	24.9^{e}	34.20^{c}	0.085^{ef}	17.80^{gh}	82.5^{b}	0.14^{c}	0^{c}	0^{c}	0^{b}		
C. imbricatus	15.8^{de}	121.1^{b}	0.19^{c}	13.40^{g}	46.8^{b}	0.063^{bc}	13.2^{g}	126.4^{b}	0.16^{f}	13.2^{g}	32.9^{e}	0.043^{fg}	20.7^{e}	37.90^{b}	0.078^{f}	19.10^{fg}	46.0^{e}	0.08^{f}	0^{c}	0^{c}	0^{b}		
C. distans	14.0^{fg}	84.2^{d}	0.11^{fg}	14.89^{efg}	48.1^{ab}	0.072^{b}	12.9^{g}	94.7^{d}	0.12^{g}	12.9^{g}	32.2^{e}	0.041^{g}	21.6^{f}	30.10^{e}	0.065^{g}	18.50^{fgh}	49.0^{de}	0.09^{ef}	0^{c}	0^{c}	0^{b}		
C. difformi	20.5^{b}	67.2^{e}	0.13^{def}	17.10^{c}	33.3^{e}	0.056^{cde}	19.6^{e}	94.7^{d}	0.18^{ef}	19.6^{e}	34.5^{de}	0.067^{de}	28.2^{cd}	31.80^{de}	0.089^{e}	17.10^{hi}	41.6^{e}	0.06^{f}	0^{c}	0^{c}	0^{b}		
C. haspan	13.9^{g}	70.1^{e}	0.09^{g}	$14.40e^{fg}$	35.8^{de}	0.051^{de}	37.7^{a}	96.4^{d}	0.36^{b}	37.7^{a}	44.0^{b}	0.166^{a}	33.1^{b}	38.70^{ab}	0.128^{b}	40.10^{a}	54.8^{cde}	0.21^{b}	0^{c}	0^{c}	0^{b}		
K. erecta	19.7^{b}	100.3^{c}	0.19^{c}	15.60^{def}	39.1^{cd}	0.061^{bcde}	26.0^{c}	111.0^{c}	0.28^{c}	26.0^{c}	37.3^{cde}	0.0967^{c}	29.0^{c}	40.40^{a}	0.116^{c}	19.60^{efg}	64.4^{cd}	0.12^{cde}	138^{a}	35.7^{b}	52.00^{a}		
K. pumila	16.9^{cd}	94.0^{c}	0.15^{d}	15.70^{de}	41.4^{c}	0.065^{bc}	22.6^{d}	92.8^{d}	0.20^{de}	22.6^{d}	24.6^{f}	0.055^{efg}	28.9^{c}	35.20^{c}	0.101^{d}	25.90^{c}	69.2^{bc}	0.18^{b}	111^{b}	44.0^{a}	54.56^{a}		
K. nemoralis	17.5^{c}	83.2^{d}	0.14^{de}	16.90^{cd}	36.9^{cde}	0.062^{bcd}	19.2^{e}	77.4^{e}	0.14^{fg}	19.2^{e}	31.9^{e}	0.060^{def}	24.9^{e}	33.40^{cd}	0.083^{ef}	21.40^{e}	64.2^{cd}	0.13^{cd}	0^{c}	0^{c}	0^{b}		
M. alternifolius	14.6^{efg}	84.5^{d}	0.12^{ef}	13.80^{g}	36.6^{cde}	0.050^{e}	15.6^{f}	96.1^{d}	0.14^{fg}	15.6^{f}	34.4^{de}	0.053^{efg}	21.4^{f}	26.10^{f}	0.0561^{g}	15.50^{i}	49.1^{de}	0.07^{f}	0^{c}	0^{c}	0^{b}		
M. flabelliformis	14.6^{efg}	102.3^{c}	0.14^{d}	24.50^{b}	47.7^{ab}	0.115^{a}	20.2^{e}	112.1^{c}	0.22^{d}	20.2^{e}	31.9^{e}	0.064^{de}	26.4^{de}	31.70^{de}	0.083^{ef}	20.30^{ef}	50.4^{de}	0.10^{de}	0^{c}	0^{c}	0^{b}		
R. corymbosa	32.7^{a}	67.9^{e}	0.22^{ab}	31.9^{a}	35.7^{de}	0.114^{a}	33.2^{b}	151.0^{a}	0.50^{a}	33.2^{b}	42.7^{bc}	0.139^{b}	26.1^{de}	34.90^{c}	0.091^{e}	23.30^{d}	52.5^{de}	0.12^{cde}	0^{c}	0^{c}	0^{b}		

KEY: L = Length, B = Breadth, A = Area

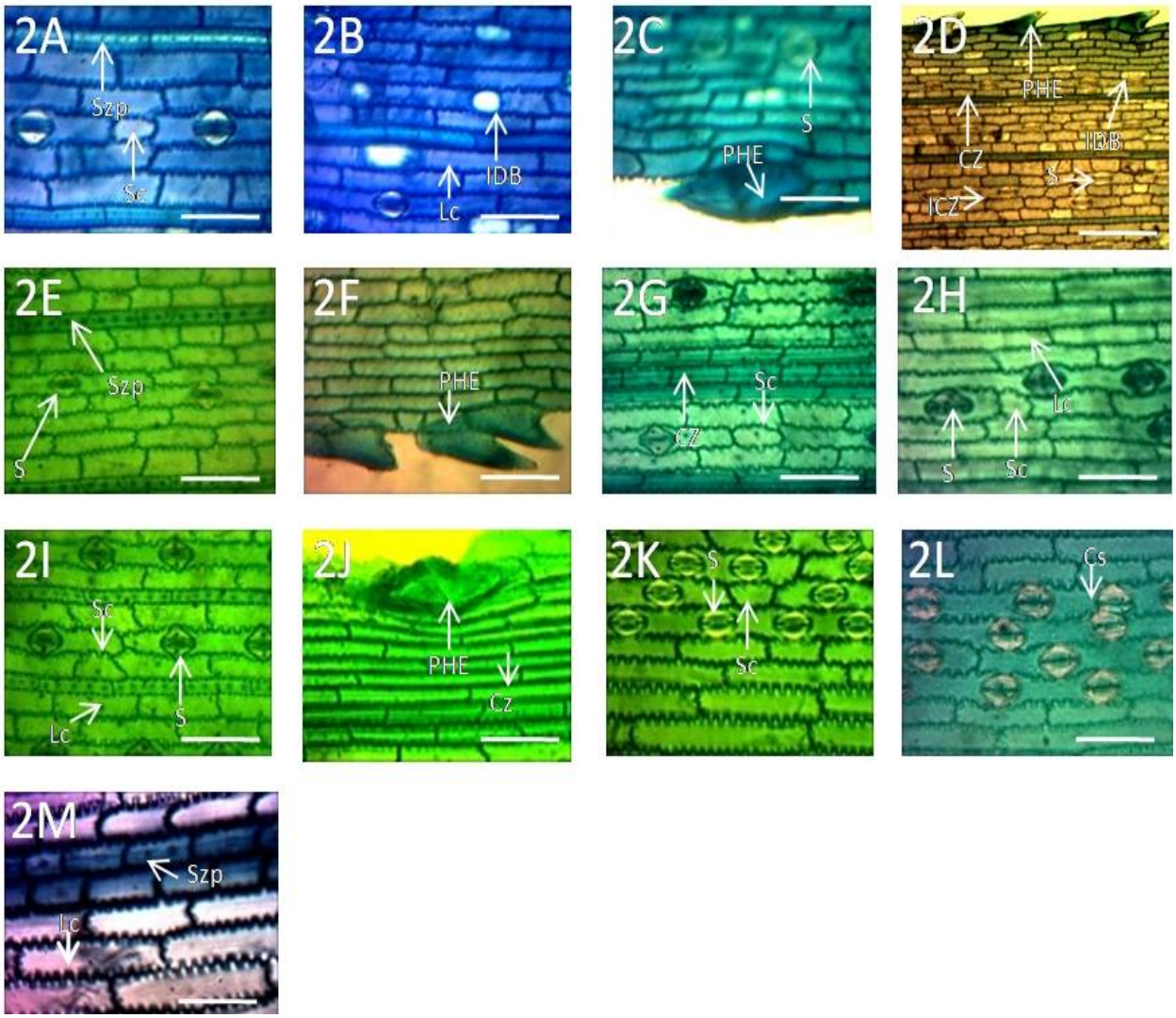

Plate 2. Abaxial surfaces of the *Cyperaceae* species studied (PLATES: A-C – *Kyllinga erecta* Schumacher., D – *Kyllinga pumila* Michx., E-F – *Kyllinga nemoralis* (Forst.) Dandy ex Hutch., G-H – *Mariscus alternifolius* Vahl., I-J – *Mariscus flabelliformis* Kunth., K-M – *Rhynchospora corymbosa* (Linn.) Britton).

Legends: S – Stomata, CS – Contiguous stomata, InSc – Interstomatal cell, Sc – Short cell, Lc – Long cell, Szp – Small size circular papillae, Bzp – Big size circular papillae, IDB – Idioblast, Cz – Coastal zone, ICZ – Intercoastal zone, PHE – Prickle hair at the edge, PHC – Prickle hair on the coastal zone, PHI – Prickle hair on the intercoastal zone.

Magnification: X400: Plate 2 A, B, C, E, F, G, H, I, J, K, L, M; X100: Plate 2D.

Plate 3. Adaxial surfaces of the *Cyperaceae* species studied (**PLATES:** A – *Cyperus compressus* Linn., B-E – *Cyperus imbricatus* Linn., F-H – *Cyperus dilatatus* Schum. & Thonn., I-M – *Cyperus distans* Linn. (F.) Retz**.**, N-P – *Cyperus difformis* Linn., Q-S – *Cyperus haspan* Linn., T - *Kyllinga erecta* Schumacher).
Legends: S – Stomata, CS – Contiguous stomata, InSc – Interstomatal cell, Sc - Short cell, Lc – Long cell, Szp – Small size circular papillae, Bzp – Big size circular papillae, IDB – Idioblast, Cz – Coastal zone, ICZ – Intercoastal zone, PC – Prismatic Crystal, PHE – Prickle hair at the edge, PHC – Prickle hair on the coastal zone, PHI – Prickle hair on the intercoastal zone.
Magnification: X400: Plate 3 B, C, D, E, F, G, J, K, L, M, O, P, Q, S, T; X100: Plate 3 A, H, I, N; X40: 3 R.

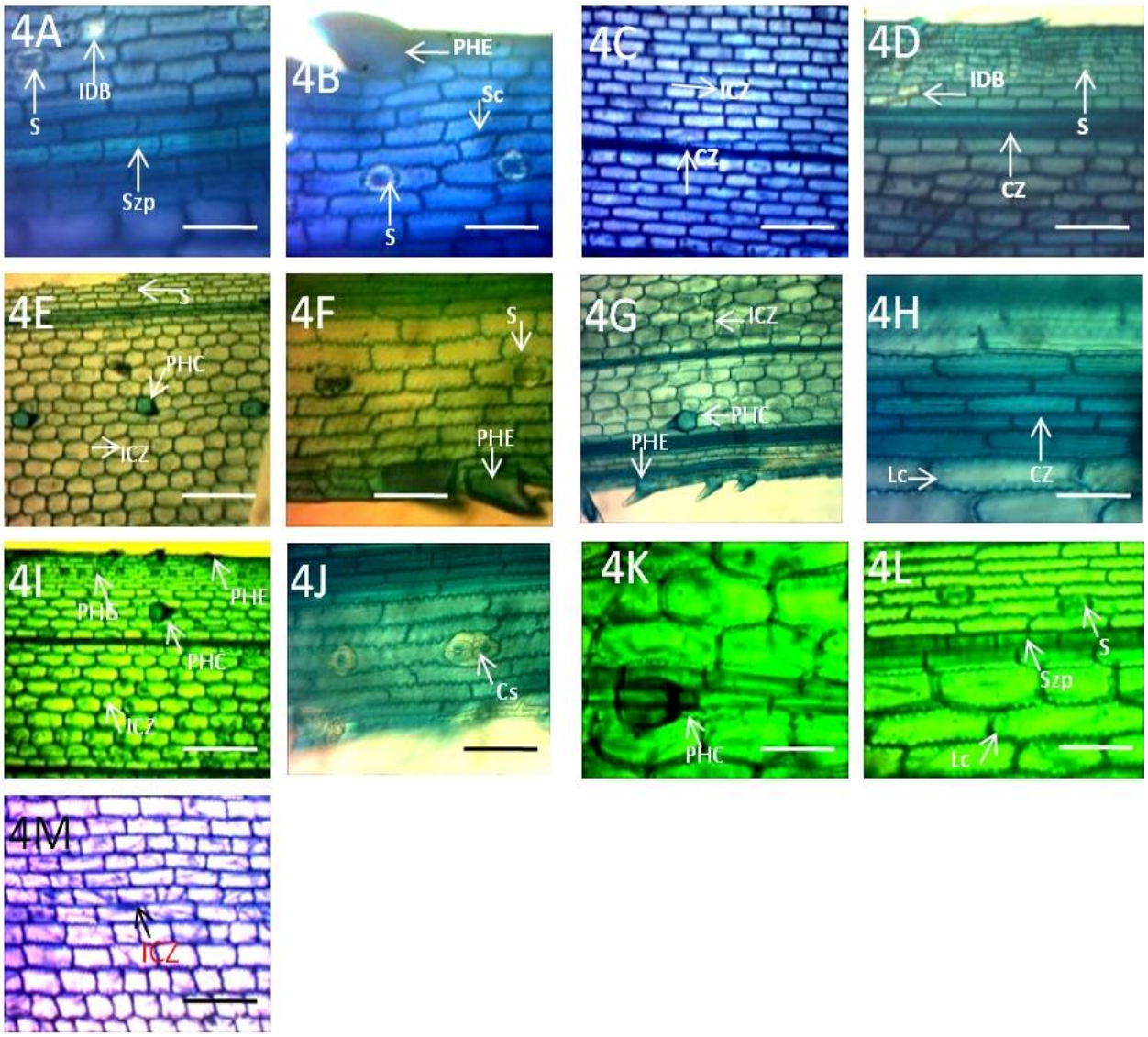

Plate 4. Adaxial surfaces of the *Cyperaceae* species studied (PLATES: A-B – *Kyllinga erecta* Schumacher., C-D –*Kyllinga pumila* Michx., E-F – *Kyllinga nemoralis* (Forst.) Dandy ex Hutch., G-H and J – *Mariscus alternifolius* Vahl., I and K-L –*Mariscus flabelliformis* Kunth., M – *Rhynchospora corymbosa* (Linn.) Britton).
Legends: S – Stomata, CS – Contiguous stomata, InSc – Interstomatal cell, Sc – Short cell, Lc – Long cell, Szp – Small size circular papillae, Bzp – Big size circular papillae, IDB – Idioblast, Cz – Coastal zone, ICZ – Intercoastal zone, PHE – Prickle hair at the edge, PHC – Prickle hair on the coastal zone, PHI – Prickle hair on the intercoastal zone.
Magnification: X400: Plate 4 A, B, D, E, F, H, J, K, L, M; X100: Plate 4 C, G, I.

4. Discussion

4.1 Foliar Leaf Epidermal Study

Foliar anatomically, the twelve species from the family Cyperaceae studied show remarkable differences and similarities among them. Metcalfe (1954) pointed out that certain characters of the epidermis such as shape of the subsidiary cells of the stomata, micro hairs, trichomes, and prickles are important systematically and these have been studied in this work.

The intercoastal zones show variations in the distribution of the features between the two (abaxial and adaxial) surfaces. Islam *et al.*, (2009) reported long and short cells, stomata with guard cells, prickle hair, papillae etc. on epidermal surfaces of the leaves of some *Oryza* species. In this work, the long epidermal cells show size variations in all the species studied. The epidermal cells are polygonal ranging from rectangular to hexagonal but are mostly rectangular. This support the findings of Ahmad *et al.*, (2010); Zafar *et al.*, (2011) on their work on *C. difformis* where they reported the type of epidermal cells to be mostly tetragonal with pentagonal and hexagonal cells also present, with wavy walls. The short cells are mostly solitary in all the species studied except on the abaxial surface of *C. difformis* and *R. corymbosa* where they are occasionally paired. This disagrees with the findings of Zafar *et al.*, (2011) where they reported the presence of short cells on the abaxial surface to be single or solitary only.

Papillae are protrusions of various shapes and sizes from the outer walls of the epidermis (Islam *et al*., 2009). Small sized circular papillae are present on the coastal zones of all the species studied except in *C. haspan* where big/conspicuous sized circular papillae are found on the intercoastal zone and this is the only species in which such occurred and it is a distinguishing character for delimiting the species from the others. Islam *et al.*, (2009) and Nwokeocha (1996) also reported the occurrence/presence of papillae on both abaxial and adaxial surface of *Oryza sativa* and *Oryza punctata* leaves respectively.

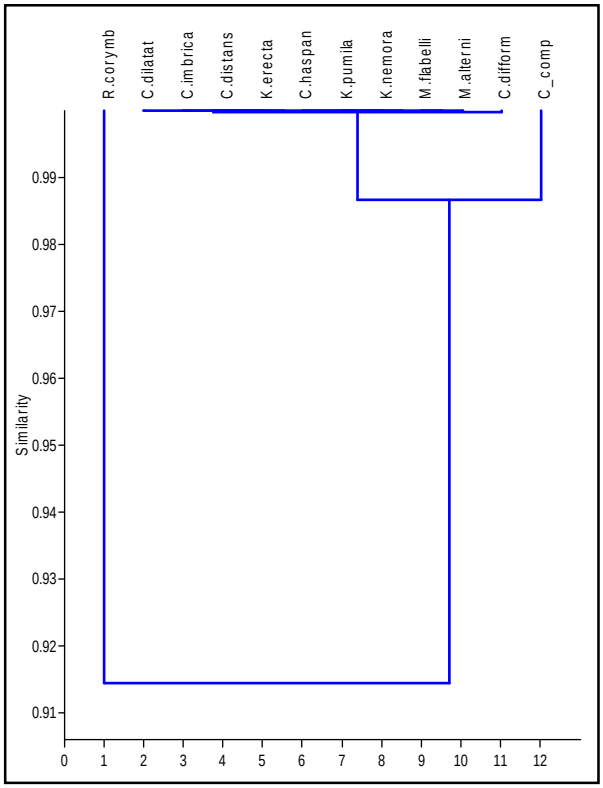

Fig. 1. Single Linkage Cluster Analysis of the Cyperaceae species studied using the quantitative anatomical characters.

The type, size, and shape of stomata are important taxonomically (Thair and Rajput, 2009). Paracytic stomata type (guard cells surrounded by two subsidiary cells) is present in all the species studied. Parveen *et al*., (2007) also reported the occurrence of paracytic stomata on both abaxial and adaxial surfaces of some monocots. All the species are amphistomatic except in *R. corymbosa* which is hypostomatic. The subsidiary cells are mostly triangular in shape, but often low dome too. This is in close agreement with the work of Islam *et al.*, (2009) on Rice leaf and Zafar *et al*., (2011) on *C. difformis* where they reported the subsidiary cells to be triangular to the low dome and low dome in shape respectively. *R. corymbosa* is unique in having the highest number of bands of stomata i.e. 5 bands occurring after a big coastal zone and 1-5 rows of stomata per band and *C. compressus* has the biggest stomata size on the abaxial surface and *C. haspan* on the adaxial surface as seen from the Duncan Multiple Range Test. The occurrence of bigger stomata will certainly lead to evapotranspiration in this species. The increase in evapotranspiration will make this species poorly adapted to an ecological regime where there are more insolation, diminished rainfall and longer dry seasons. This supports the findings of Adedeji and Faluyi (2006) on some accessions of *Panicum maximum* in South Western Nigeria. Stomata are restricted to the terminal intercoastal zone on the adaxial epidermal surfaces. Contiguous stomata are observed in *C. dilatatus*, *C. difformis*, *M. alternifolius* and *R. corymbosa* and are absent in other species. This can be suggested to be a diagnostic feature separating these species from the others.

Prickle hair has been used as a diagnostic feature by scientists such as Islam *et al*., (2009) on their work on epidermal features of rice leaf. Adedeji and Faluyi (2006) also reported the presence and absence of prickle hair in their work on some accessions of *Panicum maximum* in South Western Nigeria; Nwokeocha (1996) also reported the occurrence of prickle hair in her study on foliar epidermal studies in *Oryza punctata*. Prickle hair is present in all the species studied except in *C. compressus*, *C. dilatatus*, *C. haspan* and *R. corymbosa* where they are absent. Prickle hair is absent on the coastal zone of the abaxial surfaces except in *C. imbricatus* and *M. flabelliformis* where it is present. It is present in the coastal zone of the adaxial surfaces and intercoastal zones of both surfaces at different frequencies in all the species studied except in the species where they are absent. The prickle hairs on the leaf margin/edge are distributed more or less equidistantly in the work of Islam *et al*., (2009) on a rice leaf. This is in agreement with this study, as the prickle hairs at the edge/margin are often distributed at equal distance to each other.

Metcalfe and Chalk (1950) stated that crystals in the form of small needles or prisms are widely distributed in the parenchymatous tissues of both leaf axis of the family Verbenaceae and is diagnostic for this family. Prismatic crystals which are scattered are found on the adaxial surfaces of *C. imbricatus* and *C. distans.* This has not been reported before on any work on the family Cyperaceae. The presence of prismatic crystals in these two species is a diagnostic feature in delimiting these two species from the other species of the family Cyperaceae studied.

Idioblast of different sizes and shapes are present in the *Kyllinga* species studied except in *K. nemoralis.* This feature is more abundant in *K. pumila* than in *K. erecta* but is not significantly different in the area as seen from Duncan Multiple Range Test values. The presence of idioblasts in the genus *Kyllinga* is quite diagnostic for the genus as it is absent in the other genera studied.

Adedeji *et al.*, (2007) reported the importance of trichome types in the different organs of the plant body in the delimitation of genera and species within family

Solanaceae. Ramayya & Rao (1976) and Rao & Ramayya (1977) have also emphasized the taxonomic importance of trichomes. In this study, tripod-shaped, three – armed, T-shaped and tricellular non-glandular trichomes are present on the abaxial surface of *C. distans.* Presence of trichomes occurred only in this species and it is also a diagnostic feature that separates it from the other species studied. Quantitative data on the leaf epidermal characters on the adaxial surface revealed that *C. haspan* has the highest length, breadth, and area of long cells on the coastal zone which makes it significantly different from the other species while *R. corymbosa* has the lowest values. Also, on the intercoastal zone, *R. corymbosa* has the highest values in the length, breadth, and area of long and short cells while *C. imbricatus* has the lowest value. Therefore, the epidermal long and short cells on the coastal and intercoastal zones can be used to separate the species studied. *C. haspan* has the highest value in length and area of inter stomata cells on the adaxial surface which may be because of the paucity of stomata on this surface while *C. imbricatus* has the highest value in breadth. Quantitative data on leaf epidermal characters on abaxial surface reveals that on the intercoastal zone, *R. corymbosa* has the highest significant value in breadth and area of long cells while *C. compressus* has the longest length; *C. distans* has the least significant values in length and area of long cells and *K. nemoralis* has the least value in breadth of long cells. In short cells, *C. haspan* has the highest value in length and area; *C. compressus* has the highest value in the breadth of short cells while *C. distans* has the lowest value in length and area, *K. nemoralis* has the lowest value in the breadth of short cells. Also, *C. compressus* has the most significant value in length and area of stomata cell size, *K. erecta* has the highest value in breadth while *C. distans* has the lowest value in length and area and *M. alternifolius* has the lowest value in the breadth of stomata cell size. For inter stomata cells, *C. compressus* has the highest value in breadth and area; *C. haspan* has the highest value in length of inter stomata cells. *K. erecta* and *K. pumila* only have idioblast cells, which are significantly different in length and breadth, but not in the area.

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