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Anatomy Of The Grass Tribe *Isachneae* (Fam. Poaceae) And Its Taxonomic Significance-I

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Abaxial and adaxial leaf epidermis of three species and one variety of *Coelachne* and one species each of *Limnopoa* and *Sphaerocaryum* and 17 species of *Isachne* have been studied. The study included the anatomy of leaf of 2 species and one variety of *Coelachne*, one species each of *Limnopoa* and *Sphaerocaryum* and 14 species of *Isachne*, and anatomy of culm of one species of *Sphaerocaryum* and 5 species of *Isachne*. The anatomy of most of the species was studied for the first time; particularly, the adaxial epidermis of none of these texa had been studied earlier.

Structure of leaf-epidermis and anatomical features of leaves, stems and roots are helpful in the systematics of highly specialised family Poaceae (Gramineae). The importance of leaf anatomy in classification was first shown by Duval-Jouve (1875) who noted differences in the distribution of bulliform cells in different tribes. Avdulov (1931) recognised two basic types of leaf anatomy. Prat (1932, 1936) pointed out the importance of leaf epidermis in taxonomy; it correlated well with data on internal anatomy (Avdulov 1931). Prat called Avdulov's sub-divisions as 'Festucoid' and 'Panicoid'. Brown (1958) studied leaf anatomy of 101 species in 72 genera and recognised six groups; 'Bambusoid', 'Festucoid' 'Arundoid', 'Panicoid', 'Aristidoid', and 'Chloridoid'. Tateoka *et al* (1959) surveyed leaf-epidermis of 238 species and found taxonomic significance of bicellular micro-hairs.

Metcalfe (1960) synthesized characters of leaf-epidermis and internal anatomy of 413 species representing 206 genera. Other authors discussed the significance of leaf anatomy in grass systematics (Soderstrom, 1967; Soenarko, 1977; Davidse, 1978).

Potztal (1952) made comparative study in the genera of *Isachneae*. She studies 23 species of *Isachne*, 4 of *Coelachne* and one each of *Limnopoa*, *Sphaerocaryum* and *Heteranthoecia*. According to her, the characteristic T.S. of leaves showed striking similarity; they have in common, uniform distribution of chlorophyll throughout the mesophyll (chlorenchyma), tending to be arranged radiately around the vascular bundles (Chlorenchyma irregular in some species) and outer bundle sheath (parenchymatous) which is more or less developed and does not contain chloroplasts. She also noted the characteristics of silica cells and bicellular hairs of epidermal structures. However, the characters recorded by her do not, in some cases, entirely agree with those noted by us; these are discussed later.

Tateoka (1957) studied the anatomical structure of *Coelachne japonica* Hack.and correlated it with *sphaerocaryum malaccense* (Trin.) Pilger.

Metcalfe (1960) examined the leaf anatomy and epidermis of three species each of *Isachne* and *Coelachne* and one species each of *sphaerocaryum* and *Heteranthoecia*. He stated

that the anatomical and epidermal structure of leaves of these genera and *Limnopoa* is Panicoid but as a rather special type, and he recognised *Isachneae* sub-type as sub-division of Panicoid group. He recorded that the rectangular, often acute-angled silica bodies, almost cubical inter-costal long cells of epidermis, and narrow elongated radiate and somewhat spongy assimilatory cells of mesophyll are very characteristic of the genera of *Isachneae* and stand out from other Panicoid grasses. The present study also supports this view of Metcalfe.

The epidermis and anatomy of leaf and culm in the genera *Coelachne*, *Limnopoa* and *Sphaerocaryum* are dealt in this part.

MATERIALS & METHODS The material was taken from midle portion of mature leaves of both fresh and usually unmounted herbarium specimens. The specimens of most of the species were collected by the authors and preserved in F.A.A. In the case of herbarium specimens, the dried leaves free from cracks and abrasions were boiled in water to soften the tissues, until the leaf has been restored, as much as possible to its original shape. It was suspended in F.A.A.

For the preparation of epidermal peels of abaxial surface, the leaf blade was placed with the abaxial surface down on a clean glass slide. With the aid of a 10 X binocular microscope, the sub-epidermal tissues of the leaf were gently removed with a razor-blade leaving only the epidermis. The same process was adopted for adaxial surface. The epidermal peelings were stained with 1% aqueous solution of safranin and mounted in 50% glycerin.

For the study of cross-section of leaves free hand sections were cut, and observations made from temporary preparations. Line drawings were made with the help of camera lucida.

OBSERVATIONS *COELACHNE* R. Br

1. **Leaf-Epidermis** - The epidermis of 3 species and one variety of *Coelachne* viz. *C.simpliciuscula*, *C. minuta*, *C. perpusilla* and *C. perpusilla* var. *nilagirica* was studied.

The intercostal zones comprise of only long cells. The cells are almost squarish or hexagonal to polygonal and with thin non-sinuous walls in abaxial surface of all the above taxa except *C. perpusilla* where the cells are narrow, and horizontally elongated with slightly sinuous or non-sinuous walls in both abaxial and adaxial surfaces. The shapes and size of long cells on the adaxial and abaxial surfaces are different in *C. simpliciuscula, C.minuta and C. perpusilla* var. *nilagirica*. In these taxa, long cells on the adaxial surface are narrow, horizontally elongated with slightly sinuous or non-sinuous walls.

The short cells in the costal zones are arranged in regular rows with alternating silica and cork cells. Silica bodies are mostly cross-shaped or cubical and acute angled. The arrangement of the short cells is similar in both surfaces.

Stomata occur in one or two rows among the long cells mainly in abaxial surface. The shape of the subsidiary cells is triangular to low dome-shaped.

Microhairs, which normally consist of two cells and hence referred as 'bicellular hairs', are multicellular to unicellular in the genus *Coelachne*. Potztal (1952) reported multicellular microhairs in *C. africana*. Tateoka (1957) noted club-shaped bicellular microhairs in *C. japonica*, whose lower cell is sunken among the epidermal cells and apical cell is swollen and rounded at apex. Metcalfe (1960) examined unicellular microhairs along with bicellular hairs in *C. simpliciuscula*. In the present study, bicellular microhairs were found in *C. perpusilla*; no microhairs could be seen in *C. simpliciuscula*, *C. minuta* and *C. perpusilla* var. *nilagirica*. This range of variation in microhairs is quite remarkable in this genus.

Macrohairs which are thick walled with sunken bases are present in all the taxa studied here except in *C. simpliciuscula.*

Prickle hairs are common in *C. perpusilla and C. perpusilla* var. *nilagirica,* but are seen only occasionally in *C. simpliciuscula* and *C. minuta.*

One large, globose or oblique papilla occurs in each of the long cells of abaxial surface in all species studied here. Papillae may be present or absent in adaxial surface.

Epidermal characters of each species are shown in Figs. 1-7.

2. **Leaf-Anatomy** - The transverse sections of *C. simpliciuscula, C.minuta* and *C. perpusilla* var. *nilagirica* were examined. The description given below applies to all the species examined, unless otherwise stated.

The cells of mesophyll tissue (chlorenchyma) are long, narrow and distinctly radially arranged. The midrib is not very prominent and hence the main vascular bundle (MVB) which is of basic type, is often not conspicuous. The other vascular bundles of the blade may be distinguished as primary vascular bundles (PVBs) and secondary vascular bundles (SVBs).

The PVBs are slightly larger than SVBs, and characterized by two large metaxylem vessels on either side of the protoxylem and thus almost similar to MVB. The PVBs are separated by 2-3 SVBs. The SVBs are the smallest ones in which there are no metaxylem vessels but xylem and pholem can be recognised. All the vascular bundles are surrounded by one layered bundle sheath (OS) which does not contain ·nlasts, and is made up of thin-walked enchymatous cells. The inner bundle ... f sclerenchyma fibres is scarcely differentiated in *C. perpusilla* var.*nilagirica* (Fig. 8.).

Inside the abaxial and adaxial epidermis and above and below the vascular bundles, there are two girders of sclerenchyma fibres. Sometimes a few vascular bundles towards margin are not accompanied by sclerenchyma. In some cases, the vascular bundles are accompanied by sclerenchyma strand adaxially and sclerenchyma girder abaxially.

Bulliform cells occur in groups in furrows, but sometimes they are not so conspicuous. The cells of abaxial and/ or adaxial epidermis are with outward directed papillae resembling finger stalls. The adaxial surface has well developed tall, rounded ribs and shallow to moderately deep furrows. The width of lamina opposite the furrows is less than half the height of the ribs. Very shallow furrows are present on the abaxial surface.

LIMNOPOA C.E. Hubb.

The genus has only one species, *L. meeboldii* (Fischer) C.E. Hobb.

1. **Leaf-Epidermis** - The epidermal structure of this species closely resembles *Coelachne.* The epidermal structure of both adaxial and abaxial surface is almost similar (Fig. 10).

The intercostal zones are made up of uniform, almost squarish or hexagonal to polygonal cells (13 - 33 µm X 13 - 17 µm) and each bearing one large, globose or oblique papilla. The short cells, which occur only over the veins (costal zones) are arranged in rows, often of more than 5 cells, and with alternating silica and cork cells. The silica bodies (Fig. 12) are mostly cubical and acutely angled, and have papillae. Stomata occur in rows with low dome-shaped subsidiary cells (Fig. 13).

Bicellular microhairs (Fig. 14) are present but are not common; their basal cell (13 µm) is shorter and broader than distal cell (17 - 20 µm). Macrohairs are absent but prickle hairs are common in both costal and intercostal zones which are surrounded by 5 epidermal cells (Fig. 11).

Potztal (1952), who examined the leaf-

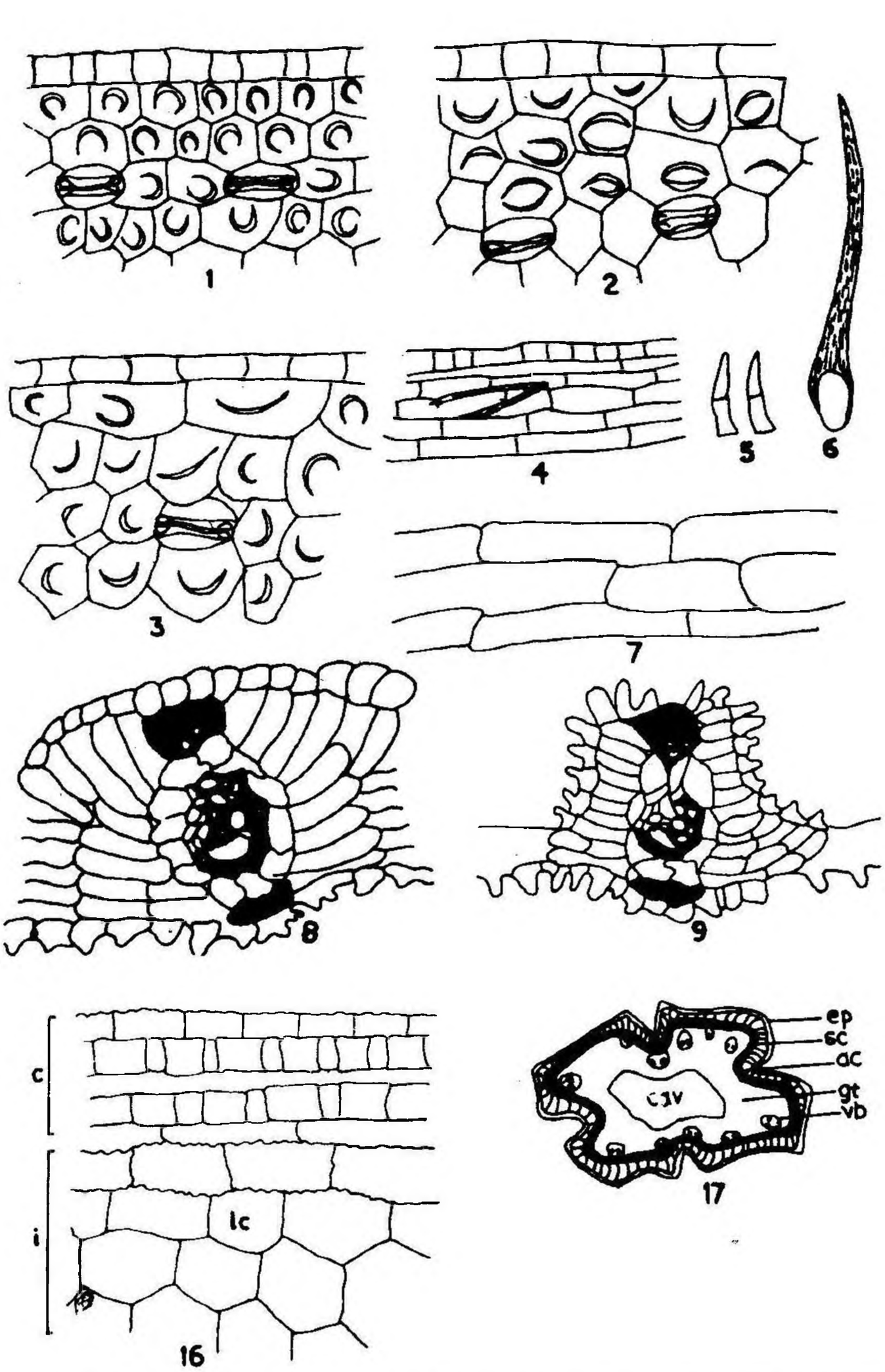

Fig. 1-17 Leaf epidermis and transverse sections of leaf-blades of *Coelachne, Limnopoa* and *Sphaerocaryum.* 1. Abaxial epidermis of *C. Simpliciuscula* in surface view. 2. Abaxial epidermis of *C. minuta* in surface view. 3. Abaxial epidermis of *C. perpusilla* var. *nilagirica* in surface view. 4. Abaxial epidermis of *C. perpusilla* var. *perpusilla* in surface view. 5. Bicellular hair of *C. perpusilla* var. *perpusilla.* 6. Macrohair of *C. perpusilla* var. *perpusilla.* 7. Adaxial epidermis of *C. perpusilla* var. *nilagirica* in surface view. 8. T.S. of blade of *C. perpusilla* var *nilagirica.* 9. T.S. of blade of *C. minuta.* 10. Adaxial epidermis of *L. meebodii* in surface view. 11. Prickle hair of *L. meeboldii.* 12. Silica cells of *L. meeboldii.* 13. Stoma of *L. meeboldii.* 14. Bicellular hair of *L. meeboldii.* 15. Abaxial epidermis of *S. malaccense* in surface view. 16. Adaxial epidermis of *S. malaccense* in surface view. 17. T.S. of culm of *S. malaccense.*

(C – Costal zone; i – intercostal zone; ac – aerenchyma; ep – epidermis; lc – long cell; sc – sclerenchyma; gt – ground tissue; vb – vascular bundle); cav – cavity).

Scale A for Fig. 1-7. B for Fig. 8,9. C for Fig. 10-16. D for Fig. 17.

epidermis of this grass, reported that the silica bodies are dumb-bell shaped and microhairs are absent. The silica bodies are cubical and microhairs are present.

Voucher specimen: Cook 1088.

2. **Leaf-Anatomy** - The cells of chlorenchyma (mesophyll) are long, narrow and mostly loosely arranged in a radiate manner. The main vascular bundle (MVB) is the largest and lies in the mid-rib. The MVB is characterised by having two metaxylem vessels and distinct phloem and xylem. The other 1-2 vascular bundle present on either side of the mid-rib, are small; the phloem is not easily distinguishable from the xylem due to small size of the cells. An outer (parenchymatous) bundle sheath surrounds all the vascular bundles; it has no chloroplasts. The inner sheath is scarcely differentiated (not well developed) in the MVB. Mostly all vascular bundles are accompanined by very small abaxial and adaxial sclerenchyma strands. The cells of abaxial and or adaxial epidermis have outward directed papillae resembling finger stalls.

The study shows that the leaf-anatomy of this species is very similar to *Coelachne*.

Voucher specimen: Cook 1088.

SPHAEROCARYUM Nees ex Hook.f

The only species *S. malaccense* (Trin.) Pilger has been studied.

1. **Leaf-Epidermis** - The leaf-epidermis shows resemblance in arrangement of cells with other genera of the tribe *Isachneae*.

The intercostal zones are made up of long cells. In abaxial surface the long cells are uniform, thin-walled, polygonal (30-46 µm X 17-30 µm) which are somewhat vertically elongated (Fig. 15). The arrangement of long cells in adaxial surface is different from that of the abaxial surface (Fig 16). In the abaxial surface, the long cells are of two types; (1) horizontal elongated cells with sinuous walls (43) 76-122 um X 13-20 µm) which are arranged in 2-4 rows on either side of the costal zones, (2) almost hexagonal cells with non-sinuous walls(40) 59-83 µm X 23-60 µm) and are arranged in middle portion of the intercostal zones.

The short cells, which occur only over the veins (costal zones), are arranged in long rows with alternating silica and cork cells. The arrangement of short cells is similar in both surfaces. The silica bodies are cross-shaped (- quadratic) and acute-angled. Bicellular microhairs could not be observed.

The prickle hairs are absent but microhairs are common in both surfaces. Papillae are present mainly in long cells of abaxial surface.

Stomata occur in rows in abaxial surface only with variable subsidiary cells (26-30 µm X 17-23 µm).

Potztal (1952) examined the bicellular microhairs in this species. The lower cell is sunken among the epidermal cells and distal cell is small and rounded at apex.

Voucher specimen: Ved Prakash 188.

2.**Leaf Anatomy** - The anatomical characteristics of this species are closely related to *Isachne* and other allied genera.

The cells of mesophyll tissue (chlorenchyma) are long, narrow and are radially arranged. There are three types of vascular bundles. The MVB is the largest, is of basic type and lies in the mid-rib of the blade. However, sometimes the MVB is not conspicuous. The PVBs are separated by 2-3 SVBs. The PVBs are devoid of vessels but xylem and phloem are distinguishable. In some cases, PVBs are almost similar to MVB. The SVBs are the smallest ones in which xylem is not distinguishable from phloem due to small size of cells. All vascular bundles are surrounded by one-layered, complete outer bundle sheath, which has no chloroplasts. Most of the vascular bundles are accompanied by abaxial and adaxial girders of sclerenchyma. Bulliform cells are arranged in

regular groups. In adaxial surface there are slight to moderate rounded ribs which are widely spaced and separated from one another by wide shallow furrows. The cells of abaxial and or adaxial epidermis have outward directed papillae resembling finger stalls.

Voucher specimen: Ved Prakash 188.

3. **Culm-Anatomy** - The culm shows aquatic character. The epidermis is subtended by a zone of large intercellular cavities, separated from one another by radiating strips of thin-walled cells. This zone is bounded on inner side by a sinuous circle of 1-celled (occasionally 2-3 celled), very thick walled, sclerenchymatous fibre. The fibre zone is followed by ground tissue consisting of 5-6 layers of large thick-walled cells, extending to the large central cavity. Outermost vascular bundles are arranged in a circle at the inner boundary of sclerenchymatous ring. Remaining vascular bundles are in 1-2 circles and embedded in the ground tissue (Fig 17)

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