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LEAF ANATOMICAL STUDIES IN SOME SPECIES OF CONVOLVULACEAE

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ABSTRACT:

The present paper reports internal structure in 12 species belonging to seven genera of Convolvulaceae. They are surveyed for various anatomical features with respect to epidermis, mesophyll and midrib region. The leaves are generally dorsiventral. The vascular tissue received in the midrib region is generally resolved into an arc. the arc is generally crescent-shaped and cup-shaped in few cases. The arcs are generally prominent and bicollateral. The vascular arc is usually capped abaxially by sclerenchymatous layers. In most of the species, it is single layered. In few cases, it is one or two layered. Sometimes, trichomes occur in some species on the epidermis.

KEY WORD: Leaf, Anatomy, Convolvulaceae.

INTRODUCTION:

On leaf anatomical characters for the family Convolvulaceae particularly of the leaf parts are available through the monumental compilations of Solereder (1908) and Metcalfe and Chalk (1950). There are few more attempts on this line covering various aspects of leaf anatomy (*cf.* Inamdar 1969, Inamdar and Patel 1971, Karatela and Gill 1985, Leela and Rao 1994, Pant 1965, Singh, Jain and Sharma 1974, Shah 1967, Tayade and Patil 2003). There are still convolvulaceous taxa worth revealing from anatomical point of view. The present authors' extended anatomical observations on twelve species of the family, there are being presented in this communication.

MATERIAL AND METHODS:

The plant materials were collected from various places like Toranmal, Amblibari, Leghapani and Kakarda of Nandurbar districts, Nakana Dam, Dhule of Dhule district, Padalsa of Jalgaon district, Silver Beach of Goa, Royal Botanic garden, Kew, England and Museum national d'Histoire naturelle, laboratoire de Phanerogamie, Paris, France. They were fixed with F.A.A. and preserved in 70 % Alcohol. Free hand

transactions of leaves were taken. Fresh, preserved and herbarium materials were used. They were stained in safranin (1%) and fast green (1%) and mounted in D.P.X. after the customary methods of dehydration. The sketches were drawn using a camera lucida.

OBSERVATIONS:

1) *Argyreia nervosa* (Burm.f.) Boj.: (Fig.1)

The leaves are dorsiventral and amphistomatic. The midrib is ridged above. The adaxial epidermis is single layered and consists of barrel shaped, compactly arranged cells. The outer walls of the cells are thicker than their inner walls. It is moderately cutinized from outside. The abaxial epidermis is more or less similar to the adaxial one. However, the cuticle is slightly thinner on it. Unicellular elongated trichomes are distributed all over.

The mesophyll is differentiated into the palisade layer and spongy tissue. The former is constituted out of compactly arranged columnar cells. It is single layered and its cells contain larger number of chloroplasts. The spongy tissue is present beneath the palisade layer and occupies major portion in between the two epidermises. The cells are rounded, loosely arranged and contain intercellular spaces in between. However, they possess fewer chloroplasts.

The midrib region exhibits internal structure different from that of laminar region. The entire midrib region is delimited by single layered epidermis. The cells are barrel shaped and moderate in size. It is followed from within by single chlorenchymatous layer, except in the ridge. The epidermis in the region of ridge is followed by a group of collenchymatous cells. The vascular tissue is present in the form of a crescent shaped arc. It is bicollateral. It is lined abaxially by more or less continuous single layer of sclerenchyma. The rest of the region of midrib consists of conjunctive tissue, the cells of which are thin walled. The cells are polygonal. They reduce in size towards the vascular arc and epidermis.

2) *Argyreia onilahiensis* Derooin : (Fig.2)

The leaves are dorsiventral and amphistomatic. The midrib is two furrowed. The cells of upper epidermis are compactly arranged and mostly barrel shaped to rounded. The outer wall of the epidermis is single layered and is covered by moderately thick cuticle. The cells of lower epidermis are more or less similar to those observed in case of the upper epidermis. The cuticle on lower epidermis is slightly thinner as compared to the upper one. Unicellular elongated trichomes are present mostly on the upper epidermis and the midrib region of leaves.

The mesophyll is differentiated into the palisade and spongy parenchyma. The cells of former are columnar and compactly arranged. Some of the cells of palisade layer contain tannin. It is one layered and contains abundant chloroplasts. The cells of spongy tissue are irregular or rounded in shape. They are loosely arranged and enclose intercellular spaces. The cells contain fewer chloroplasts.

The internal structure in the midrib region is obviously different from that of laminar part. The cells of adaxial and abaxial epidermises in this region are slightly larger with thick cuticle. The upper and lower epidermises are one layered. The former is followed from within by two layered collenchymas, whereas the latter is followed by chlorenchymatous layer. The vascular tissue is resolved into a conspicuous and continuous arc. It is bicollateral. It is capped adaxially by a continuous sclerenchymatous layer. The remaining portion is occupied by the ground tissue. The cells are parenchymatous and polygonal. Their cell walls are thin. Few cells of the ground tissue especially in the upper region contain tannin.

3) *Argyreia sericea* Dalz. : (Fig.3)

The leaves are dorsiventral and amphistomatic. The midrib is prominently ridged above. The upper epidermis consists of barrel shaped, compactly arranged cells. The outer wall of these cells is thicker than the inner ones. It is single layered and covered by thick cuticle. The cells of lower epidermis are slightly smaller than those of the upper epidermis. It is more or less similarly cuticularised.

The mesophyll is distinctly differentiable into the palisade and spongy parenchyma. The columnar tightly arranged cells constitute the former. It is single layered in laminar part and its cells contain numerous chloroplasts. The loose irregular shaped cells enclosing air spaces, are the spongy tissue present beneath the palisade layer. They however contain less number of chloroplasts. It is interesting to note the extension of palisade and spongy layer in the midrib region. However, the cells of the latter are compactly arranged. The cells of either of these also contain chloroplasts.

The midrib region presents interesting internal structure. It is bounded by single layered epidermis. The cells are uneven in size and shape. The cells of epidermis on adaxial side are conspicuously larger. The cuticle is thicker. The midrib is prominently ribbed in the centre. The region of rib is occupied totally by collenchymatous cells which actually lie above the so called palisade layer. A bicollateral vascular arc is present in the centre. It is lined by single layered sclerenchyma. It is discontinuous at some places. The vascular tissue is surrounded by conjunctive tissue. The conjunctive tissue usually consists of large and small cells. The cells are parenchymatous and polygonal. They are usually smaller towards the epidermis. Their cell walls are thin. Few unicellular and multicellular trichomes are present abaxially in the midrib region.

4) *Argyreia splendens* (Roxb.) Sweet : (Fig.4)

The leaves are dorsiventral and amphistomatic. The midrib is ridged in the middle. The cells of the upper epidermis are barrel shaped and compactly arranged. The outer wall of epidermal cell is thicker than its inner wall. The epidermis is one layered and covered by a moderately thick cuticle. The cells of the lower epidermis are slightly larger than those of the upper one. It is similarly cuticularised. Unicellular elongated trichomes are present on lower epidermis of the foliar and midrib region.

The mesophyll is clearly differentiated into the palisade and spongy parenchyma. The former consists of columnar and compactly arranged cells, whereas the latter is composed of irregular or rounded cells with intercellular spaces. The cells of the spongy tissue contain less number of chloroplasts.

The midrib region is delimited by the outermost epidermal layer. It is single layered and composed of medium sized rounded or barrel shaped cells. Cuticle is moderately thick. It is followed from within by collenchymatous tissue. It is usually two layered abaxially, whereas the region of the ridge is totally occupied by collenchymatous cells. The vascular tissue is in the form of a shallow arc in the centre. It is bicollateral and capped abaxially single layer of sclerenchyma. It is enshrouded by the conjunctive tissue, the cells of which are parenchymatous, large and usually polygonal. They are thin walled.

5) *Calystegia affinis* Endl.: (Fig.5)

The leaves are dorsiventral and amphistomatic. The midrib is flat adaxially. The adaxial epidermis is single layered and consists of comparatively larger barrel shaped cells which are tightly arranged. Their outer walls are thicker than the inner ones. They are moderately cutinized from the outside. The abaxial epidermis is more or less similar to the adaxial one. It also shows moderately thick cuticle.

The mesophyll is composed of the palisade layer and spongy tissue. The region of palisade is relatively narrower. The cells are columnar and tightly arranged. It is one layered and contains numerous chloroplasts. The spongy tissue present below the palisade consists of loosely arranged irregular cells. They enclose plenty of intercellular spaces and contain fewer chloroplasts.

The midrib region is bounded from outside by single layered epidermis. The cells of epidermis are uneven in size and shape especially adaxially. Some of the cells are conspicuously large in the upper epidermis in this region. They are rounded to barrel shaped abaxially. It is followed by two layered chlorenchyma from within particularly in the abaxial midrib region. Two layered patch of collenchyma is present beneath the upper epidermis. The vascular tissue is present in the form of a shallow arc in the centre. It is bicollateral and lined by single layer of sclerenchyma. It is surrounded by the ground tissue. The ground tissue consists of uneven large and small cells. Few cells are considerably larger. The cells of ground tissue are parenchymatous and usually polygonal. It is usually reduced in size towards the epidermis. Unicellular trichomes are present abaxially in the midrib region.

6) *Cressa cretica* Linn.: (Fig.6)

The leaves are dorsiventral and amphistomatic. The midrib is elevated in the middle adaxially. The upper epidermis consists of large rounded or barrel shaped cells. The cells are uneven in size and shape. Their outer walls are thicker, whereas inner walls are thinner. It is one layered and have thicker cuticle. The cells of lower epidermis are relatively smaller. They are usually barrel shaped and moderately cuticularised.

The mesophyll is distinctly distinguished into palisade and spongy parenchyma. The palisade layer is composed of tightly arranged columnar cells. It is two layered and contains abundant chloroplasts. It is

followed from beneath by a broader region of spongy tissue. The cells of spongy tissue are rounded or irregular containing less chloroplasts and more intercellular spaces in between them.

The internal structure of midrib region presents interesting variations. The upper epidermis is composed of large, uneven cells. It is also one layered and thickly cuticled. The cells of outer wall are thicker. It is followed by single layer of chlorenchyma. The cells of chlorenchymatous layer are also larger. The lower epidermis in this region consists of mostly barrel shaped cells. The cells are, however, smaller than those of the upper one. It is followed from within by single layer of chlorenchyma. The cells of chlorenchyma are also smaller than those of upper chlorenchymatous layer. The vascular tissue is represented by a medium sized bicollateral vascular bundle. It is capped by single layer of sclerenchyma abaxially. The region between the lower and upper chlorenchymatous layers is occupied by the ground tissue, except the central vascular region. The cells are usually larger, parenchymatous and thin walled. Few unicellular trichomes are observed abaxially in the midrib region

7) *Evolvulus alsinoides* Linn. : (Fig.7)

The leaves are dorsiventral and amphistomatic. The cells of adaxial epidermis are barrel shaped and tightly arranged. Few are rounded. They are relatively larger in size. The outer wall of epidermis is thicker than the inner wall. The epidermis is one layered with moderate thick cuticle. The cells of abaxial epidermis are more or less similar to those observed in case of adaxial epidermis. The cuticle is also moderately thick.

The mesophyll is distinguishable into the upper palisade layer and the lower spongy tissue. The former occupies narrow space, whereas the latter occupies broader region in between the two epidermises. The cells of the palisade layer are arranged compactly in one row just beneath the upper epidermis. They contain abundant chloroplasts. The cells of spongy parenchyma are mostly rounded with many intercellular spaces in between. They contain fewer chloroplasts.

The internal structure of midrib region also presents interesting variations. The outermost delimiting layer is epidermis. It is single layered and consists of relatively larger cells. The cells of adaxial epidermis and abaxial epidermis have few conspicuously larger cells. The cuticle is thick on both surfaces. Three layered collenchyma is present beneath the upper epidermis in this region. However, the lower epidermis is followed from within by just single layer of collenchyma. A medium sized vascular bundle is present in the center. It is bicollateral and capped abaxially by large sized sclerenchymatous cells. It is one layered. The vascular bundle is surrounded by the conjunctive tissue. It is broader on the abaxial side and narrower on the adaxial side. It consists of large cells. The cells are parenchymatous, thin walled and generally polygonal.

8) *Hewittia sublobata* (L.f.) O.Ktze.: (Fig.8)

The leaves are dorsiventral and amphistomatic. The midrib region is shallowly channeled. The cells of upper and lower epidermises are large. Both of them are single layered. Their outer walls are thicker than the inner ones. Thick cuticle is present on either surface.

The mesophyll consists of well distinguished upper palisade layer nad lower spongy tissue. However, the latter occupies broader region of the mesophyll tissue. The palisade layer is single layered. The cells are tightly arranged containing numerous chloroplasts. The cells of spongy tissue enclosed some intercellular spaces in between and contain few chloroplasts. The anatomy of the midrib region reveals interesting features. The lower and upper epidermises in this region are composed of small and very large cells. They are also thickly cuticularised on outside. A three layered collenchymatous patch of tissue is present in the channeled region on adaxially side. However, the lower epidermis is followed by two layered chlrenchyma.

Small sized vascular arc is present in the centre of midrib. It is bicollateral and capped by single layer of sclerenchyma on adaxial side. Large to very large cells of conjunctive tissue surround the vascular strand. Their cells are thin walled. They are parenchymatous, cells being polygonal. Few cells of the conjunctive contain clusters of crystals.

9) *Hildebrandtia valo* Derooin : (Fig.9)

The leaves are dorsiventral and amphistomatic. The midrib is furrowed. The cells of upper epidermis are medium sized. They are compactly arranged in one layer. They are barrel shaped to round in shape. The outer wall of epidermal cell is thicker than the inner wall. It is covered by thick cuticle from outside. The lower epidermis presents more or less similar features of the cells and cuticle as the upper ones.

The mesophyll is distinctly recognizable into the upper palisade layer and lower spongy tissue. The cells of former are in one row, compactly arranged and contain abundant chloroplasts. The latter has loosely arranged, irregular or rounded cells enclosing intercellular spaces in between. They contain fewer chloroplasts.

The internal structure of the midrib region presents some interesting features. The cells on upper and lower sides are mostly considerably medium sized. Few cells are relatively smaller. Their outer walls thicker than the inner ones. They also show thick cuticle. Single layered collenchymatous patch of tissue is present adaxially in the furrowed region just beneath the upper epidermis. The lower epidermis in this region is followed by single layered chlrenchyma. The vascular tissue extends in the centre. It is represented by bicollateral vascular bundle which is capped by single layer of sclerenchyma abaxially. Surrounding it is present the conjunctive tissue. The cells of conjunctive tissue are also medium sized. Very few cells are large. They are thin walled, parenchymatous and polygonal.

10) *Ipomoea biloba* B: (Fig.10)

The leaves are dorsiventral and amphistomatic. The midrib is deeply channeled adaxially. The cells of upper epidermis are medium sized. The outer walls of the epidermal cells are thicker. It is single layered and has thick cuticle on the outside. The cells of lower epidermis are larger or smaller. It is also single layered. Their outer walls are also thicker. It has thick cuticle.

The mesophyll is very broad. It is distinguishable into two regions, the upper palisade and the lower spongy tissue. The former is generally seven to eight layered. The cells are moderately elongated, compactly arranged and contain numerous chloroplasts. The latter has loosely arranged cells. They are rounded or irregular in shape enclosing intercellular spaces. They contain few chloroplasts. The palisade and spongy parenchyma occupy area in equal proportion.

The midrib is very prominent and exhibits interesting internal structure. The adaxial epidermis in the midrib region has relatively small cells. It is single layered with thick cuticle. The lower epidermis has comparatively larger cells. The cells are mostly rounded. Their outer walls are thicker. It also shows thick cuticle. It is followed from within by single layer of chlorenchyma. A very large vascular arc represents the vascular tissue in the centre. It is bicollateral and lined abaxially by two layered sclerenchyma. It is surrounded from all sides by many layered ground tissue. The cells of ground tissue are parenchymatous, thin walled and polygonal. It presents an admixture of small, large and very large cells. They reduce in size towards the epidermis. Secretory cavities are present in the ground tissue.

11) *Ipomoea clarkei* Hook. : (Fig.11)

The leaves are dorsiventral and amphistomatic. The midrib region is prominently ridged in the middle. The upper epidermis consists of larger, barrel shaped compactly arranged cells. Their outer walls are thicker than the inner ones. It is single layered and covered by a moderate thick cuticle. The lower epidermis shows more or less similar structure as upper ones.

The mesophyll consists of the upper palisade parenchyma and lower spongy parenchyma. The tightly arranged cells of former contain numerous chloroplasts. They are arranged in two rows. The latter consists of loosely arranged rounded cells enclosing spaces in between. The cells of spongy tissue contain fewer chloroplasts. Both occupy area more or less in equal proportion.

The midrib region has interesting internal variation in structure. The epidermis on upper surface in the region of ridge is composed of small and large cells. The ridge has collenchymatous cells beneath the upper epidermis. Unicellular trichomes are present on it. Their outer walls are thicker and has thick cuticle. The lower epidermis consists of small cells and very few slightly larger cells. They are rounded in shape. Their outer walls are thicker. It is single layered. It is followed from within by single layered chlorenchyma. The vascular tissue is present in the form of a shallow arc. It is bicollateral and capped abaxially by one or two layered sclerenchyma. It is surrounded by the ground tissue. The cells of ground tissue are large or small, parenchymatous, polygonal and thin walled.

12) *Ipomoea illustris* (Clarke) Prain: (Fig.12)

The leaves are dorsiventral and amphistomatic. The midrib region is ribbed adaxially. The cells of epidermis are medium sized and barrel shaped. They are compactly arranged in one row. Their outer walls are thicker than the inner ones. Thick cuticle is developed on the outer side. The lower epidermis shows more or less similar features as the upper epidermis.

The mesophyll is distinguished into two distinct regions viz., the palisade and the spongy parenchyma. They occupy area more or less in equal proportion. The palisade is two layered and its cells are compactly arranged. The cells contain abundant chloroplasts. The loosely arranged rounded cells enclosing spaces in between constitute the spongy parenchyma.

The epidermis on either surface in the midrib region shows similar structure. The cells are barrel shaped and medium sized. It is single layered. Their outer walls are thicker than the inner ones. Thick cuticle is formed on the outside. A patch of four to six layered of chlorenchyma is present beneath the upper epidermis in the region of the rib. The lower epidermis is followed by a two layered collenchyma. A prominent shallow vascular arc is situated in the centre. It is bicollateral and capped by one or two layers of sclerenchyma. It is embedded in the ground tissue. The ground tissue is composed of small or large cells. The cells are parenchymatous, thin walled and polygonal. Trichomes are occasionally present on the lower epidermis of the midrib.

DISCUSSION:

The leaves are dorsiventral in all the species investigated. Metcalfe and Chalk (1950), however, reported them isobilateral especially in some genera like *Cladostigma*, *Convolvulus*, *Seddera*, *Stylisma*, *Cressa*, *Evolvulus* and *Hildebrandtia*. The present authors also investigated some species of these genera viz., *Cressa*, *Evolvulus* and *Hildebrandtia*. In these, the leaves are clearly dorsiventral and not isobilateral as reported earlier. This discrepancy is also pointed out by Metcalfe and Chalk (*loc.cit.*) especially in case of *Evolvulus alsinoides*. Similar discrepancy is also noted in case of the genera viz., *Cressa* and *Hildebrandtia* of the present account. Possibly, this character is plastic in these taxa. Nevertheless, more number of populations of species should be studied prior to such a conclusion.

The epidermal cells of epidermis differ in shape, size and form, stomatal distribution, distribution of trichomes, etc. There is a distinction between the epidermis of adaxial and abaxial foliar surfaces. The cells of epidermis are relatively smaller or larger and vary from species to species and surface to surface. The cells are smaller and equal in size in case of *Argyreia splendens*. In majority of others, they are either larger or smaller on both surfaces. Although so, in majority of species sporadic occurrence of very large cells are noteworthy. The cuticle on adaxial surface is generally thicker than the one on abaxial surface. The epidermis is generally interrupted by the occurrence of the stomatal openings and trichomes. However, there are few exceptions especially in respect of trichomes. They are totally absent on leaf

surfaces in case of *Hewittia sublobata* and *Ipomoea biloba*. The leaves are dorsiventral and the mesophyll is differentiated generally into an upper palisade and a lower spongy tissue. Out of twelve species studied, eight species show single layered palisade, whereas four species exhibit two layered palisade. It is interesting to note massive development of palisade in case of *Ipomoea biloba*. It is nearly eight to nine layered. The cells of palisade in this case are relatively smaller than those observed in the species presently investigated. It is unusual to have extended palisade layer beneath the ridge in petiolar region. These palisade cells are larger or smaller and slightly randomly arranged. They are covered atop by many layered collenchyma. The cells of spongy tissue are arranged irregularly and loosely enclosing air spaces in between.

The internal structure especially in the midrib region is different in respect of nature and number of layers of hypodermis and distribution of vascular tissue from species to species. The hypodermis in this region is either collenchymatous or chlorenchymatous. These also vary on adaxial and abaxial surfaces of the midrib. Hypodermis is observed on both sides of midrib in few cases e.g. *Argyreia sericea*, *Evolvulus alsinoides*, *Ipomoea clarkei*, and *I. illustris*. However, the number of collenchymatous layers varies on both sides in different species. They are three to eight layered adaxially and one or two layered abaxially. The hypodermis is developed on both sides of the midrib in case of *Cressa cretica* and *Ipomoea biloba*. It is abaxially chlorenchymatous and adaxially collenchymatous in rest others. It is usually single layered and two layered in few cases.

The vascular tissue received in the midrib region is generally resolved into an arc. The arc is generally crescent-shaped except few in which it is cup-shaped. The arcs are mostly conspicuous and bicollateral. The vascular arc is usually lined abaxially by sclerenchymatous layers. In most species, it is single layered, whereas in few cases, it is one or two layered. The cells of conjunctive tissue surrounding the vascular arc are always polygonal and parenchymatous. They are moderately thick or thin. Usually, they are thinner inwards. The size of these cells varies from species to species and place to place in the midrib region. Clustered crystals are observed in few cells of ground tissue in case of *Hewittia sublobata*. The tanniferous cells are also recorded only in the palisade and ground tissue in case of *Argyreia onilahiensis*. Their occurrence in the conjunctive tissue is also confined to the adaxial side of vascular arcs.

The family Convolvulaceae is characterized by laticifers in most taxonomic accounts (Lawrence 1950, Srivastava 1983, Lowell and Lucansky 1986). The present investigators noted the secretory cavities especially in the conjunctive tissue of the midrib in case of *Ipomoea biloba*. These are also recorded in this region of the genus *Dichondra* (Metcalf and Chalk 1950). They also reported isolated secretory or laticiferous cells in the mesophyll, particularly at the boundary between the palisade and spongy parenchyma. Present authors experienced difficulty in detecting these in the mature leaves and also due to disappearance of their contents. It appeared that proper chemical fixation and methods are needed to

investigate them. Carlquist (1961) remarked that anatomically the leaves of angiosperms being most varied organ, affords many anatomical characteristics of taxonomic value. The present authors lend support to such a opinion on the convolvulaceous species presently studied. The epidermal cell wall contours, development of collenchyma, sclerenchyma, forms of vascular tissue, cell inclusions, laticifers, etc. do vary species to species. These are, therefore, taxonomically significant.

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