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FOLIAR ANATOMY OF SOME UNINVESTIGATED SPECIES OF CONVOLVULACEAE

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ABSTRACT:

The present paper communicates leaf anatomy of some species of Convolvulaceae. In all, seven genera and thirteen species have been surveyed for anatomical features in detail. They have been investigated regarding epidermis, mesophyll and midrib region. The leaves are generally bifacial. The vascular tissue received in the midrib region is generally resolved into an arc. The arc is mostly crescent-shaped and cup-shaped in few cases. The arcs are generally prominent and bicollateral. The vascular arc is generally capped abaxially by sclerenchymatous layers. It is single layered, however in few cases, it is one or two layered. Sometimes, trichomes occur in some species on the epidermis.

KEY WORD: Leaf, Anatomy, Convolvulaceae.

INTRODUCTION:

The convolvulaceous taxa are predominantly herbaceous or shrubby climbers and rarely erect (Lawrence, 1951). They inhabit mostly in subtropical, tropical and temperate regions of the world. Foliar anatomical studies covered some species in past (*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 many more species awaiting for anatomical investigations. This paper communicates thirteen species of convolvulaceae with a view to fill in this lacuna. The data so revealed will be of some utility in taxonomic and phylogenetic appraisal.

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, 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) *Ipomoea mauritiana* Jacq.: (Fig.1)

The leaves are dorsiventral and amphotomatic. The midrib is conspicuously ribbed adaxially and two pronged abaxially. The lower portion of the leaf is curved inward which appears sandwiched in between the lamina and the pronges. The gross structure presents an interesting outline simulating a frog. The upper epidermis of laminar part consists of large barrel shaped or rounded cells. Their outer walls are thicker. Thick cuticle is present on the outside. The lower epidermis has relatively smaller cells. Its structure is similar to the upper one.

The mesophyll is distinguishable into two regions viz., the palisade parenchyma and spongy parenchyma. Either of these occupies area more or less in equal proportion. The palisade is usually two layered, the cells of which are compactly arranged and contain abundant chloroplasts. The loosely arranged irregular or rounded cells enclosing spaces in between constitute the spongy tissue.

The midrib, as described above, is ribbed above and pronged below. The adaxial epidermis consists of small and larger cells which are compactly arranged in one row. The outer walls of these cells are thicker and covered by thick cuticle. The rib is totally filled up by a patch of collenchymatous medium sized cells beneath the epidermis. The lower epidermis in the midrib region consists of medium sized rounded cells. It is one layered. Their outer walls are thick and covered by a thick cuticle. The epidermis is followed from within by single layered chlorenchyma. A prominent vascular arc is present in the centre. It is bicollateral and lined by one or two layered sclerenchyma abaxially. The ground tissue surrounding it is composed of parenchymatous thin walled polygonal cells. The cells are medium sized, however, few cells present above and below the vascular arc are considerably larger. Secretory cavities are present in the ground tissue.

2) *Ipomoea triloba* Linn.: (Fig.2)

The leaves are dorsiventral and amphotomatic. The midrib is ridged in the centre adaxially. The adaxial and abaxial epidermises are single layered containing barrel shaped or rounded cells. They are one layered. Their outer walls are thicker and covered by well-developed cuticle.

The mesophyll consist the upper palisade parenchyma and lower spongy parenchyma. The former is single layered, the cells of which contain numerous chloroplasts. The latter has loosely arranged, rounded or irregular cells enclosing spaces in between. The spongy parenchyma is broader than the palisade parenchyma.

The adaxial epidermis in the midrib region shows interesting variations. The epidermis is single layered and consists of small rounded or barrel shaped cells. Intermittently, few cells are very prominent. The

epidermis in the region of ridge has very large cells. A patch of collenchymatous cells is present in the region of ridge. The abaxial epidermis is composed of small rounded or barrel shaped cells. It is also single layered and followed from within by a layer of chlorenchyma. A prominent shallow vascular arc is situated in the centre. It is bicollateral and capped abaxially by two layered sclerenchyma. It is surrounded by the ground tissue which fills up area in between the upper and lower epidermises. The cells of the ground tissue are parenchymatous, thin walled and polygonal. The cells of ground tissue particularly above the middle of the arc are considerably larger in size. Tannin cells are present in the palisade and spongy parenchyma.

3) *Jacquemontia paniculata* (Burm. f.) Hallier f.: (Fig.3)

The leaves are dorsiventral and amphistomatic. The upper and lower epidermises are composed of barrel shaped compactly arranged cells. The epidermis is single layered. The outer walls are thinner. Moderately thick cuticle is present on their outside.

The mesophyll is clearly distinguishable into the two regions viz., the palisade and spongy parenchyma. The former is single layered and narrower as compared to the latter. The cells of palisade layer contain numerous chloroplasts. The irregular, loosely arranged cells containing intercellular spaces make up the spongy tissue.

The adaxial and abaxial epidermis in the midrib region consists of relatively larger cells. They are rounded or barrel shaped in single row. The outer walls of these cells are thicker and provided with thick cuticle to the outside. A patch of two layered collenchyma is observed beneath the upper epidermis in this region. The lower epidermis is followed within by single layered chlorenchyma. A medium sized lunar shaped vascular arc is present in the centre. It is bicollateral and capped abaxially by one or two layered sclerenchyma. It is embedded in the ground tissue present in between the lower and upper epidermis. The cells are usually larger and smaller towards the epidermises. They parenchymatous, thin walled and polygonal.

4) *Merremia aegyptia* (L.) Urb.: (Fig.4)

The leaves are dorsiventral and amphistomatic. The midrib is channeled adaxially. The adaxial epidermis is single layered and composed of barrel shaped or rounded tightly arranged cells. Their outer walls are thicker than the inner ones. Thick cuticle is present on their outside. The abaxial epidermis consists of smaller or larger cells which are rounded or barrel shaped. Their outer walls are thicker and also have thick cuticle.

The mesophyll is composed of of the palisade and spongy parenchyma. The former is one layered, the cells of which contain abundant chloroplasts. The latter consists of rounded or irregular cells with some intercellular spaces. They contain fewer chloroplasts and occupy slightly broader region than the palisade parenchyma.

The midrib is channeled. The adaxial and abaxial epidermis consists of large and considerably large cells. They are one layered. Their cells are barrel shaped with outer walls thick. Thick cuticle is developed on their outside. A patch of two or three layered cells of collenchyma is present below the adaxial epidermis. The abaxial epidermis is followed from within by single layered chlorenchyma. A prominent lunar shaped vascular arc is present in the centre. It is bicollateral and capped abaxially by two or three layered sclerenchyma. It is embedded in the conjunctive tissue present in between the adaxial and abaxial epidermises. The cells of conjunctive tissues are large to very large, parenchymatous and thin walled. They are polygonal in shape. Few layers of this tissue lining the chlorenchymatous layer have relatively smaller cells.

5) *Merremia dissecta* Hallier f.: (Fig.5)

The leaves are dorsiventral and amphistomatic. The midrib is channeled. The adaxial and abaxial epidermises consist of large barrel shaped compactly arranged cells. It is one layered. Their outer walls are thicker than the inner ones. Thick cuticle is developed on outside.

The mesophyll is made up of two types of tissues viz., first the palisade and second the spongy parenchyma. The former is single layered present beneath the upper epidermis. The latter is comprised of rounded or irregular cells enclosing spaces in between. This occupies broader area of the mesophyll.

The epidermis of lower and upper sides in the midrib region consists of moderately small or large cells. They are compactly arranged in one layer. Their outer walls are thicker with the thick cuticle present on the outside. A patch of collenchyma tissue present beneath the upper epidermis. The lower epidermis is followed from within by single layer of chlorenchyma. A prominent crescent shaped vascular arc is present in the centre. It is bicollateral and lined by the one to two layered sclerenchyma abaxially. It is surrounded by the ground tissue present in between the adaxial and abaxial epidermises. The cells are parenchymatous, thin walled and polygonal. The cells are generally larger but reduced in size gradually towards the epidermis. Few secretory cavities are observed in the ground tissue.

6) *Merremia emarginata* Hallier f.: (Fig.6)

The leaves are dorsiventral and amphistomatic. The midrib is ribbed adaxially in the centre. The epidermises are composed of large barrel shaped cells. Their outer walls are thicker than the inner ones. On outside they are covered by thickly developed cuticle.

The mesophyll is comprised of the palisade and spongy parenchyma. The former is two to three layered. The latter consists of irregular and rounded cells containing spaces in between. The palisade and spongy tissue occupy area nearly in equal ratio. The palisade layers also extend beneath the rib to some extent.

The midrib region is ribbed adaxially in the centre. The upper epidermis in the midrib region consists of large barrel shaped or rounded cells, whereas medium sized to relatively larger cells comprise the lower epidermis. The outer walls of the cells of both the epidermises are thicker than inner walls. They are thickly cuticularised on their outside. The vascular tissue is represented in the centre in the form of a

shallow arc. It is bicollateral and capped abaxially by one or two layer of sclerenchyma. It is surrounded from all sides by the conjunctive tissue. The conjunctive tissue also extends towards the rib adaxially up to the epidermis. The cells of conjunctive tissue are large, parenchymatous, thin walled and polygonal. They reduce in size towards the epidermis.

7) *Merremia tridentata* Hallier f.: (Fig.7)

The leaves are dorsiventral and amphistomatic. The midrib is channeled. The lower and upper epidermises are composed of barrel shaped or rounded cells. They are tightly arranged in one row. The outer walls of these cells are thicker than those of the inner ones. Cuticle is thick on either surface.

The tissue constituting the mesophyll is divisible into two viz., first the palisade and second the spongy parenchyma. The former is usually two layered and is made up of compactly arranged elongated cells. Few cells of the palisade contain tannin. It is followed from within by three to four layered spongy parenchymas. These contain intercellular spaces. Few cells also contain tannin.

The midrib region shows usual internal structure. The upper epidermis in this region is composed of small cells, whereas the lower epidermis is made up of unequal sized cells. The epidermises are one layered, the outer walls of their cells are thicker as compared to their inner walls. The lower epidermis is followed from within by single layered chlorenchyma. A shallow arc in the centre represents the vascular tissue. It is bicollateral and lined by one or two layered sclerenchyma abaxially. The ground tissue extends in between the upper and lower epidermises. It is usually composed of large cells and slightly reduces towards the epidermis. Adaxially, the ground tissue extends up to the epidermis.

8) *Mina lobata* Cerv.: (Fig.8)

The leaves are dorsiventral and amphistomatic. The midrib has a well elaborated and conspicuous raised rib in the centre. The upper epidermis consists of large to very large cells arranged in single layer. The outer walls of their cells are thicker than the inner ones. Thick cuticle is developed on their outside. The lower epidermis has relatively smaller cells. They are also unequal in size. It is single layered. The outer walls of its cells are also thicker than the inner ones. It is also thickly cuticularized.

The mesophyll is composed of the palisade and the spongy tissue. The former is single layered in the laminar part. It extends in the midrib region where it is one to few layered. The latter is composed of loosely arranged rounded cells containing few spaces in between. It occupies major portion of the mesophyll.

The midrib has well-developed rib in the centre. The epidermis overlining the rib is composed of some unequal sized small or large curiously shaped cells. The outer wall of these cells is very thick than the inner ones. The rib region is totally composed of collenchymatous tissue beneath which also extend few layers of the palisade. Few unicellular trichomes are present on the upper epidermis. The lower epidermis in the midrib region is composed of relatively larger cells. The cells are rounded or barrel shaped and uneven in size. Their outer walls are thicker than the inner ones. Thick cuticle is also present covering

them. It is followed from within by single layer chlorenchyma. The vascular tissue is represented by a shallow, prominent vascular arc in the centre. It is bicollateral and capped abaxially by a row of sclerenchyma. It is embedded in the ground tissue. The cells of ground tissue range from large to very large and usually reduce towards the lower epidermis. The cells are parenchymatous, thin walled and polygonal.

9) *Porana paniculata* Roxb.: (Fig.9)

The leaves are dorsiventral and amphistomatic. The midrib is ribbed in the centre adaxially. The epidermis of lower and upper surfaces is composed of large, barrel shaped or rounded compactly arranged cells. It is one layered. The outer wall of their cells is thicker than the inner ones. They are thickly cuticularised on outside.

The tissue composing the mesophyll is divisible into the palisade and spongy parenchyma. The former is single layered and made up of tightly elongated cells containing numerous chloroplasts, whereas the latter consists of rounded loosely arranged cells containing spaces in between and the few chloroplasts. The spongy tissue occupies major portion of the mesophyll.

The epidermis extending over the rib adaxially is composed of relatively larger cells. It has few multicellular, uniseriate trichomes. The epidermis is one layered. The outer wall of these cells is thicker than the inner ones. The cells are thickly cuticled on the outside. The region of the rib is filled entirely with the collenchymatous tissue. The abaxial epidermis in the midrib region has relatively smaller barrel shaped or rounded cells. Their outer wall is thicker than the inner ones. Thick cuticle covers them from outside. It is single layered and followed from within by the collenchymatous layers. A shallow arc of vascular tissue extends in the midrib region. It is bicollateral. It is capped abaxially by one or two layered sclerenchyma. It is embedded in the ground tissue. The ground tissue towards the abaxial side is broader than the one lying above the vascular arc. The ground tissue is made up of large to very large cells. They reduce in size towards the vascular tissue as well as the collenchymatous layer. The cells of ground tissue are parenchymatous, thin walled and polygonal.

10) *Porana sericea* sp. nov.: (Fig.10)

The leaves are dorsiventral and amphistomatic. The midrib is bulged out moderately on either side. The epidermis consists of large barrel shaped compactly arranged cells. It is one layered. The outer wall of these cells is thicker than the inner ones. Thick cuticle is present covering their outer walls.

The mesophyll is distinguished into the palisade and spongy parenchyma. The former is composed of compactly arranged cells, whereas the latter is comprised of rounded of loosely arranged cells containing intercellular spaces. They, however, contain few chloroplasts.

The epidermis extending over the midrib region is made up of medium sized compactly arranged cells. It is also single layered. The outer walls of these cells are thicker than the inner ones. They are covered by thick cuticle. The abaxial epidermis in this region is followed from within by a row of chlorenchymatous

cells. A vascular bundle extends in the midrib. It is bicollateral and capped abaxially by one or two layers of sclerenchyma. It is embedded in the ground tissue which is composed of parenchymatous, thin walled and polygonal cells. The ground tissue extends up to the upper epidermis in this region. The cells of ground tissue are larger. Few trichomes are seen in the midrib region abaxially.

11) *Rivea hypocrateriformis* Choisy : (Fig.11)

The leaves are dorsiventral and amphistomatic. The midrib is shallowly furrowed. The lower and upper epidermises are composed of larger and small barrel shaped or rounded cells. They are single layered and compactly arranged. Their outer walls are thicker than the inner ones. Thick cuticle covers their outer walls.

The mesophyll is well developed and is divisible into the palisade and spongy parenchyma. The two layered compactly arranged elongated cells constitute the palisade. It occupies only one third of the mesophyll tissue. The spongy tissue occupies two third of the mesophyll. It is nearly seven to nine layered and constituted out of rounded or irregular cells containing spaces between them.

The upper epidermis in the midrib region is made up of small or large tightly arranged cells. It is single layered. The outer wall of these cells is thicker than the inner ones. Thick cuticle is developed over them. The abaxial epidermis in this region is composed of medium sized cells. Their outer walls thicker and a thick cuticle extend over them. It is followed from within by single layer of chlorenchyma. The vascular tissue extends in the centre of the midrib and is represented by a prominent crescent shaped vascular arc. It is bicollateral. It is lined by the one or two layered sclerenchyma. The ground tissue consists of larger to very large cells present in between the upper and lower epidermises, except in the vascular region. The cells especially above the arc are very large. The cells of ground tissue are parenchymatous, thin walled and polygonal.

12) *Turbina bracteata* Derooin: (Fig.12)

The leaves are dorsiventral and amphistomatic. The cells of upper epidermis are larger rounded and barrel shaped. It is single layered and compactly arranged. The outer walls are thicker than the inner ones and they are covered from the outside by thick cuticle. The lower epidermis is composed of smaller cells. They are usually rounded or even barrel shaped. They are compactly arranged in one row. The outer walls of their cells are thicker. Thick cuticle is present on lower epidermis.

The mesophyll is distinguished into the palisade and spongy parenchyma. A layer of compactly arranged elongated cells constitute the palisade beneath the upper epidermis. The spongy tissue occupies major portion of the mesophyll. It is made up of loosely arranged rounded or irregular cells containing intercellular spaces. Few cells of the palisade and spongy parenchyma contain tannin.

The midrib is ribbed above. The upper epidermis is composed of large rounded cells in single row. The outer walls of these cells are thicker. The thick cuticle is also present covering the upper epidermis. The lower epidermis in the midrib region is composed of relatively smaller cells. It is single layered and have

compactly arranged cells. The outer walls of which are thicker than the inner ones. This layer also shows thick development of cuticle. Few cells in this layer are however relatively larger. It is followed from within by single layer of chlorenchyma. The vascular tissue extends in the centre of the midrib in the form of a large vascular bundle. It is bicollateral and capped by two layered sclerenchyma. It is embedded in the conjunctive tissue which shows large parenchymatous, thin walled and polygonal cells. They diminish in size towards the lower epidermis. Few cells of palisade layer, spongy tissue and conjunctive tissue contain tannin. Trichomes are abaxially present.

13) *Turbina corymbosa* (L.) Raf.: (Fig.13)

The leaves are dorsiventral and amphistomatic. The midrib is shallowly furrowed. The upper epidermis is made up of larger cells. It is single layered. The cells are compactly arranged and has outer thick wall which is also covered by thick cuticle. The cells of lower epidermis are relatively smaller. They are also barrel shaped as the cells of upper epidermis. The lower epidermis is also single layered. The cells are compactly arranged and have outer thicker walls. Thick cuticle covers them.

The mesophyll is distinguished into the palisade and spongy parenchyma. The former is single layered and occupies narrow region of the mesophyll. The latter has loosely arranged, rounded or irregular cells enclosing spaces in between. Few cells of the palisade and spongy parenchyma contain tannin.

The lower and upper epidermises of the midrib region are composed of medium sized cells. Their outer walls are thicker and also have thick cuticle. The lower epidermis is followed from within by single layer of chlorenchyma. A prominent lunar shaped vascular arc is present in the centre. It is bicollateral and capped abaxially by two layered sclerenchyma. It is embedded in the ground tissue. The cells of ground tissue are large, parenchymatous, thin walled and polygonal. Few cells of the ground tissue especially above the vascular arc contain tannin.

DISCUSSION:

The leaves are bifacial in all the species studied. Isobilateral leaves are reported especially in some genera like *Cladostigma*, *Convolvulus*, *Seddera*, *Stylisma*, *Cressa*, *Evolvulus* and *Hildebrandtia* (Metcalf and Chalk,1950). In these, the leaves are clearly dorsiventral. 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. However, more populations of these species are obviously desired to arrive at such a conclusion.

The cells of epidermis differ in respect of shape, size and form, stomatal distribution, distribution of trichomes, etc. A distinction can be made 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 of upper and lower epidermises are larger in the few plants e.g. *Jacquemontia paniculata* and *Mina labata*. In case of latter the cells of upper epidermis is very large Likewise, the cells

are smaller and equal in size in case of *Porana sericea*. In majority of others, they are either larger or smaller on both surfaces. Although so, in many species sporadic occurrences of very large cells are noteworthy. In most plants, the cuticle on adaxial surface is generally thicker than the one on abaxial side. The epidermis is usually interrupted by the occurrence of the stomatal openings and trichomes. However, there are few exceptions particularly in respect of trichomes. They are totally absent on leaf surfaces in case of *Ipomoea mauritiana* and *Merremia tridentata*. The leaves are bifacial and the mesophyll is differentiated generally into an upper palisade and a lower spongy tissue. Out of thirteen species, studied eight species show single layered palisade, whereas five species exhibit two layered palisade. It is noteworthy to have extended palisade layer beneath the ridge in petiole region. These palisade cells are larger or smaller and slightly irregularly arranged. They are covered atop by many layered collenchyma. The cells of spongy tissue are arranged irregularly and loosely containing 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 taxon to taxon. The hypodermis in this region is either collenchymatous or chlorenchymatous. These also vary on adaxial and abaxial sides of the midrib. Hypodermis is observed on both sides of midrib in *Porana paniculata*. Although so, the number of collenchymatous layers varies on both sides in different species. Usually, they are three to eight layered adaxially and one or two layered abaxially. The hypodermis is present on either sides of the midrib in case of *Merremia emarginata*, *M. tridentata*, *Porana sericea*, *Rivea hypocrateriformis*, *Turbina bracteata* and *T. corymbosa*. It is chlorenchymatous abaxially and collenchymatous adaxially in remaining species.

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. It is also two four layered in case of *Ipomoea triloba*, *Jacquemontia paniculata*, *Merremia dissecta*, *Porana paniculata*, *Turbina bracteata* and *T. corymbosa*. The cells of ground tissue surrounding the vascular arc are always polygonal and parenchymatous. They are usually moderately thick or thin. Usually, they are thinner inwards. The size of these cells differs from taxon to taxon. The tannin cells occur in the palisade, spongy parenchyma and ground tissue in *Turbina bracteata* and *T. corymbosa*. Their occurrence in the ground tissue is also restricted to the adaxial side of vascular arcs. Tannin cells are found only in the palisade and spongy parenchyma and usually lack in the ground tissue e.g. *Ipomoea triloba* and *Merremia tridentata*.

The convolvulaceous taxa are described laticiferous in most taxonomic accounts (Lawrence 1951, Cronquist 1968, 1981, 1988, Takhtajan 1969, 1980, Hutchinson 1926, 1959, 1967, 1969, 1973, 1979). The present authors observed the secretory cavities particularly in the ground tissue of the midrib in case of *Ipomoea mauritiana* and *Merremia dissecta*. These are also recorded in this region of the genus *Dichondra* by Metcalfe and Chalk (1950). Metcalfe and Chalk (*loc.cit.*) also reported

isolated secretary or laticiferous cells in the mesophyll, particularly at the boundary between the palisade and spongy parenchyma. It appeared difficult to detect these in the mature leaves and also due to disappearance of their contents. Obviously, it needs proper chemical fixation and methods to investigate them in particular.

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