STUDY OF FLORAL EPIDERMAL FEATURES IN PETREA VOLUBILIS L. (VERBENACEAE)

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Petrea volubilis L. is an extensive perennial liana, up to 10 m high, stem ash coloured, covered with grayish pubescence. Leaves 14-16 X 6.5-8 cm, elliptic, scabrous above, pubescent on nerves beneath, flowers 2-2.3 cm long, showy, purple in pendulous, 15-19 cm long axillary racemes, remarkable for large persistent star shaped calyx, rachis densely covered with soft whitish pubescence. Floral epidermal features including nature of epidermal cells, stomata and trichomes alongwith their dimensions of all floral parts are studied. Epidermal cells are polygonal, straight walled, papilllose in peduncle, bract, deeply sinuate in calyx, broadly sinuate, papilllose and straight walled in adaxial and abaxial corolla lobes respectively. Polygonal, elongate, straight walled in corolla tube, straight walled in stamen, carpel and fruit. In all organs cuticular striations are absent. Peduncle and fruits are astomatic, bracts and calyx are amphistomatic with anomocytic and anisocytic stomata in bracts and anomocytic in calyx respectively. Corolla lobes hypostomatic with anomocytic stomata. Trichomes are of two types non-glandular and glandular. Most of the organs are papilllose. Trichomes vary in minute details. They are papillae, to unicellular papilloform to bi-tricellular ones. Glandular trichomes are sessile, short or long stalked with multicellular head with dense contents. Trichomes on corolla lobes are typical including tuberculate trichomes. Floral trichomes are found species specific and suggestive of their functional significance.

Key words : Epidermal cells, Floral epidermal features, Floral trichomes, Glandular trichomes, Petrea volubilis, Stomata.

Trichomes are reliable taxonomic markers as they are of diverse types and are diagnostic characters not only helpful in identification of particular plant species but also of crude drugs and detection of adulterants. Moreover in recent times they have attracted the attention because of their secretary products, which range from essential oils to being insect repellents and for biotechnological intervention (Wagner et al. 2004, Marin et al. 2008). Trichomes because of their morphological and medicinal features and metabolites influence several aspects of plant physiology and ecology (Wagner et al. 2004)


Present study deals with the morphological studies on the trichomes along with other epidermal features of all floral parts in Petrea volubilis (Verbenaceae). Genus Petrea volubilis L. is native of tropical America and it is found in many gardens in India.

It is an extensive perennial liana, up to 10 m high, stem ash colored, covered with grayish pubescence. Leaves 14-16 × 6.5-8 cm, elliptic, scabrous above, pubescent on nerves beneath. Flowers 2-2.3 cm long, showy, purple in pendulous, 15-19 cm long axillary racemes remarkable for large persistent star shaped calyx, rachis densely covered with soft whitish pubescence; pedicels slender, 1.8 cm long, cylindric, purplish-green, densely pubescent with shining hairs; bracts 1.5 × 0.4 cm, caduceus, distinct with young flowers, linear, shorter than calyx, acute, entire, softly hairy with shining hairs, older ones leaving a dot like scar, older bracts apparently slight extraxillary. Calyx campanulate, petaloid, purplish-blue, often becoming green, dry in fruits; tube 0.5 × 0.25 cm, narrow at base,
slight expanded above, densely pubescent outside, lobes 5, 2.2 – 2.5 × 0.4 – 0.5 cm, spreading, radiating, star shaped, equidistantly placed, oblong, sub-acute or rounded, posterior two, slight smaller, each 1.8 – 1.9 × 0.4 cm, with reticulum of fine veins and prominent midvein; 5, very short 0.2 × 0.05 cm, acute, alternating scaly papillae present in throat, densely pubescent outside with whitish shining hairs. Corolla deep violet, often deciduous, funnel shaped, 2.2 × 2.3 cm; tube 0.6 – 1.7 × 0.3 cm, short, cylindric, oblique, glabrous, whitish at base, distally purple with obscure purplish stripes, short shining hairs outside, hairy inside; lobes spreading, somewhat unequally 2-lipped, intensely purple. (Figure – 1).

**Figure 1: Petrea volubilis**

**MATERIALS AND METHODS**

Plant material for the present study collected from various gardens in different localities from Amravati and identification is confirmed with standard Floras. Small pieces of floral parts are fixed in formalin-acetic alcohol (FAA) for 24 hours. To get an integrated picture of trichome types and their organographic distribution, mature floral parts including peduncle and fruits were used. Varied temporary micro preparations were made by: Epidermal peels, Mounts using sodium hydroxide (aq.) and 2% acetic acid treatment, Scrapping of trichomes, Transverse sections.

Trichomes were stained in safranin (1% aqueous) and mounted in glycerine. For study of epidermal cells and stomata floral parts like bracts, sepals, petals were treated with 1-2% aqueous sodium hydroxide for clearing. Cleared parts were treated with 2% acetic acid and prepared peels were stained with 1% aqueous safranin followed by mounting in 50% glycerine. Quantitative analysis of stomatal complex was made by calculating stomatal frequency (Salisbury, 1927), size of stomata and epidermal cells from random samplings of 5 different peels on either surfaces in case of dorsi ventral parts. Other parameters include stomatal and epidermal cell shape, distribution and orientation were investigated. Stomatal classification is based on the present morphological classification recorded by Baranova (1992). Observations were made under Olympus compound microscope and camera lucida sketches were made.

**OBSERVATIONS**

Floral epidermal features in surface view are shown in Plates 1 and 2, Figs. 1 – 71.

**PEDUNCLE**

**Epidermal cells** : In between angular portions, polygonal, elongated, papillose, 56 × 16 m; walls - straight, thin; orientation - longitudinal to long axis of organ. Cuticular striations - absent (Plate 1, Fig. 11).

**Stomatal complex** : Surface astomatic.

**Trichomes** :

1. **Non-glandular uniseriate filiform**

   1. **Unicellular conical**

      1.1 Papillae – Body tapering above; papilloform; subacutely pointed at apex; contents hyaline; wall-moderate, thick; surface smooth; lumen broad; seated on single or vertical division-wall between two adjoining epidermal cells, 24 × 20 m (Plate 1, Figs. 1, 3, 5, 8, 9).

      1.2 Body: straight - conical, short or longer, 160×12 m, acutely pointed at apex; base flat; contents thin; hyaline, wall moderate thick or thin; seated upon single epidermal cell (Plate 1, Figs. 1, 3).

2. **Multicellular conical**

   Body - 2-celled in length, 180 × 16 m,
PLATE 1 (Figs. 1 – 38)

pointed at apex; terminal cell longer; contents-hyaline; walls-lateral straight to convex; cross walls straight; surface smooth; seated upon vertical division-wall between 2-adjoining epidermal cells. (Plate 1, Fig. 6)

II. **Uniseriate glandular capitates**

1. **Capitate sessile or shortly stalked**

   Foot-one-celled, not sunken; contents-hyaline; stalk-1-2-celled; narrower than base of head; cells squarish; lower cell longer than broad; basally broader; contents-hyaline; head-spherical, many celled; contents-dense, 40 x 20 m.

2. **Long stalked**

   Foot-1-celled, distinguished, roundish; contents-hyaline; stalk-2-celled; stalk-narrower than base of head; lower cell long; broad end walls arched; lateral walls-straight; contents-hyaline; subterminal cell small, short, much narrower; head-globose, 6-8 celled; contents-dense, 136×16 m (Plate 1, Fig. 10).

**PEDICEL**

**Epidermal cells**: Polygonal, elongated, papillose, 36 x 20 m; walls - straight, thin; orientation - longitudinal. Cuticular striations - absent (Plate 1, Fig. 14).

**Stomatal complex**: Surface automatic.

**Trichomes**:

1. **Non-glandular uniseriate filiform**

   Similar to those of peduncle, 196 x 16 m.

2. **Uniseriate glandular capitate**

   Similar to those of peduncle, 40 x 20 m. Stalk-lower cell much longer (Plate 1, Figs 12-13).

**BRACT**

**Epidermal cells**: **Adaxial surface** - polygonal, papillose, 48 x 20 m; walls – straight; Orientation - longitudinal to long axis of organ. Cuticular striations- absent. (Plate 1, Fig. 26)

**Abaxial surface** - similar to those of adaxial surface, 40 x 16 m. Cuticular striations - absent. (Plate 1, Fig. 31)

**Stomatal complex**: Surface hypostomatic.

**Adaxial surface** - automatic (Plate 1, Fig. 26).

**Abaxial surface** - stomatal distribution - on intercostal area, orientation - oblique, longitudinal; shape - elliptic, guard cells similar to those of lamina. Distributional pattern - nonspecific, few cells apart. Type - anomocytic, adjacent cells 5-6 in number. Size - 24 x 22 m; frequency - 2 / unit square (Plate 1, Fig. 31).

**Trichomes**:

1. **Non-glandular uniseriate filiform**

   1.1 Papillae- similar to those of peduncle, 20 x 12 m (Plate 1, Fig. 15).

   1.2 Body-falcate-conical, 20 x 14 m, subacutely or acutely pointed at apex. Seated upon single or vertical division - wall between 2-adjoining distinguished epidermal cells. Frequent abaxially, marginally (Plate 1, Fig. 19).

   1.3 Body- short, narrow, small, ovate - conical, 100 x 12 m, acutely pointed at apex, base-round; contents-hyaline; seated upon single distinguished, roundish epidermal cell, containing dense contents; surrounded by 4-adjoining cells arranged cross-wisely. Occasional adaxially.

   1.4 Body - flagellate - conical, narrow, 160 x 12 m, acutely pointed at apex. Seated upon vertical division - wall between 2-adjoining epidermal cells. Frequent abaxially on nerves. Occasionally 2-bodies long or short, sharing common basal cell (Plate 1, Figs. 27, 18, 21).

2. **Multicellular conical**

   2.1 Body - 2-celled in length, falcate-conical, 160 x 16 m, acutely pointed at apex; basal cell short, bulbous; terminal cell longer, tapering; contents - hyaline. Seated upon single or vertical division wall between 2-adjoining epidermal cells.
Frequent marginally, abaxially (Plate 1, Fig. 17).

2.2 Body - 2-celled, long, 240 x 12 m, lower cell elongated; base-bulbous, terminal cell much longer, narrow, contents - hyaline, wall - straight. Seated upon group of few epidermal cells. Frequent abaxially on nerves (Plate 1, Fig. 20).

II. Uniseriate glandular capitates

1. **Capitate sessile or shortly stalked**

Similar to those of pedicel, peduncle, 42 x 22 m. Frequent abaxially (Plate 1, Fig. 24).

2. **Long stalked**

2.1 Similar to those of peduncle. Frequent abaxially.

2.2 Foot - 2-celled; stalk - lower cell broad; lateral walls - convex; contents - fine granular; head - 6-8 celled; contents - dense. Frequent abaxially (Plate 1, Fig. 25).

2.3 Stalk - 3-celled, intermittent cell longer; head- 4-8 celled; contents - dense. Frequent abaxially. Various trichomes - 84 x 20 m (Plate 1, Fig. 23).

**CALYX**

**Epidermal cells : Adaxial surface** - regular, isodiametric or elongated, 50 x 32 m; walls-deeply sinuate; orientation-various to long axis of organ. Cuticular striations - absent (Plate 1, Fig. 38).

**Abaxial surface** - similar to those of adaxial surface, 55 x 32 m. Cuticular striations absent (Plate 1, Figs. 36, 37).

**Stomatal complex :** Surface hypostomatic.

**Adaxial surface** - astomatic (Plate 1, Fig. 38).

**Abaxial surface** - stomatal distribution - irregular, uneven; orientation - longitudinal, oblique, transverse to long axis of organ, shape - oval - round, guard cells similar to those of other parts. Distributional pattern - nonspecific, few or many cells apart. Type - predominantly diacytic, cells in pair slightly unequal, sinuate; anomocytic, adjacent cells 3 in number, occasionally adjacent cell commonly shared. Size - 28x22 m; frequency - 12 / unit square (Plate 1, Figs. 36, 37).

**Trichomes :**

1. Non-glandular uniseriate filiform

1. ** unicellular conical**

1.1 Calyx papillae : Body - papillate, triangular, 20 x 16 m, acutely pointed at tip, base - flat; contents - hyaline; surface - smooth. Projecting from margin (Plate 1, Fig. 33).

1.2 Body - short, broad, papilloform, 52 x 8 m, acutely pointed at tip, base-bulbous; contents - hyaline, wall - thin, surface - smooth. Seated upon vertical division - wall between 2-adjoining or 4-ordinary epidermal cells, having common anticlinal walls cross-wisely, arranged. Frequent adaxially and on calyx corona (Plate 1, Fig. 38, Plate 2, Fig. 71).

1.3 Body - ovate-conical, 88 x 40 m, acutely pointed at tip. Seated upon 7-8 adjoining epidermal cells, in rosette. Frequent abaxially (Plate 1, Figs. 32, 34).

1.4 Body - straight - conical, longer or shorter, 160 x 12 m, acutely pointed at apex, similar to those of peduncle. Frequent on outer part of tube, calyx corona (Plate 1, Figs. 28, 29, Plate 2, Fig. 66).

1.5 Body - flagellate-conical, 280 x 12 m, similar to those of bract. Frequent on calyx coronal tip (Plate 2, Fig. 68).

2. **Multicellular conical**

2.1 Body - 2-celled, longer, 240 x 16 m, acutely pointed at apex, similar to those of peduncle. Frequent on outer part of tube (Plate 1, Fig. 29).

2.2 Body - 2-celled, falcate-conical, 200 x 16 m, acutely pointed at apex; lower cell squarish, short; terminal cell longer; contents - hyaline. Frequent on calyx coronal tip (Plate 2, Fig. 67).

II. Uniseriate glandular capitate

1. **Capitate sessile or shortly stalked**

Stalk - 2-celled; cells equal, short, rectangular; contents - hyaline; head -
PLATE 2 (Figs. 39 – 71)

globose, 4-8 celled; contents - dense, 32 × 12 m. Frequent on calyx corona (Plate 2, Fig. 70).

2. Long stalked

Foot - 1-celled, distinguished, cell round – squarish; contents - hyaline; stalk-3-celled, 128 × 12 m; lower cell longer, intermittent cell short, squarish; contents - hyaline or dense; subterminal cell equal to intermittent; contents – dense; lateral walls - straight; head - globose, 4-8 celled; contents - dense. Frequent on outer parts of tube, calyx coronal margin (Plate 1, Fig. 30, Plate 2, Fig. 65).

COROLLA LOBE AND TUBE

Epidermal cells : Adaxial surface - isodiametric, regular, papillose, 34 × 40 m; walls - broadly sinuate, thin, orientation - various to long axis of organ. Cuticular striations- absent (Plate 2, Fig. 50).

Abaxial surface - similar to those of adaxial surface, 64 × 40 m. Cuticular striations - absent (Plate 2, Fig. 47, 48).

Tube- Inner cells - polygonal, elongated, 36 × 20 m; walls - straight; end walls - oblique; orientation - longitudinal to long axis of organ. Cuticular striations - absent. Outer cells - similar to those of inner cells, 40 × 20 m. Cuticular striations - absent (Plate 2, Fig. 57).

Stomatal complex : Surface hypostomatic.

Adaxial surface - astomatic (Plate 2, Fig. 50).

Abaxial surface - stomatal distribution - even; orientation - longitudinal, oblique, shape - oval-round, guard cells similar to those of other parts, inner walls much thicker. Distributional pattern - nonspecific, few cells apart. Type - anomocytic, adjacent cells 5 in number. Size - 40 × 35 m. frequency- 2 / unit square (Plate 2, Fig. 48).

Trichomes : Tube outer part atrichous, trichomes frequent mid-proximally inside tube, near staminal insertion and on lobes.

I. Non-glandular uniseriate filiform

1. Unicellular conical

1.1 Body - straight-conical, short, 100 × 25 m, subacutely or obtusely pointed at apex; base - round or triangular. Similar to those of peduncle. Seated upon vertical division - wall between 2-adjoining arched epidermal cells. Frequent abaxially, marginally on lobes (Plate 2, Figs. 39, 40, 43).

1.2 Body - straight - conical, longer, 140 × 35 m. Hair base surrounded by 7-8 adjoining epidermal cells in rosette. Frequent adaxially (Plate 2, Fig. 46).

1.3 Body - ovate - conical, short, 75 × 30 m, acutely pointed at apex, contents - hyaline or granular. Seated upon 2-4, slight distinguished or arched epidermal cells (Plate 2, Fig. 42).

1.4 Body - short, broad, slight bent, 110 × 28 m, acutely pointed at apex, base - broad, bulbous. Seated upon vertical division - wall between 2-adjoining epidermal cells, protruding, resting on 2-tiered raised epidermal cells. Frequent adaxially (Plate 2, Fig. 41).

1.5 Body - long, tapering, narrow, 200 × 16 m, acutely pointed at apex, base - rounded, contents - hyaline, walls - straight, surface - smooth. Seated on ordinary epidermal cells. Frequent inside tube (Plate 2, Fig. 61).

1.6 Body - long, broad, 368 × 20 m, obtusely pointed at apex; base-round; contents - coarse – granular; wall - warty, verrucose; surface - tuberculated. Seated on single epidermal cell. Frequent inside tube (Plate 2, Fig. 63).

1.7 Corollate papillae Body - 10 × 15 m, rounded or mucronate at tip; contents – hyaline; wall - moderate thick; surface - smooth. Projecting from adaxial, abaxial, marginal cells (Plate 2, Figs. 47, 50, 62).

2. Multicellular conical

2.1 Body - 2-celled, 115 × 32 m, acutely pointed at apex, lower cell bulbous, short; contents - hyaline. Seated upon vertical
division - wall between 2-adjoining, arched, distinguished epidermal cells. Frequent on lobes (Plate 2, Fig. 56).

2.2 Body - 2-celled, 120 × 30 m, obtusely pointed at apex, lower cell short, squarish; terminal cell slight longer; wall - lateral-constricted at cross-walls, cross-wall-straight. Seated upon 2-arched epidermal cells, protruding. Frequent adaxially (Plate 2, Fig. 58).

2.3 Body - 2-celled, 125 × 35 m, obtusely pointed at apex, lower, terminal cells equal, longer; wall - lateral - constricted at cross-wall. Seated upon vertical division - wall between 2-adjoining epidermal cells. Frequent adaxially (Plate 2, Fig. 56).

2.4 Body - 3-4 celled, 225 × 35 m, obtusely pointed at apex, cells of varied length; lower cell short, squarish or broad, rounded, subterminal, terminal cells equal, longer than broad; contents - hyaline, wall - lateral - constricted at cross-walls, little concave. Seated on 2-protruding epidermal cells. Frequent adaxially (Plate 2, Figs. 52, 53).

II. Uniseriate glandular capitates

1. Capitate sessile or shortly stalked

Stalk - 1-2 celled; head - large, spherical or peltate; contents - thin, 50 × 25 m. Frequent adaxially on lobes (Plate 2, Fig. 59).

2. Long stalked

2.1 Foot - 2-celled, not sunken; cells distinguished, arched; contents - hyaline, stalk-2-celled, 215 × 30 m, narrower than base of head; lower cell long, basally rounded; contents - hyaline; subterminal cell short, squarish; contents - dense or hyaline; lateral walls - straight; head - globose, many (10) - celled. Frequent abaxially on lobes (Plate 2, Figs. 44, 45).

2.2 Foot - 1-celled; stalk - 3-celled, 204 × 20 m, as broad as base of head, much longer; lower cell longest, intermittent cell short, squarish; contents - hyaline; sub terminal cell equal to intermittent; contents - dense; head - globose, 2-8 celled; contents - dense. Frequent inside tube (Plate 2, Fig. 60).

STAMEN


Trichomes :

I. Non-glandular uniseriate filiform

Similar to those of inside corolla tube, frequent on lower portion of filament (Plate 2, Figs. 63, 61).

II. Uniseriate glandular capitate

Long stalked

Foot-1-celled; stalk-many-celled, 105 × 20 m, narrower; cells equal, squarish; contents - dense; lateral walls slightly constricted at cross-walls; cross-walls - straight; head-globose, 4-8 celled; contents-dense. Frequent on anthers (Plate 2, Fig. 64).

CARPEL


Trichomes :

Uniseriate glandular capitate

1. Capitate sessile or shortly stalked

Similar to those of other parts. Fewer terminally on style.

2. Long stalked

2.1 Similar to those of other parts.

2.2 Similar to those of anthers.

Fewer on proximal and lower portions of ovary.

FRUIT

Epidermal cells : Irregular, polygonal, small, 12 × 20 m; walls - straight, thick; orientation - various to long axis of organ. Cuticular striations-absent (Plate 2, Fig. 69).

Stomatal complex : Surface stomatic.

Trichomes : Absent.
DISCUSSION

Detailed descriptions of trichomes are available in the literature for many commercially important general (Chaudhary and Dantu 2014). In present study trichomes are categorized between two types non-glandular and capitate glandular. The non-glandular trichomes are having conical tipped terminal cell while capitate glandular trichomes having terminal cell capitate and globose distinguished as head and may be secretory in nature. Chaudhary and Dantu termed conical tipped trichomes as digitiform. They found 3 types of trichomes as digitiform, capitate and branched in Boerhavia diffusa L. They found capitate and digitiform trichomes on floral organs while only digitiform on vegetative parts. In earlier work on Petrea volubilis on study of vegetative trichomes both non-glandular conical and capitate trichomes were noticed (Ingole, 2014). In floral parts number of capitate glandular trichomes is exceeding and may be suggestive of their role as attractants to enhance pollination. The distribution and structure of trichomes on plant surfaces contribute to the control of transpiration and temperature of organ. Trichome density affords the organ protection (Bosabalidis, 2002). Trichomes function in plant defence or act as attractants to facilitate pollination (Weiss, 1997).

In present study, trichomes are found of two major types non-glandular and glandular. Most of the organs are papillose. These trichomes vary in minute details on different parts and ranging from papillae to unicellular papillose to bi-tricellular ones. Glandular-capitate trichomes are sessile, short or long stalked with multicellular head with dense contents. Trichomes on corolla lobes are typical including tuberculate trichomes.

Epidermal cells are found polygonal, straight walled, papillose in peduncle and bract; deeply sinuate in calyx; broadly sinuate, papillose and straight walled in adaxial and abaxial corolla lobes respectively; polygonal, elongate straight walled in corolla tube; straight walled in stamen, carpel and fruit. In all organs cuticular striations are absent.

Peduncle and fruits are astatic, bracts and calyx are amphistomatic with anomocytic stomata in bracts and diacytic and anomocytic in calyx respectively. Corolla lobes are hypostomatic with anomocytic stomata.

CONCLUSION

Floral trichomes are suggestive of their functional significance. They differ in their details and are special and typical for particular taxon and particular organ and surface. Other floral epidermal features including nature of epidermal cells and stomata are also species specific when considered correlative and useful as an aid to identification.

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