**Urtica dioica** Linn.

A perennial dioecious often robust herb 1-1.5 mm high with grooved stem. Leaves opposite long stalked, ovate or lanceolate, base usually cordate, tips long-pointed, margins usually cordate, long-pointed, with large, coarse, acute, regular teeth; stipules usually free. Flowers small, green, clustered on the branches of loosely spreading axillary panicles. Fruit a flattened achene embraced by the persistent perianth.

**Leaf**

**Lamina**

Dorsiventral, hypostomatic.

The upper epidermis (Fig. 20:1,3-5) is single layered. The cells in surface view, are polygonal, isodiametric to elongate, with flat walls, 20-42 μ long and 14-24 μ broad, scattered within are numerous cystoliths, usually spherical in shape, 35-42 μ in diameter; other shapes (and sizes) are oval, pyriform to conical, elongate, groundnut like (elongate with one constriction on the long sides). They show reticulate wall thickenings. The subsidiary cells are not markedly different from the adjacent epidermal cells. The cystoliths are not associated with trichomes. In T.S., the epidermal cells appear more or less rectangular 14-21 μ high and 14-24 μ broad with the outer walls convex to rounded radial walls, the inner concave, and the sometimes undulate. The cuticle is a very thin, cutinized and smooth. The cystoliths, in T.S., appear spherical to ovoid, attached directly at the dorsal wall of the lithocyte or are carried on a short stalk, the lithocyte lies embedded in the palisade tissue up to 50 μ deep.

The lower epidermis (Fig. 20:2,4) is also single layered with isodiametric to elongate cells, differing from those of the upper
epidermis in having sinuous contacting walls and being comparatively smaller in size. Cystoliths similar to those of the upper epidermis and also about as numerous occur on this surface as well. In T.S., the epidermal cells appear widely rectangular upto 14 µ high and 14-24 µ broad. The cuticle is thin, cutinized and smooth. The cystolith cells in contrast to those of the upper epidermis are not deeply embedded is punctured by anomocytic superficial stomata.

The mesophyll is differentiated into palisade and spongy parenchyma. The palisade (Fig. 20:3-5) is normally single layered though the cells of the spongy tissue in contact with this layer are often vertically elongate giving the palisade a double layered appearance. The cells are columnar, appear compact and about 18 µ high and upto 7 µ broad. They contain abundant peripheral chloroplasts.

The spongy tissue (Fig. 20:4) is greater in extent than the palisade, 28-35 µ in extent. It comprises globular to oval cells rather densely packed. They contain few peripheral chloroplasts.

The mesophyll under the stinging hairs is almost all spongy (Fig. 20:6).

Midrib (Fig. 20:7-9)

The leaf in this region shows a prominent dorsal groove. The midrib in itself, however, exhibits a circular outline. The upper epidermal cells are in a single layer, vertically oriented, narrow 1.5-2 as high as wide, about 18 µ high and upto 10 µ broad, with outer rounded walls. The cuticle is thin, cutinized and wavy. The lower epidermal cells are similar in shape, 14-18 µ high and upto 13 µ broad, with rounded outer walls and covered by thin cutinized, wavy cuticle.
The epidermis is followed by a 2-3 layered angular collenchymatous zone of small cells sometimes with small lacunae here and there. It is about 42 μ in extent under the upper epidermis, 1-(or occasionally 2-) layered of larger cells, about 35 μ in extent above the lower epidermis. On the sides (the middle) of the midrib, the cells are parenchymatous.

The ground tissue is parenchymatous comprising large, thin walled oval or rounded cells, with small intercellular spaces. A few cells on the dorsal side contain clustered crystals of calcium oxalate.

The stele (Fig. 20a) is crescent-shaped and is situated closer to the dorsal side. The xylem lining the inside of the crescent faces the upper epidermis, and has its usually solitary vessel elements arranged in a basal layer narrowly or widely spaced from one another. A few scattered ones occur in front of this basal layer. The vessel elements have a circular or oval lumen with a radial diameter upto 24 μ. The phloem occurs on the convex side of the crescent facing the ventral side.

**bundle sheath extensions** (Fig. 20a, b, e)

In the major veins the vascular elements are enclosed in a sheath of thin walled oval cells. This is almost always in contact with the lower epidermis, whereas it is extended towards the upper usually by single layer, one to two cells wide, of thin walled cells. The upper epidermal cells in contact with the sheath extension cells are smaller than the rest of the epidermis. In contrast the lower epidermal cells in this region are larger than the rest, 13-21 μ high and upto 21 μ broad.

The minor veins lack a dorsal extension. The vascular elements along with the bundle sheath occupies whole of the spongy region.
Fig. 20. *Urtica dioica*.

1, 2. Leaf epidermis in surface view: (1) dorsal and (2) ventral. 3-6. T.3. lamina: (3) through major vein and (5) through minor vein and (6) under stinging hair. 7. T.3. midrib (Diag.). 8, 9. Midrib dermal tissues: (4) upper and (9) lower. 10-12. T.3. petiole: (10) Diag. X 15 (11) showing spongy and (12) collenchymatous sub-epidermal zones. 13, 14. T.3. stem: (13) diag. and (14) cellular sector. 15-23. Structure and development of glandular trichomes.
petiole (Fig. 20: 10-12)

In outline the petiole is deep-arc or horse-shoe shaped (Fig. 20: 10). The epidermis consists of a single layer of rectangular to oval cells, about 14 \( \mu \) high and up to as broad, with outer convex to rounded walls. It is covered by a thin, cutinized wavy cuticle, followed by collenchymatous zone of uneven thickness which is single layered under the dorsal notch, 1-few layered along the convex side, and several layered at the horns. It is generally of the angular type, though small lacunae are also observed at some places. The tissue is not continuous under the epidermis, its continuity being broken, at about six places in the dorsal half, by mesophyll-like chlorophyllous, thin-walled, loosely arranged cells. Just down the slope towards the notch, the chlorophyllous zones is seen to contain a cystolith-cell lying deep into whole of chlorophyllous region.

The vascular structures comprises 6-7 discrete bundles almost equally spaced in an arc shaped manner separated by, and embedded in, a parenchymatous ground tissue of large thin-walled rounded or oval cells with small intercellular spaces. Each vascular bundle is collateral, xylem facing the notch and the phloem the convex side of the petiole. The xylem contains usually solitary, oval and almost uniformly scattered vessels with radial diameter of up to 24 \( \mu \). Occasionally the elements are paired or crowded, and in such cases they are polygonal. Clustered crystals of calcium oxalate occur in a few phloem parenchyma cells.

STEM (Fig. 20: 13, 14; 21: 6)

The young stem in outline is four lobed, the lobes being arranged crosswise. It is bound by a single layered epidermis of more or less rectangular narrow cells about 14 \( \mu \) high and 10 \( \mu \) broad with rounded outer walls. The cuticle is very thin but highly
cutinized. Occasionally cystoliths contained in large cells up to 24 μ deep and as wide are also observed.

The epidermis is followed by a 2-3 layered collenchymatous zone of small polygonal cells with angular thickenings. Its continuity is interrupted along the slopes by thin-walled, rounded 3-4 layered chlorophyllous cells. Next is a few layered zone of cortical parenchyma cells, almost compactly arranged, with little or no intercellular spaces.

The vascular bundles are discrete, occurring in groups of three (in one lobe four) closer together in each lobe, separated, from the other groups, by wide parenchymatous medullary rays lying opposite the grooves. Each vascular bundle is collateral and open. The secondary vascular structure is in the form of a continuous cylinder. The xylem is traversed by narrow medullary rays. The primary and secondary xylem are distinct. Solitary or variously clustered secondary xylem vessel elements occur in diverging radial strands separated by tangentially alternating bands of lignified and un lignified parenchyma (Fig. 21: 6). The vessels have simple perforations. The secondary phloem elements contain a large number of clustered crystals of calcium oxalate. Isolated patches of pericycle fibres with cellulose thickenings occur outside the secondary phloem.

The pith is parenchymatous. The cells are large, rounded with small intercellular spaces. Many cells contain clustered crystals.

TRICHOME

Both glandular and nonglandular trichomes are found on the young vegetative organs. They originate from the superficial epidermal cells.
glandular trichomes: It is of spherical as well as peltate head type. The foot in either case is one celled.

The stalk is single celled, usually elongated and 20-25 μ long and 5-8 μ broad, narrower towards the base and gradually broadening above (Fig. 20:20-23). The head is pleuricellular and of two types: (i) peltate-head which has typical peltate arrangement (Fig. 20:26) and (ii) the spherical head where the cells are arranged in two layers, being 27 μ in height and 25-27 μ in breadth (Fig. 20:22-23).

The initial protrudes outwards as a papilla, being full of dense protoplasmic contents (Fig. 20:15). It soon elongates and undergoes two transverse divisions to form a row of three cells (Fig. 20:16). The basal foot, the central stalk and the terminal cell which is spherical in outline, full of dense cytoplasmic contents, is destined to form the head. The foot may undergo slight elongation and the stalk elongates fairly to carry the head much above the surface. Further division in the head cells are different.

In the peltate head, the first division is vertical, dividing the head into two unequal cells (Fig. 20:24). Next another vertical to oblique division is laid in the larger cell forming a three celled head (Fig. 20:25-27). Further divisions are also vertical, each cell dividing once or twice (Fig. 20:28). The cells meanwhile expand laterally producing the characteristic peltate-structure at the centre of which the stalk is attached.

In the spherical head type, the first vertical division of the head cell is equational producing two equal cells (Fig. 20:17, 18). The next division is also vertical and at right angles to the first producing four diagonally opposite cells (Fig. 20:19). This is followed by a transverse division in each cell resulting in a two
layered head of four cells each (Fig. 20:20-23). The cells expand out slightly to produce the characteristic spherical head.

**Non-glandular trichomes**: They are usually simple, single celled superficial structures of not very varied types. They fall under the following two categories:

(1) **Stinging hairs**: They are of the universal occurrence on all the vegetative organs and persist almost through its life. A typical stinging hair consists essentially of a single large cell with abundant protoplasmic contents (Fig. 21:1,5). The lower end of the cell is expanded to form a vesicle or bulb which is embedded in a cup shaped emergence. The hair gradually tapers anteriorly ending, however, in a small swollen head attached obliquely with the tip of the hair. This terminal swelling breaks off at the slightest touch, leaving an open point which can readily penetrate into the body (Fig. 21:7). Except in the region of the bulb the wall of the hair is thick and brittle, the distal part being silicified and the proximal calicified. The stinging hair may be up to 1 mm long with the bulb about 30 μm broad.

The chemical nature of the irritant material in the stinging hairs has not been definitely established. At one time it was supposed to be formic acid, but Heberlandt (1914) has disproved it. Instead he believes it to be an albuminoid substance, held in solution in the cell sap, and in many respects resembling an enzyme, especially as regards its solubility. Flury (1928) believed the irritant to be a non-nitrogenous, unsaturated substance of an acid nature resembling resinic acid.
(2) **Bracket**

(a) **Shortly or longly conical**: Borne on the leaves, petioles and stems, these hairs have a broad base about 30 μ wide and a gradually tapering body ending in a fine point (Fig. 21:2, 3). The are 140-180 μ long with a thick wall. The epidermal cells surrounding the foot are slightly greater in height tending to form a collar.

(b) **Fusiform**: Borne on all the vegetative organs, just above the foot, the base of the body is swollen and about 22 μ broad, gradually tapering towards the apex into a sharp point (Fig. 21:4). They are about 130-150 μ long with a straight or bent body. The wall towards the distal end is thrown into wart-like tumors.

*Urtica pterygota* Roxb.

A perennial, monoecious herb with copious stiff stinging hairs, and slender, sparingly branched, obtusely angled stems, 1-2 m high. Leaves ovate or lanceolate, usually cordate, 5-10 x 2½ - 7 cm, long pointed at the tip, with small, acute, irregularly jagged teeth; petiole 6-50 mm; stipules united.

**Leaf**

**Lamina**

Dorsiventral, hypostomatic.

Both the upper and lower epidermis are single layered (Fig. 21:8, 9). The cells in the upper are rectangular, 2-3 as long as wide. The outer walls flat to convex, all walls being thinner. In the lower epidermis the cells are also rectangular 2-3 as long as wide. The epidermal cell directly above and below lateral veins are very large with rounded outer faces. The cuticle is thin and smooth.
The palisade is single layered, cells cylindrical, thinner, compactly placed and nearly \( \frac{1}{2} \) leaf depth. The tissue is separated from the epidermis by a lumen. It does not extend into the midrib nor over the veins. The spongy tissue is parenchymatous without sclerenchyma. The cells are spherical to oval with straight to wavy walls. Cystoliths are common on the upper surface, some as deep as spongy tissue.

**Midrib** (Fig. 21:10-12)

The midrib is nearly spherical in outline with shallow mid-dorsal groove and a very irregular surface. The dorsal epidermal cells are shorter, vertically placed and highly thick walled with outer rounded faces. The lower epidermis has cells 2-3 as long as wide, narrow and with equally thickened walls. The hypodermis is 3-4 layered with shorter cells in dorsal and larger cells in the ventral region basically angular collenchyma, leading into a 3-5 layered parenchymatous zone, with large, polygonal cells with wavy walls and often intercellular spaces.

**Petiole**

The petiole (Fig. 21:13,14) is spherical in outline with deep mid-dorsal groove at the base and smooth surface. The upper epidermal cells resemble those in the midrib but the hypodermis has large cells with highly thickened angular collenchymatous region 1-2 layers at dorsal region and 2-3 layers in ventral region. The ground tissue is parenchymatous, of polygonal cells with wavy walls. Stellate crystals are common in this tissue. In the lower epidermis the cells are vertically placed, slightly larger than those in upper epidermis.

**TRICHOME**

Both glandular and nonglandular trichomes are superficial in
origin, the latter are more common, even on mature vegetative organs.

*Glandular* (Fig. 21:15-21). It is typical peltate type. The foot is either undistinguished from the adjacent cells or much wider; and the stalk appears to have been eliminated with the result that the head rises hardly above the surface.

The three celled stage (Fig. 21:20, 21) is rare, the first division in the head may divide it into 2 equal (Fig. 21:17, 18) or unequal halves, in the former instead of the first 3-celled peltate head, a 4-cell head would be the result.

*Non-glandular* (Fig. 21:22-29). It is typically of bracket type, with various modifications in the foot.

(1) *Filiform*: Foot unmodified, the body filiform and short (Fig. 21:22).

(2) *Elongated-acicular*:

(a) Foot unmodified, hardly to not wider than adjacent cells, simple (Fig. 21:25) or with lateral sides in body elongated, variously bent.

(b) Foot modified; dilated laterally, 3-10 as wide as adjacent cells, the base flat to concave (Fig. 21:23) or with a central peg (Fig. 21:27).

(c) Foot dilated in pyriform shape the wall of the trichome warted (Fig. 21:29).

Trichomes of the type figured in 21:24 appear to be of stinging type. An unusual type, not uncommon had the foot 2 celled with a short, bent conical body (Fig. 21:30).
1-7. **Urtica dioica.** 1,5,7. Stinging hair with the head removed in (7). 2b-4. Non-glandular hairs. 6. T.S. old stem showing alternate tangential bands of lignified and unilignified parenchyma.


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Fig. 22.


Laportea Gould.

Perennial herbs, shrubs or trees. Leaves alternate, entire or toothed, 3- or penninerved; stipules in opposite free or connate pairs. Flowers in axillary paniculate usually unisexual cymes or racemes. Achene oblique, flattened or compressed.

Leaf

*L. microstigma* (Fig. 22: 14, 15).

Dorsiventral, hypostomatomic. The upper epidermis is two layered, the cells of the outer layer in surface view are regularly polygonal. In T.S. they are 2-3 as long as wide, rectangular; all the walls being thin, the outer flat to insensibly convex in the next layer the cells are larger, + squarish, 2-3 as wide as the upper layer. Occasionally radial walls wavy in upper epidermis (outer layer). The cuticle is rather thin on both the surfaces. The lower epidermis is single layered, of narrow cells, 2-2.5 x as long as wide, with the outer walls + convex.

The palisade is 2 layered, cells being narrow cylindrical and compactly placed, occupying less than \( \frac{1}{2} \) the depth of leaf. It does not extend into the midrib or over the lateral veins. The spongy tissue is composed of spherical compactly held cells without aerenchyma.

Cyslothis are common on the upper surface, of vermiform type as deep as spongy tissue; or spherical with a long drawn out neck and not going beyond the first layer of palisade.

Trichomes are common on both surfaces. Stomata are of ranunculaceous type.

*L. decurrens* : Dorsiventral. The upper epidermal cells in surface view are large, polygonal with distinct intercellular spaces and thin
cuticle. Those around the base of nonglandular trichomes are arranged in form of a ring. The lower epidermal cells are larger but unequal in size with wavy walls and numerous cuticular striations. The stomata are of ranunculaceous type.

Trichomes are common on both surfaces, cystoliths are occasional, mostly with a spherical body.

The pith in the stem (Fig. 22:58-61) abounds in canals. It is composed of parenchymatous cells in which are found crystals of various shapes. Trichomes are common on stem surface also.

TRICHOMES

Both glandular and nonglandular types are superficial in origin.

Glandular: It is either peltate or oblong type. The earliest stages in development are similar (Fig. 22:43,45,46,47,49).

Peltate: (Fig. 22:16,13,19,55-57). The head has the typical peltate appearance in L. microstigma but the stalk is definitely eliminated. The foot either remains very short, undistinguishable from the adjacent epidermal cells and hardly lifting the head above the surface (Fig. 22:13,19); or the foot may elongate outwards and lift the head above the surface (Fig. 22:55-57). In L. decurrens the head though peltate is capitate - oblong in shape.

Oblong (Fig 22:17,43,50). Here the normal 3-cell stage is the rule and the first vertical wall is laid in the head cell which before undergoing further divisions (mainly transverse) elongates further, assuming oblong shape. The stalk may remain uni or biseriate and often increase in length. This type is found in both L. microstigma and L. decurrens.

In L. decurrens, there are instances of spherical head also
being detected (Fig. 22:52,53) but only two such were observed.

In *L. microstigma* simple glandular trichomes, a spherical unicellular head on an elongated stalk (Fig. 22: 25,26) or glandular elongated cells (Fig. 22:20) were also observed.

_Nonglandular_. In *L. microstigma* it is short unicellular, simple and of bracket type. The foot is dilated with flat to concave base (Fig. 22: 23,24).

In *L. decurrens*, the nonglandular trichome is of bracket type, long filiform or acicular, in the latter case with the apex bent or straight (Fig. 22:28 -42). They are either unicellular, or divided into 2 or 3 cells, some have a tip recalling the stinging apex in _Urtica_ (Fig. 22: 38, 31).

(1) _Unicellular_. These are either short, conical structures with the foot simple (Fig. 22:23,29,41) or elongated(-acicular) with bent apices (Fig. 22:32) and the foot short, peg like (Fig. 22:30) or bulbous (Fig. 22:33, 37) or apices straight and the foot narrowly expanded with two side pegs (Fig. 22:34).

(2) _2-many cells_. They are either acicular, straight tipped, 2-5 celled, the foot bulbous or pegged (Fig. 22: 39,40,38) straight, hooked (Fig. 22:36) or at an angle (Fig. 22:42); or the tip may be beaked (Fig. 22:35).

_Urera baccifera_

_TALHOME_

They are superficial in origin and borne on all vegetative organs.
glandular (Fig. 22:1-7). It is typically peltate, though development is characteristic. The initial protrudes outwards into a papilla and undergoes a transverse division, cutting off a short foot (Fig. 22:1) followed by another transverse wall in the outer cell which has elongated) dividing it in two equal cells (Fig. 22:2), the terminal cell is the head cell. Uncommonly, the stalk cell is suppressed and the first wall laid is vertical (Fig. 22:1). The basal cell (foot) may remain short (Fig. 22:4) or elongate slightly or to much extent (Fig. 22:3, 7). The head either tends to undergo typical divisions leading to peltate head or the walls may be slightly displaced (Fig. 22:3-6). Fig. 6 shows an instance where the stalk is bisporate but appearing as a part of the head. Such cases were rarely observed.

Non-glandular (Fig. 22: 8-11). These are of four types, simple and unicellular:

1. Acicular brackets. These are thin, usually bent with simple foot and smooth walls (Fig. 22:8).
2. Filiform, short, much dilated with the foot and 1-1.5 as wide as adjacent cells (Fig. 22:9).
3. Short conical, dilated, foot pseudopodial (Fig. 22:10).
4. Elongated with much dilated foot and a heavy collar (3 cells a cross, 3-4 cells high) around it (Fig. 22:11).

The stem shows the usual structure; the epidermis of short 2-1.5 as long as wide thin walled cells. The cuticle is + thin. The hypodermis is hardly differentiated. The cortex is composed of large polygonal parenchymatous cells with wavy walls and intercellular spaces. Pericycle fibres are common and appear in 1-3 layers in a T.S. (Fig. 22:12). The wood does not show any special peculiarities. Crystals (Fig. 22:13) are common in cortex.
Fleurya interrupta Gaud.

An annual, erect, nettle-like, usually branched herb, 0.75-1.50 m high, covered with stinging hairs. Leaves soft, 5-15 cm, ovate, pointed at the tip, rather rounded or slightly pointed at the base and with prominent teeth along the edges. Petiole as long as the blade and the stipules connate in opposite pairs. Monoecious or dioecious, flowers small inconspicuous, clustered in solitary axillary, spiciform or paniculate, very slender, erect cymes, 15-30 cm long. Fruit an oblique, compressed and membranous achene.

Leaf

Lamina

Dorsiventral, hypostomatic.

The upper epidermis (Fig. 23:2) is single layered. In surface view the cells are polygonal, with straight and thin walls. In T. i. they are rectangular, 2-3 as long as wide, the outer walls flat to insensibly convex and the lateral wavy. There is lumen between the inner walls and the palisade. All walls are thin. The cuticle on both surfaces is rather thin.

The lower epidermis (Fig. 23:1, 2, 5) is single layered, cells in surface view are large, polygonal with wavy walls; in T. i. they are rectangular, thinner than in upper epidermis, 2-3 as long as wide, many projecting slightly to markedly outwards; cells bordering the non-glandular trichome bases show cuticular striations on both the surfaces. Stomata are of ranunculaceous type.

The palisade (Fig. 23:2) is single layered, the cells wide, tending to be rectangular, compactly placed, about the leaf
depth. The spongy tissue is hardly 2 layered, the cells spherical with wavy walls, intercellular spaces but no aerenchyma. Trichome except for a few acicular nonglandular ones were not observed but cystoliths are numerous on both surfaces, being of long verniform shape, almost confined on either side of veins (Fig. 23: 1, 6, 7).

**Midrib** (Fig. 23: 2)

The midrib is nearly spherical in outline with a shallow middorsal groove. The upper epidermis is hardly 1-3 cells; cells being 2 x as long as wide with 1-2 layered hypodermis of thick walled spherical cells. The lower and lateral epidermal cells are short, vertically placed with outer rounded walls and highly thickened. There is no hypodermis, the ground tissue being of large polygonal cells with wavy walls, intercellular spaces and thin walled 4-5(-6) layered on ventral side and 2-3 layered on lateral side. Nonglandular trichomes are common on midrib. The cuticle is thick, uneven.

**Petiole** (Fig. 23: 3, 4)

The epidermal cells in the petiole are as long as wide, vertically placed with outer rounded walls followed by a ground tissue of large, polygonal parenchymatous cells with or without small intercellular spaces, and 3-4 layered all round. The outer walls of lower epidermal cells are projected outwards often into papillae, giving it a rough appearance. The cuticle is thick and wavy.

In *E. cuneata* the epidermal cells appear similarly shaped in surface view but show numerous cuticular striations. They form a ring around the base of nonglandular trichomes. Non-glandular of *bracket* type with enlarged spherical foot.
Vermiform cystoliths are also met with.

Non glandular trichomes. They are simple, unicellular either short conical to filiform or acicular. The foot is either simple, + spherical (Fig. 23:8, 9, 10) or much enlarged into a pseudopodium (Fig. 23:11) or 1-1.5 as wide as the adjacent cells (Fig. 23:12).

*Girardinia heterophylla* DCne.

A tall, stout, erect, tufted, perennial herb, 1-2 m high, armed with very long, rigid, sharp stinging hairs and with the stem and branches furrowed. Leaves large, broadly ovate 3-nerved, 10-30 cm long and often as broad with sharply toothed margins, upper leaves often palmately 3-5 lobed; petioles 10-15 cm long; stipules large, foliaceous and connate. Dioecious or monoecious with small and green flowers clustered in paniced cymes; the male cymes shorter than the leaves, while the female elongate (sometimes 32 cm long and pendulous), becoming thick and densely bristly in fruit. Fruit broadly ovate or sub-cordate compressed black achene with the persistent style.

Leaf

Dorsiventral, hypostomantic.

The upper epidermis is single layered (Fig. 23:13); cells in l.s. are rectangular, 2-4 as long as wide, the outer walls flat to convex, the radial straight and the inner walls slightly projecting inwards, all walls thin. Between the inner walls and the palisade is lumen. The cuticle is + thin on both surfaces. The lower epidermis (Fig. 23:13) is of shorter cells, resembling otherwise the upper epidermal cells. Stomata are of ranunculaceous type. Trichomes are common on both surfaces but cystoliths are less frequent.
The palisade is composed of short columnar cells, in two rows. The cells are unequal in size and mostly project into the spongy region. Palisade is not compact. The spongy tissue is parenchymatous, occupying more than ½ the leaf depth. Cells are spherical, loosely oriented with large aerenchymatous cavities.

STEM

The stem in T. s. (Fig. 23:14-16) shows the epidermis composed short, vertically placed thickly set cells, highly thick walled, the outer faces convex to rounded to projecting outwards. The hypodermis is thick walled, 3-4 layered with thickened corners; followed by cortex of large, polygonal cells with wavy walls, most of the cortical cells contain spherical crystals, which also abound in the pith where they occur in rows.

TRICHOME

Both glandular and nonglandular trichomes are superficial in origin.

Glandular: Two types are discernible: the peltate and the oblong.

Peltate (Fig. 23:35-42) 51. Early development shows clearly a variation in that the stalk is either eliminated (Fig. 23: 35,37,39) or formed regularly (Fig. 23: 38,41).

(a) Stalk eliminated: Here again two types of development are noted:

(i) Here after the first transverse wall is laid the terminal cells hardly elongates further and soon undergoes a vertical division dividing it into 2 equal or unequal cells. However, the foot remains very short or 1-1.5-2 as wide as the adjacent cells and the head only slightly laterally dilated.
The head in such cases is hardly above the surface and often situated in a "pit".

(ii) The initial protrudes outwards into a papilla and before a transverse wall is laid it elongated further and soon cuts off a small terminal cell. The latter now undergoes the typical divisions leading to a peltate head. The "elongated" basal cell becomes the foot!

(b) Stalk present: Here the initial divides by two transverse divisions to form a 3-celled filament, the terminal forming the head, the middle the stalk and the basal the foot.

Oblong (Fig. 23: 43-50) The three cell stage is the rule here, but the position of the seta cell is displaced.

(i) In normal cases the initial immediately cuts off a foot and the terminal cell undergoes another transverse wall forming two equal or unequal cells, the terminal forming the head (Fig. 23:43,44,47). The first vertical wall is laid into this cell but soon the stalk cell follows suit often the stalk cell and the head now elongate further and the stalk cell may undergo a transverse division (Fig. 23:43). Rarely wall formation is up to the foot (Fig. 23: 49).

(ii) The initial before cutting off a foot elongates into a filament, and soon a transverse wall is laid in the upper half. The terminal cell before dilating laterally, immediately cuts off a basal small cell. This is the stalk cell, and it-self assumes a spherical shape (Fig.23:45,46). The basal elongated cell is the foot. In the terminal cell the first wall is vertical and further vertical and transverse divisions in the head (which elongates in the
meantime) result into an oblong and elongated (Fig. 23: 49, 50).

**Nonulundular.** They are simple, unicellular with walls thin or thick, smooth or warted and often with a collar around the foot. They belong to the bracket type but are filiform or acicular.

(a) Filiform (Fig. 23: 19, 20 A, 21). The trichome is short, rather oblong (Fig. 23: 21) or long with rotundate to rather oblong (Fig. 23: 21, 20A). The foot is pseudopodial collared (collar 3-5 cells high 6-8 cells across and strong; Fig. 23: 21); much dilated laterally with a collar 2-3 cell high and 8-10 cells across (Fig. 23: 19); or it may be simply pseudopodial and without a collar (Fig. 23: 20 A).

(b) Acicular: Collared

(i) Trichome short with the foot 2-3 pegged (Fig. 23: 23) or raised on a platform (foot dilated into 2 lateral pegs) surrounded by 3-4 very short trichomes with warted walls (Fig. 23: 25) and acute-acuminate tips.

(ii) Trichome long, elongated with a broad base. The foot may be much dilated with 2 broad rounded pegs and a collar much stronger and characteristic (Fig. 23: 22) with a short basal row supported on elongated row of cells, wider at base and narrowed towards the mouth, at least 8-10 cells across. Another type with collar simple 2 cell high and 6-3 cells across is shown in 26.

**Collar absent**

(i) The foot may be less enlarged laterally but dilated laterally and longitudinally in such a manner...
Fig. 23.


Fig. 24. *Pilea scripta*.

as to form a raised heel and sole (resembling human foot) the sole deep set in epidermis (Fig. 23:30). A definite collar was not discernible in such cases.

(ii) The trichome is short, with much warted wall, the foot short pseudopodial, resembling a "golf tee", (Fig. 23:29).

(iii) The trichome elongated, tip tending to be bent, walls much thickened, lumen only detectable in lower 1/3, the foot much enlarged with irregular (indistinctly pegged) base (Fig. 23:32 A) such types are also very short (Fig. 23:32 B).

In a rare case of this type the foot was separated from the body by a transverse wall and had become biseriate (Fig. 23:31). It is doubtful, some trichomes are massive approaching a spine (Fig. 23:17, 24, 28).

Pilea acerata Wedd.

A tall and branched, glabrous herb. Leaves elliptic lanceolate, 7-15 cm long, 2½ -7 cm wide with long pointed tip, acute or narrowed and rounded base, rarely notched, and minutely toothed margins; petiole 1.5- 5 cm; stipules short. Monoecious or dioecious; flowers minute, green sessile, in stalked axillary, dichotomously branched cymes. Fruit a minute less than 1 mm ovoid or elongate rough achene, granulate within the intramarginal ridge.

LEAF

Lamina

Dorsiventral, hypostomastic.

The upper epidermis is two layered (Fig. 24:1) cells in
surface view are regularly polygonal and sclerenchymatous. In T. s. the outer cells are large, as long as wide, with the outer walls ± convex to flat, the lateral straight and the inner ± undulate, all walls are thin. The inner layer is of short cells, each 1.5-2 as wide as long, thin walled and with lumen between their inner walls and the palisade. The epidermis is about 1/2 the leaf thickness. The cuticle is thin on both surfaces.

The lower epidermis (Fig. 24: 4) is one layered, of thin, rectangular cells 3-4 as long as wide with the outer walls flat to convex. Stomata are of the ranunculaceous type.

The mesophyll (Fig. 24: 1,4) is nearly ½ the leaf thickness and does not extend into the midrib or over the veins. The palisade is single layered and compact. The cells are short cylindrical hardly to not intruding into spongy tissue. The latter is parenchymatous without sclerenchyma; the cells being spherical - rounded with intercellular spaces.

Cystoliths and trichomes are common on both leaf surfaces.

**Midrib**

The midrib is spherical in outline with a slight mid-dorsal cell depression. The upper epidermal (Fig. 24: 3,7) are thin walled, elongated as well as narrow and vertically placed with a ± thin cuticle. The outer wall of elongated cells is convex and rounded to papillate in narrower cells which are restricted to regions between or adjoining the trichomes and for cystoliths. The lower epidermal cells (Fig. 24: 6,8) are strongly thickened, the outer thick walls projected outwards as papillae or forming 2-3 pegs over each. Nearly all cells are potential trichomes. The ground tissue is 6-7 layered of very thick walled angular collenchymatous cells.
petiole

The petiole is spherical in outline at the base with a deep mid-dorsal groove. The epidermal cells (Fig. 24: 9, 1) are rectangular narrow 4-5 as long as wide with flat (concave) to convex outer walls. Rarely the outer walls are rounded. Numerous cystoliths project much above the surface and give it a rough appearance. The cortex is composed of 2-3 layers large, angular collenchymatous cells, the thickened corners appearing as heads. The ground tissue is parenchymatous, the large polygonal cells tending to be collenchymatous.

STEM

The stem is circular in outline with roughened surface (Fig. 24: 30). The epidermis is composed of long rectangular cells with the outer walls convex to rounded to projected outwards as papillae (Fig. 24: 32, 34). The cortex, angular collenchymatous, highly thickened (Fig. 24: 31) and harbouring a few canals (Fig. 24: 33). It is 3-5 layers deep with frequent presence of fibres, which are often in 1-2 rows (Fig. 24: 30-33), star (and other shaped) shaped crystals are common (Fig. 24: 37). The cortical parenchyma is wholly parenchymatous, cells polygonal and with wavy walls. The pith is parenchymatous (Fig. 24: 30) with numerous cells containing crystals of various shapes (Fig. 24: 36). Patches of an inter xylary lignified parenchyma are present (Fig. 24: 30).

TRICHOME

Both glandular and nonglandular trichomes are common on all vegetative parts; and superficial in origin.

Glandular: It is primarily of peltate head type, though rarely an oblong head is also observed (Fig. 24: 29).
In the peltate head, suppression of the stalk cell (Fig. 24; 3, 4, 17-22, 24, 26, 27) is as common as its retention (Fig. 24; 23, 25, 28). The early stages in development are typical and the peltate head soon becomes pleuricellular and massive (Fig. 24; 27, 28). The foot normally remains very short and is hardly differentiated from the adjoining cells; the head hardly to not raised above the surface, and occasionally situated in a pit; or may be elongated narrow or wider and raising the head above the surface. Uncommonly the head may first undergo a transverse division followed by vertical walls in the upper cell in the usual fashion, but only one vertical wall being laid in the lower (Fig. 24; 24 b).

**Nonglandular**: It is simple, unicellular, bracteate type, the principal shape being filiform. The foot is variously modified. Initial stages are similar (Fig. 24; 11, 12).

(a) Short filiform, straight or bent at an acute angle (Fig. 24; 7, 14), with a rounded apex. The foot is wide, 2-3 as wide as the adjoining cells, with 2-3 pegs at the base (Fig. 24; 7, 14).

(b) Long filiform. The foot is either dumbbell shaped (Fig. 24; 3 right) or wide with a broad (Fig. 24; 3 left) or a narrow peg (Fig. 24; 3 centre).

(c) Short, conical, triangular, spindle shaped, usually around the leaf apex and margin (Fig. 24; 15).

(d) "Tongue" shaped with subrotund apex (Fig. 24; 13) the foot is as wide as the body of the trichome.

(e) Rarely the trichome may be biseriate (Fig. 24; 7 left), the foot being wide with a single median peg.
Cystoliths: These have spherical, spindle, vermiform or of various shapes and are much raised above the surface (Fig. 24; 39, 10, 5, 7, 31-33, 35). The adjoining cells form a roof over the cystoliths.

Pilea umbrosa Wedd.

A tall and robust herb, often densely clothed with flexuous cellular hairs. Leaves broadly elliptic-ovate or oblong, 7-12 cm long, 5-8 cm wide, with a wedge-shaped, rounded or cordate base, tail-like tip and broadly toothed margins; petiole 2½ - 7½ cm stipules large, membranous, sub-persistent. Mono-or dioecious, flowers minute, in axillary, longer or shorter (than the petiole) penduncled dichotomously branched cymes. Fruit a minute, less than 1 mm, flattened, nearly smooth achene with often a raised intra-marginal ridge.

Leaf

Lamina

Dorsiventral, hypostomatic.

The upper and lower epidermis is single layered (Fig. 25; 1, 2). The cells are rectangular, narrow 3-5 as long as wide in upper and 3-6 as long as wide in the lower; the lateral walls are wavy and the outer flat, all walls are thin. The cuticle is thin.

The palisade is less than ½ leaf thickness, the cells are cylindrical, compact, long and wide. The spongy tissue is parenchymatous, cells spherical with wavy walls and intercellular spaces. Aerenchyma is not detected.

Trichomes and cystoliths are common on both surfaces. Stomata is of ranunculaceous type.
midrib: (Fig. 25: 3)

The midrib is spherical in outline, with a slight mid-dorsal depression. In the upper epidermis (hardly 3-4 cells) the cells are rectangular 1.5-3 as long as wide and with outer convex faces. The hypodermis 2-3 layered, angular collenchymatous; cells in the ground tissue are longly polygonal, with intercellular spaces and 2-3 layered only (along sides 2-4 layered). The lower epidermal cells are rather vertically placed, narrow, + rectangular, the outer walls convex to rounded.

petiole: (Fig. 25: 4,5)

The petiole is spherical in outline with a deep mid-dorsal groove and irregular surface. The cuticle is very thick. The epidermal cells are short, oval with outer rounded walls and highly thickened. The hypodermis is 2 layered, angular collenchymatous, followed by a cortex (3-4 layered) of equally angular collenchymatous cells but large in size. The pith is parenchymatous, cells contain crystals of various shapes.

stems

In the stem the epidermal cells (Fig. 25:24-26) are broad, rectangular 2.5-3 as long as wide, with thin walls and radial walls wavy. The cuticle is thick. The hypodermis is 3-4 layered, angular collenchymatous followed by 3-5 layered cortex. The cells are large polygonal and collenchymatous. Pith is parenchymatous cells with crystals.

trichome

Both glandular and non-glandular trichomes are superficial in origin and occur on all vegetative parts.

Glandular: It is typically peltate (Fig. 25: 9,21-23) with tendency towards suppression of the stalk cell; and towards the head remaining + spherical in outline (Fig. 25: 20).
Fig. 25. *Pilea umbrosa.*


Fig. 26. *P. repens.*

The presence of a simple glandular trichome, 3 cell long, with the terminal spherical undivided head (Fig. 25: 5, 15), the stalk cell short or elongated, is quite common in this species.

**Non-glandular:** These are basically bracket type, multisériate as well as unicellular. The following types are common.

(a) **Filiform,** short (i) wide, apex rounded, the foot wide, with 1-2 basal pegs (Fig. 25: 12); (ii) narrow, rounded apex, foot not or differentiated into pegs (Fig. 25: 17, 18).

(b) **Conical,** spindle, papillate. The foot has a 2-3 cell high collar (Fig. 25: 13, B, D) around it, may be simple (Fig. 25: 5, 10, 15) or pegged.

(c) **Acicular,** elongated, 3-5 cells (Fig. 25: 13 A, C, 14, 15, 24). The foot is dilated, flat (Fig. 25: 13 C, 14, 15); knee shaped (Fig. 25: 24) pseudopodial with pegs (Fig. 25: 6 A), wide with deep peg (Fig. 15: 6 B), short 3-4 pegs (Fig. 25: 11, 13 A). The apex is acute, acuminate (Fig. 25: 16). A definite collar is found around the foot.

**Cystolith:** There are spherical, vermiform or pyriform (Fig. 25: 2, 4, 9, 19, 24). They have the typical structure.

**Pilea repens** Linn.

**LEAF**

**Lamina.**
Dorsiventral, hypostomatic.

The **upper epidermis** (Fig. 26: 1, 4, 5) is single layered. The cells in surface view are large, thin-walled and polygonal in shape, and about 33 μ in length and 52 μ in breadth.

In T. s. they are rectangular, 4-4.5 as wide as high, 35 μ high and 35-83 μ wide with the outer walls flat to convex.
the lateral smooth or shallowly wavy and the inner walls concave. At certain places the epidermis is double layered, (Fig. 26: 5). A number of cystoliths occur in upper and lower epidermis but their frequency is much less in the former. In surface view they are elongated and vermiform.

The lower epidermis (Fig. 26:2,4) is usually single layered. The cells in surface view have wavy anticlinal walls. In t.s. they are rectangular about 28 µ high and up to 70 µ wide, with the outer walls convex to flat, and the lateral walls tend to be + wavy. Occasionally certain cells undergo transverse divisions and form a double layered epidermis which is as high as the single layered tissue. The stomata are of anisocytic type.

The mesophyll shows weak differentiation into palisade (Fig. 26: 4-3) and spongy tissues. The palisade is single layered, the cells cylindrical to broadly papillate with the broad base attached to the epidermis, being about 13 µ high, 18-24 µ broad, and rather compactly arranged. They contain few large chloroplasts situated either at the centre or confined to the walls.

The spongy (Fig. 26:4) tissue is about 13 µ in extent and comprises one or two layers of rather densely packed spherical to oval cells containing few peripheral chloroplasts. In paradermal sections, the spongy cells appear armed with small air spaces (Fig. 26: 14).

Midrib (Fig. 26: 3).

In cross section the midrib is ± hemispherical in outline. The dorsal epidermis comprises short rectangular cells 1-1.5 as high as wide, about 20 µ high and 23-35 µ broad. The outer wall is comparatively thicker and convex, the inner concave and the
laterals shallowly or deeply sinuous. The cuticle is thin. The lower epidermal cells are narrower, as high as wide, with the outer walls rounded, the inner concave and uniformly thick walled. The epidermis is followed by a parenchymatous ground tissue of large, thin walled compactly arranged cells with wavy to sinuous walls, and usually devoid of contents. Embedded within the ground tissue is the arc shaped vascular stele with the xylem occupying a concave side and facing the dorsal surface, and the phloem ventral to it.

**Petiole** (Fig. 26:10)

The petiole in cross section is reniform in outline. The epidermis is single layered of narrow cells, ovate - oval, 1.5-2 as high as wide, about 24 μ high and 18 μ broad, with the outer walls comparatively thicker, convex to rounded, the inner thin and concave, and the lateral thin, flat to slightly wavy. The epidermis is thin.

The epidermis is followed by a parenchymatous compactly arranged ground tissue of large thin walled cells with wavy walls. Within this lie five well spaced vascular bundles arranged in a C-shaped manner.

The small veins in the leaf are surrounded by a parenchymatous bundle sheath comprising partly of chlorophyllous cells (Fig. 26:6).

**STEM** (Fig. 26:12, 13)

The stem in cross section is circular in outline. The epidermis is single layered, comprising thin-walled, narrow compactly packed cells. The cortex is differentiated into outer two layered tissue of small, polygonal, slightly thick walled and compactly arranged cells, and an inner 3-6 layered parenchymatous cortex of large, thin walled, spherical to oval
cells with intercellular spaces. The cells may have flat or wavy anticlinal walls, while most of the cells are devoid of contents, a few contain mucilage.

The vascular bundles occur in two alternating rings of six bundles each. They are conjoint collateral and open. The outer bundles are smaller than the inner ones.

The pith is small and parenchymatous with cells similar to those of the parenchymatous cortex. Some of them in the peripheral zone contain brown contents.

TRICHOMES

Both glandular and nonglandular trichomes are met with and are superficial in origin.

Glandular trichomes: They are typical peltate type, consisting always of a unicellular foot embedded deep within the epidermis, usually a short unicellular stalk, and a glandular pleuricellular peltate head projecting but little above the surface (Fig. 26: 13). The trichome initial normally divides by two transverse divisions forming a row of three cells of which the distal undergoes further divisions and forms the glandular head, while the central and basal cells may expand and elongate a little to transform into the stalk and the foot, respectively. However, uncommonly, only one transverse wall may be formed, suppressing stalk cell. The head expands laterally and divides by a vertical wall into two cells (Fig. 26: 15) followed by another similar wall in the larger cell. Yet another vertical division is laid in the next cells (Fig. 26: 16-17). More vertical or oblique walls may be laid to form a massive head, which continuous to expand laterally thus resulting in a small disc of cells, the characteristic peltate head (Fig. 26: 18)
borne on a single or 2 cell stalk.

Nonglandular trichomes (Fig. 26:19-21).

They are simple 1-2 cells long and bracket type, of two shapes:

1. Filiform (Fig. 26:22) Unicellular short, rather wider at base with rounded apex and are enlarged bulbous foot. A definite collar is lacking but the cells immediately adjoining the foot are elongated.

2. Acicular

(1) Unicellular, elongated, the apex acute or subrotund. The foot short spindle shaped with flat base (Fig. 26:19). A 1 cell high collar is discernible.

(2) 2-3 cell long, either short 2 cell long with the foot hardly differentiated; or long, acuminate and 2-3 celled (Fig. 26:20 B).
Lecanthes rightii Wedd.

A succulent, pubescent, herb with a weak thread like stem, 2½-10 cm long, ascending and often rooting. Leaves few pairs, small, sub-entire 12-25 mm long. Receptacles 6-8 mm in diameter borne on stalk barely 2.5 cm long. Achenes narrowly oblong, longer than the perianth and red in colour.

Leaf

Lamina

Dorsiventral.

The upper epidermis is single layered (Fig. 27:1) cells rectangular, narrow, 3-4 as long as wide, the outer wall flat convex, the radial + wavy, all the walls are thin. The lower epidermal cells resemble the upper ones but are smaller. On both surfaces the epidermal cells around the bases of cystoliths and larger nonglandular trichomes are enlarged variously.

The palisade (Fig. 27:1) is single layered, of compact short cylindrical cells, the spongy being parenchymatous and with small aerenchyma. The cells are spherical - ovoid with straight walls. Trichomes are common on both the surfaces, stomata are of ranunculaceous type.

Midrib (Fig. 27:1)

In the midrib and over major veins the upper epidermal cells are large, rectangular to + squarrish and with outer walls convex to rounded, the cells in the middle over the veins are rather comparatively shorter. Cells in the lower epidermis are rectangular, rather narrow and with straight radial walls. The cuticle is + thin and smooth. The ground tissue is parenchymatous-collenchymatous.
In the stem the epidermis is of short, columnar cells (Fig. 27:15) with faces rounded or projected outwards. The hypodermis is 2-3 layered with thick walled collenchymatous cells; followed by 3-4 layered cortex, the cells large, polygonal with wavy walls. Crystals mostly spherical are numerous in cortex and pith. A large number of cells are full of pinkish contents.

**Trichomes**

Both glandular and non-glandular trichomes are superficial in origin.

The **glandular trichome** is normally peltate (Fig. 27:11,12) or may be spherical (Fig. 27:13). In the peltate type the stalk cell may be present or suppressed and head may not be laterally dilated. The spherical head is without stalk cell and the foot either elongates considerably or to a short extent. Undivided-head glandular trichome, 4 cells long is quite common (Fig. 27:14).

**Non-glandular**: These are normally unicellular and of bractlet type. The following type are discernible:

1. **Unicellular**
   - Very short, narrow or wide conical protruberances (Fig. 27:3,9) or dilated to not short conical (Fig. 27:14), in either case the foot is unmodified. Some of the dilated conical trichomes have the surface warted, rough or mammillate (Fig. 27:6). The tip may be acute, acuminate or rotundate.
   - Long, acicular, with much dilated base in form of a flat foot (Fig. 27:3), the tip bent or straight.
(c) Long, filiform, wide, dilated foot and acute-acuminate apex (fig. 27:5) with smooth wall.

2. 2 celled

(d) Short, conical with a distinct short foot, raised above the surface and a body drawn into a point and at an acute angle with the surface (Fig. 27:7).

Cystoliths: These are spherical, pyriform and often borne in series, particularly along the leaf apex (fig. 27:2).

*Lecanthus wallichii* Wedd.

A succulent herb with a branched stem, 30-52 cm high.

Leaves membranous, obliquely ovate, 5-10 cm long, with a large tail like tip, wedge shaped, rounded or acute base, and sub-entire or toothed margins. Receptacles 1½ - 3 cm in diameter, carried on 5-30 cm long stalk. Achenes ovoid, shorter than the perianth and purple brown in colour.

**Leaf**

**Lamina**

Dorsiventral, hypostomatic (Fig. 27:16).

The upper epidermis is single layered, cells rectangular, thin 4-5 as long as wide, the outer walls ± flat, radial walls straight, lumen between the inner walls and palisade. All walls are thin. The lower epidermal cells are shorter 2-2.5 as long as wide. Those around bases of cystoliths and trichomes are rather elongated. The cuticle is thin. Stomata are of ranunculaceous type.

The palisade is one layered, cells cylindrical, shorter unequal in size and not compactly placed. Some of them intrude
into spongy, less than 1/3 leaf depth. The spongy is parenchymatous, aerenchymatous and the cells are spherical-oval without wavy walls. Aerenchymatous cavities are smaller.

Trichomes and cystoliths are common on both surfaces. The epidermal cells in the petiole are short (Fig. 27:17,13), columnar with rounded or columnar outer faces. Some cells are much projected outwards but do not elongate into trichomes.

TRICHOMES

The **glandular trichome** is normally peltate but rarely spherical heads are also met with (Fig. 27:20). In the former the stalk cell is suppressed, the foot very short and the head is hardly raised above the surface of the epidermis, being "sunk" in a depression. Numerous crystals, usually spherical occur in pith of petiole and stem.

The **nonglandular trichome** is of bracket type, more common along both the margins of the leaf:

(a) Unicellular short, conical with the foot not modified (Fig. 27:21), thin walled or the wall roughened (Fig. 27:21) and the foot 2-2.5 as wide as adjacent cells; or

(b 1) Filiform to conical, elongated with a wide foot flat, roughened wall (Fig. 27:22)

(b 2) 2 celled, very short (Fig. 27:17) or elongated and filiform cutting off a terminal conical cell (Fig. 27:19).

Cystoliths are common, either of long vermiform type remaining embedded, or short, spherical projecting much above the surface of leaf or petiole (Fig. 27:16,19).


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**Fig. 27.**

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**Fig. 23. *Boehmeria* platyphylla.**

Boehmeria platypylla Don.

An erect variable shrub, plant covered with a rough or sometimes, smooth pubescence. Leaves mostly opposite, broadly ovate or orbicular, 7.5-22.5 cm long, roughly wrinkled or nearly smooth, with a 3-nerved base, usually cordate, an acute tip sometimes abruptly narrowed into a tail-like point (caudate), and toothed margins, when opposite often unequal; petiole 5 mm. Flowers clustered in unisexual, simple or sparingly branched spikes; male and female spikes borne on the same or on different plants. The male 7.5-15 cm long and stand nearly erect, the female 15-33 cm long and pendulous. Fruit an achene invested by the dry perianth.

LEAF

Lamina

Dorsiventral, hypostomatic.

The upper epidermis (Fig. 23:1,4,5,9) is single layered. In surface view, the cells are irregular in outline due to sinuous walls, polygonal to elongate, up to 35 μ long and 6-10 μ broad. In T.S. they are wide, rectangular, as high and broad, with the outer walls flat to convex, the inner concave and the lateral flat to undulate (Fig. 23:4,5), about 21 μ high and 13-35 μ broad. The cuticle is thin and nearly smooth. Scattered among the epidermal cells occur spherical stellate cystoliths, with warted to papillate surface. In T.S. they are shortly-stalked and contained in spherical cells about 52 μ deep and up to as wide, sunk deep to spongy tissue. The adjacent cells are not projected outwards and the general surface of the lamina remains smooth.

The lower epidermis (Fig. 23:2,4) is also single layered, in surface view the cell walls are deeply sinuous, the cells
upto 60 μ long and about 13 μ broad. In T. 3., they are shorter, rectangular and about 7 μ high and 7-18 μ broad. The cuticle is thinner. The stomata are usually of the ranunculaceous type. The stomatal index is about 25.00.

The mesophyll is clearly differentiated into palisade and spongy parenchyma. The palisade (Fig. 23:4,5,9) is single layered. The cells are cylindrical, compactly arranged along the 3/ths of the length and free towards the apices which are narrower, each 35-42 μ high and 7-9 μ broad, containing abundant peripheral chloroplasts. The palisade cells under the lithocyte are short and somewhat funnel shaped. The continuity of this layer is broken at various places by oval sac-like thin walled cells containing large stellate sphaero-crystals of calcium oxalate.

The spongy tissue is about 35 μ in extent, the cells spherical to rounded, rather laxly arranged with small to large intercellular spaces. In paradermal sections, the cells are 3-4 armed. They contain few peripheral chloroplasts.

Midrib (Fig. 23:3,6,7)

The midrib, in T. 3. is roughly circular in outline. The epidermis is single layered, the upper usually of short columnar, cells about 13 μ high and 10-18 μ broad covered by a wavy cuticle about 3 μ in thickness and the lower of similarly columnar cells, about 10 μ high and upto 13 μ broad, covered by a thinner cuticle. The outer walls in the upper epidermis are rounded and those in the lower epidermis convex to rounded.

The subepidermal collenchyma is of the angular type, unevenly distributed being single layered on the lateral side, 2-3 layered along the ventral and many layered on the
dorsal side.

The parenchyma, surrounding the vascular structure, comprises large, thin-walled, more or less rounded cells with small intercellular spaces. Most of them in close proximity to the vascular elements contain stellate sphaerocrystals.

The vascular structure is in the form of a nearly filled crescent, with a massive xylem filling its inside and facing the dorsal epidermis (Fig. 23:3). Sometimes a fragment of the crescent on one side separates into a small discrete bundle (Fig. 23:11). The xylem has its vessel elements arranged in radial rows. They show spirally thickened walls. The thinner phloem that lies on the convex side of the crescent contains a number of lignified fibres. It also contains in its elements a large number of sphaerocrystals.

**Bundle sheath extensions** (Fig. 23:4).

The vascular elements of the veins and veinlets are surrounded by parenchymatous bundle sheath of rounded to oval cells containing no chloroplasts. The sheaths lack extensions to the two epidermises, the bundles occupying whole of the spongy region.

**Petiole** (Fig. 23: 3,10)

The petiole is spherical in outline with a bilobed apex. The epidermis is single layered of more columnar cells, about 10 μ high and upto as broad, with convex to rounded outer walls, covered by a thin cuticle.

The sub-epidermal collenchyma/angular, uniformly several layered, consisting of small, polygonal and thick walled cells.

The vascular structure, comprising discrete vascular bundles, lies embedded in a massive parenchymatous ground tissue
of large cells possessing flat to undulate contacting walls, with small or no intercellular spaces. Some of the parenchyma cells, particularly those adjoining the vascular bundles, contain stellate sphaerocrystals.

The vascular bundles are in form of a deep arc, and usually five in number. The bundles at the two extremes show signs of division or are occasionally divided into two smaller bundles. In front of this vascular arc two more smaller bundles occur opposite the gap between the three median bundles. All the vascular bundles have the xylem facing the inside, with its tracheary elements arranged in radial rows and showing spiral thickenings. The phloem, facing the periphery, contain star-shaped sphaerocrystals in its elements.

STEM

The young stem is irregular in outline. Cork is superficial. The cortex is many layered with the outer few layered of angular collenchyma and with narrow lumened cells. The inner parenchymatous cortex, few to several layered, is comparatively large, thin walled, with oval cells and small intercellular spaces. A few of these cells, contain sphaerocrystals as occur in leaf and petiole. The pericycle encloses narrowly separated dome-shaped patches of fibres which possess highly thickened cellulase walls.

The vascular cylinder, in young stems, is irregular in outline. The primary xylem has its vessel elements arranged in radial rows. The secondary xylem vessels are diffuse, solitary, paired or in radial rows of three or more elements. The vessels have simple perforations and possess recticulately thickened walls. The phloem encloses a few lignified fibres,
and contains in abundance sphaerocrystals in its elements.

The central pith is large and parenchymatous. It comprises both small and large usually rounded cells with small intercellular spaces. Some of the cells, particularly in the peripheral region, contain sphaerocrystals as in the cortex.

**Wood**

**Vessels.** Few, 3-4 per mm², diffuse, predominantly solitary. Pairs usually radial or occasionally tangential not uncommon. Radial multiples of three or four elements are also seen here and there, and the clusters of other shapes of occasional occurrence. The solitary vessel elements have a pore oval to spherical in outline with the tangential diameter up to 112 µ. The individual vessel element is 140-350 µ long with an oblique end wall. The perforation is simple. The intervacular pitting is alternate, the pits are crowded, bordered, hexagonal, medium sized, about 7 µ in diameter, pit aperture narrow and slit-like. The vessel to ray and vessel to axial parenchyma pitting is simple, the pits are large and oval to elliptic. Tyloses absent.

**Rays.** Numerous, bi tri-or multiseriate. Typical uniseriate rays of infrequent occurrence, a uniseriate ray possessing a biseriate fragment at one or two places in its entire height. The height of the rays is variable. In general the uni- and bi-seriate rays are the shortest and the multi-seriate the tallest. Their height ranges from 0.15-2.5 mm. Rays heterocellular, comprising predominantly of square and upright cells with fewer procumbent layers randomly embedded within it. The cells are thick-walled, minutely pitted, the pits being simple and scattered, some of the cells contain
sphaerocrystals (druses), although solitary prismatic crystals were also seen in a few cells. Dark staining granular contents are contained in most other ray cells.

Axial parenchyma: Paratracheal, vesicentric scanty cells comparatively thin-walled, pits simple, large and oval.

Fibres: Thick walled, the wall thickness being 3.5-5 μ. Both septate and non-septate occur. The septate possesses usually 2 thin septa per element. The average length of the fibres element is 420 μ. The pits are few, simple and minute. The septate fibres contain starch grains usually in the entire element or occasionally in only one or two of its segments.

TRICHOMES

Both the glandular and non-glandular trichomes are met with on the young vegetative organs. They are superficial in origin.

Glandular trichomes: Both peltate and spherical types are common. In both the initial stages are typical and a 3 cell filament is formed:

(a) Peltate head (Fig. 23: 15, 20-23): The head cells are arranged in a single layered small peltate disc about 20-22 μ high and 27-30 μ in diameter. The stalk is elongated raising the head much above the surface. The foot is narrow, as wide as the adjacent cells and often ending above the surface of the lamina.

(b) Spherical head (Fig. 23: 12-14, 17-19): The head is typically spherical but the stalk may become biserrate; and is always elongated.
Non-fancular trichomes: They are simple, unicellular and of bracket type. The following two types are recognised:

(i) **Hooked** (Fig. 23:23). Born usually on the undersurface of the leaves, these have a filiform body which is hooked lying partly parallel with the surface. They are about 65-150 \( \mu \) long and 3-16 \( \mu \) broad. The wall is + thick, and the tip acute to acuminate.

(ii) **Filiform.** These are either simple or much elongated. On the nature of the base they may be classified into the following two types.

(a) **Simple filiform**: They are up to 330 \( \mu \) long and about 35 \( \mu \) broad, ending in an acute tip. The foot is bulbous and the wall rough to warted. The foot may be 2-2.5 as wide as the adjoining cells without a collar and the body bent parallel to the surface (Fig. 23:24); or it may hardly to not wider than the adjoining cells, with a 3-5 cells high, 3-4 cells across collar; and the body erect (Fig. 23:25).

(b) **Elongated filiform** The foot is much dilated with a flat to concave base (Fig. 23:27, 28). The wall may be thick and smooth and the collar hardly one cell high, the foot wider than the body (Fig. 23:23), or the wall may be thick and rough, the foot as wide as the body and with a 2-3(-4) cell high collar forming a "cup" through which the trichome projects (Fig. 23:27).
Pouzolzia pentandra Benn.

*P. pentandra* Benn is a nearly glabrous, stout, annual herb 3/4-1 m, erect or more slender and decumbent, often branched. Leaves sessile or shortly stalked, oblong-lanceolate, rather membranous, with rounded or cordate base, acute or long-pointed tip and entire margins; the lower opposite, 2.5-10 cm, the upper alternate, gradually decreasing in size upwards. Flowers in small clusters, sometimes of only two or three flowers. Fruit 3-winged.

**LEAF**

Lamin

Dorsiventral, hypostomatic.

The upper epidermis (Fig.29:1,5,7) is single layered. The cells in surface view are polygonal isodiametric to elongate, with flat walls, 35-33 μ long and upto 42 μ broad. In T.3. they are as long as wide to rectangular, 35-42 μ high and about as broad with their outer walls convex to flat and the laterals usually undulate. The cuticle is delicate and thin. Frequently present among the epidermal cells are spherical cystoliths with toothed margins. Their subsidiary cells differ from the adjoining epidermal cells in their convergence towards the cystolith and in having their anterior end narrower with rounded or flat anterior wall. In T.3. the cystoliths possess a long stalk attached dorsally to an ovate sac-like cell slightly bulging into the mesophyll tissue.

The lower epidermis (Fig.29:2,3,7) is also single layered. The cells in surface view are isodiametric to elongate, more or less irregular in outline due to shallowly sinus walls, upto 52 μ long and about 21 μ broad. In T.3. these are rectangular
about 13 μ high and up to 52 μ broad, covered by a thin and delicate cuticle.

The stomata are typically anomocytic (ranunculaceous) but anisocytic (cruciferous) types are not uncommon (Fig. 29:3). The stomatal index is about 36.00.

The mesophyll is divided into palisade and spongy parenchyma (Fig. 29:6,7). The former is single layered, of tubular cells about 35 μ high and 7 μ broad, rather compact and containing few peripheral chloroplasts. The spongy tissue is about the same vertical extent as the palisade and comprises rounded to oval cell rather densely arranged and containing fewer chloroplasts.

Midrib (Fig. 29:4,9,10).

The midrib in T. 3. is elliptic-oval in outline bound by a single layered epidermis; the dorsal of wide columnar cells 21-24 μ high and about 18 μ broad, with thin outer walls convex to rounded and covered by a thin cuticle; the ventral of narrower, shorter, columnar cells with the outer walls rounded to indistinctly papillate.

The subepidermal collenchyma is weakly of the angular type, usually single layered ventrally and 1-2 few layered dorsally. The ground parenchyma cells are large, thin walled, rather compactly arranged. Cells with dark contents occur scattered among the parenchyma cells.

The vascular structure is disc- or shallow crescent shaped and lies closer to the dorsal surface. The xylem faces the dorsal side and has its fewer vessel elements arranged in short radial rows. The ventral palisem contains numerous cells containing dark contents.
The vascular elements of veins and veinlets are surrounded by parenchymatous bundle sheath. Most of the cells are filled with dark contents. In the principal veins the bundles along with the sheaths are large and circular in outline as seen in cross section of a leaf. The leaf in this region is also dorsoventrally bulged. The bundle sheath is connected to the ventral side by a layer of large thin walled, polygonal to rounded cells. The sheath, however, lacks a dorsal extension. The palisade cells in this region are compressed and very reduced in height. The upper epidermal cells also are of less height than the adjacent cells.

The veinlets are small sized, and, therefore, do not induce any bulging of the leaf. They are situated in the mesophyll region. The palisade above them is also normal. Their sheaths may, however, be connected to the ventral epidermis by a layer of parenchymatous cells.

Petiole (Fig. 29: 6, 7)

The petiole in T. 3, is laterally elongated reniform in outline, with the convex ventral side sinusous at two places. The epidermis is single layered. On the dorsal side, the cells are columnar 32 μ high and 21-24 μ broad, compactly arranged with rounded outer walls covered by a thin cuticle. The ventral epidermal cells are smaller, 21-24 μ high and 18-21 μ broad.

The sub-epidermal collenchyma is angular, 2-3 layered. The ground parenchyma comprises rounded thin-walled cells with small intercellular spaces, some containing dark and mucilaginous contents. The stele comprises usually 5, discrete vascular bundles, arranged in form of an arc; 2-3 larger ones
face each lobe and the two smaller ones lie between the median and the lateral bundles opposite the grooves of the ventral side of the petiole. The xylem of each vascular bundle faces the dorsal (concave) side and the phloem the ventral (convex) side of the petiole. The few tracheary elements of the xylem are arranged in short radial rows.

STEM

It is more or less oblong in outline. The epidermis is single layered, the cells are columnar to as wide as high, compactly arranged and with rounded outer walls, about 24 μ high and 22-24 μ broad.

The cortex is differentiated into angular collenchymatous and inner parenchymatous zone. The former is 2 - 3 layered and the latter of a few layers of rounded or oval cells enclosing small air spaces. Scattered in the cortex are cells filled with dark contents.

The pericycle encloses small patches of fibres capping the vascular bundles, and possess cellulose thickened walls.

The vascular bundles are collateral and open and are arranged in a ring around a small pith. The xylem facing the centre has its vessel elements arranged in short radial rows. Sometimes only one such row represents the whole of the xylem of a vascular bundle. The vessels have simple perforation plates.

The pith comprises rounded thin-walled cells, enclosing small air spaces. Some of them are mucilaginous.

TRICHOMES

The trichomes are remarkable in their strictly deciduous nature. They are confined to very young vegetative organs and are almost entirely absent on the older ones. Both glandular and non-glandular types of trichomes are met with and are
superficial in origin.

**Glandular trichome.** It is typically spherical. The stalk is up to 16 µ high and 8 µ broad and the bi-celled spherical (Fig. 29:14) head about 16 µ high and 20-24 µ wide. The glandular trichomes are frequently borne on the lower surface of the young leaf, and less so on its upper surface, petiole and stem.

The trichome initial forms the usual row of three cells (Fig. 29:12, 13). The terminal cell divides by a transect vertical wall into two hemispherical halves (Fig. 29:14, 15). The glandular trichome with a 2-celled head are the most common. Occasionally one of the two cells, and rarely both the cells, may undergo another vertical division, thus forming a three, rarely four, celled head (Fig. 29:16).

**Non-glandular trichomes.** They are chiefly borne in the margins of the young leaves and are shed as the leaf matures. It is unicellular and simple. The most common are short filiform with a dilated foot about 30 µ broad with deep concave base. The wall may be smooth or roughened with mamillae (Fig. 29:17).

**Pouzolzia hirta** Hassk

A decumbent or sub-erect herb, 15 cm to 1 m high, often branched with tuberous roots. Leaves opposite, sessile or shortly petiolated, usually membranous, lanceolate or oblong-lanceolate, 2½ -15 cm long with a rounded or cordate base, pointed tip and entire margins; stipules broad. Flowers in small rounded, dense clusters. Fruit strongly ribbed, sometimes winged.


Fig. 30. *Pipturus repensus*.


Leaf

Lamina (Fig. 29:13-23).

Dorsiventral, hypostomatic.

The upper epidermis is single layered. The cells are very large, 1.5-2.3 as long as wide, with thin walls. The outer wall is flat to convex, the lateral walls wavy and the inner having hardly to not lumen between them and the palisade. The lower epidermal cells are narrower, rectangular, 2-4 as long as wide, with thin walls. The lower epidermal cell(s) abutting over the lateral veins are large and projecting outwards, here the corresponding upper epidermal cells also behaves similarly.

The palisade is single layered. Cells are narrow, cylindrical, compact placed and do not extend into the midrib or over the veins. They are unequal in size and some extend into the spongy tissue. The latter is 2-3 layered, the cells polygonal with wavy walls and with insignificant intercellular spaces. A few aerenchymatous spaces are formed. There is often a row of short 7-11 cell filled with brown contents above the lower epidermis near about lateral veins. Their distribution is not uneven. Along the margin the epidermal cells are enlarged with the inner outer faces rounded. Normally there are three cells ending the leaf margin. The palisade and spongy tissue extend upto the margin.

Trichomes and cystoliths are not very common (at least in the specimens examined). Stomata are of ranunculaceous type (Fig. 29:23).

Midrib (Fig. 29:21).

The midrib is not clearly demarcated from the wings and in section (of the herbarium material available to us) appears to be in the same place as the wings.
The lower epidermal cells (7-3) in this region are vertically oriented, much larger with wavy radial walls and rounded to projected outwards outer walls. The hypodermis is hardly 2-3 layered, of large polygonal cells with wavy walls lacking intercellular spaces. In the upper surface these are collenchymatous with highly thickened walls, under the upper epidermal cells (3-4) which are smaller than on the wings but of the same size and shape with outer walls rounded and the radial walls less wavy.

**Petiole (Fig. 29: 22, 23).**

The petiole at the base is hemispherical in outline without a definite mid-dorsal groove, there is however a slight depression. The cuticle is thin and smooth. The upper epidermal cells are short columnar with the outer wall above thickened, followed by a angular collenchyma of 4-5 layers, cells small. The ground tissue, 2-3 layered, is composed of large polygonal cells with wavy walls.

In the older petioles, the epidermal cells are rectangular and the angular collenchymatous cells much larger with sinuous walls.

**Stem**

The epidermal cells are short, columnar (Fig. 29: 25) or widely columnar to rectangular, 2-2.5 as wide as high. The cuticle is thin and smooth. The cortex is hardly 2-4 layered. The pericycle as well as cells in inner layer of cortex are fibrous (Fig. 29: 24, 25). The pith is parenchymatous.

In some cases, there is definite division into a 1-2 layered hypodermis of angular collenchymatous region and 1-2 layered cortex of large polygonal cells with wavy walls (Fig. 29: 25).
TRICHOMES

The glandular trichomes were not observed; the non-glandular trichomes are of bracket type, some with highly warted surfaces. The foot is enlarged, 4-6 as wide as adjacent cells and with a flat base having a median peg (Fig. 29:2). Around such larger trichomes is a collar 1-2 cells high and 4-5 cells across, but never "cup" like.

Pipturus repandus var. rubrinea

Leaf

Dorsiventral, hypostomotic.

The upper epidermal cells in surface view are large, polygonal with thin walls; the lower less larger, polygonal with wavy walls. Stomata are of ranunculeous type. The palisade appears one layered and the spongy tissue without aerenchyma (details were not observed).

Trichomes and cystoliths are common on both leaf surface, the latter are quite common on the stem as well.

TRICHOMES

Both glandular and non-glandular trichomes are met with.

Glandular. It is of peltate, oblong and elongated types.

Peltate (Fig. 30:1-4) Two types of development are discernible (a) The stalk cell is suppressed, the foot either remains very short (Fig. 33:2) or it may be elongated (Fig. 33:1). (b) The stalk cell is not suppressed, it elongates and becomes biseriate in the mature trichome, the foot remaining short (Fig. 33:3, 4).
The head, however, does not assume the typical peltate appearance.

**Oblong** (Fig. 30:5-10). The initial forms the 3-cell stage, the foot remains 1-cell, unmodified and the stalk 1-cell but may enlarge later. In the head, the first division is vertical followed by a few transverse divisions in each half accompanied by enlargement of the head and later laying off vertical divisions in some of the coils.

**Elongated** (Fig. 30:11-14). In the initial 3 cell stage either before the first vertical wall is laid in the head, transverse divisions occur forming a 6-7 cell filament (Fig. 30:12) or the vertical wall is laid first (Fig. 30:11) and the stalk undergoes a few transverse divisions. Next vertical walls are laid in each of the cells excepting the stalk all which may become biseriate (Fig. 30:14). Further transverse and vertical walls may be formed irregularly (Fig. 30:13).

**Nonglandular**. It is unicellular, and of typical bracket type. Following types are common:

1. **Filiform elongated**. The trichome is very long, highly thickened with hardly any lumen in the distal part, with rounded apex, ascending to erect and the foot bell shaped with flat base. A collar 1-cell high and 6 cells across is discernible (Fig. 30:21).
   
   Another type is shorter, with acute apex, thick walled, the bulbous foot with flat base showing an indistinct median peg (Fig. 30:19). The trichome is on a raised platform.
2. Acicular. Either narrow with acuminate apex and the foot hardly to not distinct from adjoining cells (Fig. 30:13) and without a collar; or broader with the apex acuminate and hooked and the foot 2 as wide as the adjoining cells with a flat base (Fig. 30:20). Some acicular ones may have much wider basal part of the body, acuminate apex and the foot pseudopodial with two uneven pegs (Fig. 30:17); or the foot dilated with two lateral wide pegs (Fig. 30:16).

3. Short conical. The foot may be wide with a flat base (Fig. 30:15) or the body + pyriform with a pegged foot (30:2).

Cystoliths are pyriform in shape, much raised above the stem surface. Epidermal cells adjoining them are elongated (Fig. 30:22) though otherwise these are short columnar with the outer walls convex to rounded. The outer cortex is angular collenchymatous.
Debregeasia hypoleuca Wedd.

A soft, pubescent large shrub or small tree, up to 5 m high. Leaves shortly stalked, lanceolate or oblong-lanceolate long pointed, triple-nerved, and with sharply toothed margins; petiole 3-12 mm long; stipules 2-fid; branches and leaves beneath clothed with snow-white wool. Monoecious or dioecious, flowers in rounded, sessile, axillary clusters. Fruits small, yellow drupes, aggregated in a head.

Leaf

Lamina.

Dorsiventral, hypostomotic.

The upper epidermis (Fig. 31:1) is single layered. The cells, in surface view, are polygonal, more or less isodiametric with flat walls. In T. 3. they are rectangular, about 32 μ high and 21-42 μ broad, with outer walls convex, the inner concave and the lateral flat to sinuous. The cuticle is about 4 μ thick, cutinized and wavy. Cystoliths are common and in surface view appear spherical with the surface protruding out into acute lobes, giving it a stellate appearance. They possess a short stalk, about 14 μ long, and a body up to 75 μ long and up to as broad, and are contained in a large sac-like cells up to 100 μ deep, surrounded by the palisade.

The lower epidermis is also single layered. The cells are short, rectangular, 18 μ high, 14-32 μ broad, or as wide as high, with outer walls rounded, the inner concave, the whole layer appearing as a string of beads, whose continuity is broken by anomocytic (ranunculaceous) stomata with superficial guard cells (Fig. 31:1). The cuticle is thin and wavy.

The mesophyll shows distinctly a palisade and spongy
region. The palisade (Fig. 31:1-2) is two layered occupying more than half of the leaf thickness. The cells of the upper layer are tubular, 52-62 μ high and 7-9 μ broad, and compactly arranged, those of the second layer are tubular to club-shaped, straight or sometimes slightly curved, usually laterally free to a small or large extent, 35-42 μ in height and 7-9 μ in breadth. The cells in both the layers contain abundant peripheral chloroplasts.

The spongy tissue is about 35 μ in extent, the cells are rounded, oval or oblong in shape with few peripheral chloroplasts. When young they are not as laxly arranged but in older leaves, a definite aerenchyma is visible.

The mesophyll intrudes deep into the midrib region where only few cells of collenchyma break its continuity (Fig. 31:4, 5).

**Midrib** (Fig. 31:3-6).

In T. 3, the midrib is elliptical to circular in outline. The epidermis is single layered dorsally, represented by 1 or two columnar cells, 35-42 μ high and 14 μ broad, flanked on either side by larger rectangular to pyramidal laminar epidermal cells (Fig. 31:4). The cuticle is as thick as on the lamina and more or less smooth. Sometimes the main epidermis is absent, its place being taken by the fused lateral walls of the flanking cells. In lower epidermis the cells are much shorter, columnar, about 15 μ high and up to as broad with the outer walls rounded to papillate. The cuticle is very thin and wavy. The epidermal cells flanking the midrib are larger up to 13 μ high and up to as broad.

The sub-epidermal collenchyma under the dorsal epidermis is 2-3 layered but few celled wide being flanked on either side
by the intruding mesophyll (Fig. 31:4). The collenchyma cells are small, polygonal, and of the angular type. The collenchyma above the lower epidermis is single layered, the cells being larger and comparatively thin walled (Fig. 31:6).

The vascular structure, situated close to the dorsal side, lies embedded in a parenchymatous ground tissue comprising large, and closely packed cells without intercellular spaces. Most of the cells are filled with dark brown contents.

The vascular structure is semi-lunar in outline (Fig. 31:3) with the xylem filling its inside and facing the dorsal surface. The tracheary elements are arranged in radial rows. The phloem parenchyma cells frequently contain stellate sphaerocrystals. Cells with mucilaginous contents also occur in the palaeom.

**Bundle sheath extensions (Fig. 31:1.2)**

In the major and minor veins the vascular elements are surrounded by a parenchymatous bundle sheath of rounded to oval cells containing few or no chloroplasts. The major veins have their sheath extended to the two epidermis by rounded to polygonal cells. The extension cells under the upper epidermis are slightly thickened at the angles, are 1-2 cells wide and few cells in height. One or more of these cells contain dark brown contents. The upper epidermal cells, which number one or two above the sheath extension, are drawn in into a wedge-shaped manner, with their outer surface depressed to a small or large extent. The extension cells towards the lower epidermis are thin walled. The lower epidermal cells are not much different from the adjoining cells.

The minor veins lack extensions towards the two epidermises.
the main bundle lying embedded in the spongy region.

**Petiole (Fig. 31:7-9).**

The petiole is roughly reniform in outline. The epidermis is single layered of columnar rectangular cells, about 14 μ high and 7-14 μ broad, with convex or papillate outer walls covered by a very thin and wavy cuticle.

The sub-epidermal collenchyma is almost uniformly several layered and angular.

The parenchymatous ground tissue is of large thin walled cells with little or no intercellular spaces. They usually have undulate contacting walls. Embedded in the tissue are fairly uniformly distributed rounded or oval cells containing dark contents.

The vascular structure, comprises a median shallow arc slightly sinuous on either side near the ends and with two small separate bundle over these ends (Fig. 31:7). At the base the median arc is seen to have divided into three discrete bundles, the five bundles thus produced being arranged in the form of a deep arc (Fig. 31:9). The xylem faces the inside and has its vessel elements arranged in radial rows. The phloem, facing the periphery, contains stellate sphaerocrystals in its elements, and also encloses fairly distributed oval or radially oblong cells containing dark contents.

**STEM**

The young stem is irregular in outline. The epidermis is single layered of thin-walled columnar to ovate cells, about 13 μ high and up to as broad, covered by a very thin cuticle.

The cortex is mostly parenchymatous, cells usually polygonal, frequently containing stellate crystals. Cells containing dark
contents occur fairly distributed in the cortex. The pericycle includes variously separated patches of fibres with thickened cellulose walls. The fibrous tissue becomes fairly continuous in the older stem.

The vascular bundles are arranged in a wavy ring around a small pith. The secondary vascular structure, however, forming a continuous cylinder. The primary xylem has its vessel elements arranged in small radial rows. The secondary vessels are diffuse and may occur singly, in pairs, or in small radial rows. They have simple perforations. The secondary medullary rays are narrow. The phloem, both primary and secondary, contains numerous sphaerocrystals in its parenchyma cells and also encloses a large number of dark content containing cells.

The central pith has larger, as compared to those of cortex, thin walled, polygonal cells, closely packed. Some of these cells contain sphaerocrystals. The pith also encloses cells containing dark contents.

**Wood**

Vessels: Few, diffuse, 2-3(-4) per mm². Predominantly solitary. Radial multiples of 2-4 not infrequent. Occasionally clustered. Solitary vessels have a rounded or oval pore-with an average tangential diameter about 100 µ. They are 100-350 µ long, with an oblique end wall. Perforation simple. Intervascular pitting alternate, pits medium sized 8-10 µ in diameter, crowded, spherical oval to angular, with a narrow oval to elongate pit aperture. The vessel to ray and vessel to those parenchyma pits are simple, with a large aperture than of intervascular pits, oval in outline. Numerous thin-walled tyloses extend into most of the vessel elements.
Rays: Few, predominantly tri- or bi-seriate. Uniseriate and tetra or penta-seriate rays of occasional occurrence. The height of the rays also variable. The uniseriate rays are usually shortest comprising one to four cells and measuring 140-350 \( \mu \) in height. The multi-seriate rays measure from 0.9 to 5.5 mm in height. The rays are heterocellular, with the procumbent, square and upright cells randomly arranged. The cells are thick-walled, with alternate pitting, pits not crowded, simple and minute. Some of the cells contain dark-staining granular contents, while a few others contain solitary crystals.

Axial parenchyma: Paratrecheal, scantly vesicentric. Comparatively thin-walled, with simple, large oval, scattered pits.

Fibres: Thick-walled. Both septate and non-septate, septa thin. The individual fibres are 450-560 \( \mu \) in length. Pits few minute, simple, oblique, elongate.

Trichomes

Both the glandular and the non-glandular trichomes occur on the young vegetative organs. While the glandular ones are of the spherical head type, the non-glandular ones are of various types. However, both are superficial in origin.

Glandular trichomes: The initial forms the usual three cell stage (Fig. 31:10) and the mature trichomes has a distinct foot, 1(-2) seriate stalk and a spherical head (Fig. 31:13, 14). The foot differs little from the adjoining epidermal cells. The stalk is up to 30 \( \mu \) in length and 10-12 \( \mu \) in breadth. The head is pleuricellular, about 32 \( \mu \) in height and 30 \( \mu \) in breadth. The foot and stalk do not undergo any further divisions, but simply elongate, the foot a little and the stalk considerably
to carry the head above the surface. The head initial divides by a vertical wall into two hemispherical halves (Fig. 31:11), followed by another vertical division to form four diagonally opposite cells (Fig. 31:12). The next division is transverse, resulting in a 2-tiered head of four cells each (Fig. 31:13).

Though the first division of the head initial is usually vertical, occasionally it may be transverse followed by the vertical divisions (Fig. 31:14).

Non-glandular trichomes. They are simple and normally unicellular, mostly broadly of the bracket type. The following types are recognised.

(i) Clothing. The undersurface of even the mature leaf is covered by a felt of wooly trichomes. They are slender very long thread like outgrowths of narrow epidermal cells (Fig. 31:19). These threads interwove with one another and develop a cottony cover concealing the under-surface of the leaf. Such thick is this protective cover that it is not possible to peel off the epidermis.

(ii) Conical or Prickles. Found on the dorsal surface of the leaf, they are somewhat conical, stiff, dilated at the base and tapering into a sharp point. The tapering beak may be straight, oblique or curved (Fig. 31:20-22). They are 100-150(-300) μ long and 30-50 μ broad at the base.

(iii) Fusiform. Borne on leaves, petioles and stems, they are dilated at the centre and gradually taper to the two ends (Fig. 31:23, 27). The free end terminates in a sharp or point. The body may be straight (Fig. 31:27) or bent (Fig. 31:23). The wall is thick.
They are about 110 µ long and 20 µ broad at the dilated centre. The foot is either a wide peg involving the whole base and ½ – 1 as wide as the adjoining cells, appearing constricted (Fig. 31:23) or not (Fig. 31:27) at the surface level.

(iv) **Hooked**: Also found on all the vegetative organs, fusiform in outline and are long, more or less filiform and hooked at the apex, ending in sharp point (Fig. 31:15). They are about 165 µ long with the stem about 16 µ broad. The base is slightly dilated being about 25 µ in breadth. The epidermal cells surrounding the base tend to develop a collar around it.

(v) **Collared trichome**: Found to occur on the leaf midribs, the petioles and the stems. These are usually elongated characterized by the presence of a 'collar' around the bases. On the shape of the foot they are classified into the following types:

(a) Collar 1-2 cells high, the trichome short, filiform-acicular with the foot unmodified (Fig. 31:16, 17).

(b) Collar 3-4 cells high, the trichome acicular, the foot rounded with concave base (Fig. 31:24), foot separated from the body by a partial constriction.

(c) Collar 3 cells high, cup shaped, the foot much dilated, urn shaped in section with deep concave base (Fig. 31:25) foot separated from the body by a constriction (Fig. 31:25).

(d) Collar 2-3 cells high, foot as wide as body of the trichome, tubular with flat base (Fig. 31:28 A).
(e) Collar 1-3 cells high, foot separated from the body by a constriction, as wide as the body, spherical with a concave base (Fig. 31:23 B).
Fig. 31. Debregeasia hypoleuca.


Fig. 32. Villebrunnea frutescens.

**Villebrunnea frutescens** Blume

A shrub or a small tree with very slender pubescent branches. Leaves alternate, 50-125(-200) mm long, ovate, rarely almost rounded, 3-nerved from the base and with the tip narrowed into a long, tail-like point and the margins sharply toothed except near the base, upper surface usually rough, while the lower is ashy or white with wooly hairs or glabrate. Petioles slender, 25-50(-100) mm long, and the stipules about 12 mm, lanceolate and pubescent. Flowers crowded in small, sessile or sub-sessile clusters inserted on the stem and branches between or below the leaves; the males and the females borne on different plants. Achenes minute and black and are partially immersed in a white gelatinous receptacle.

**Leaf**

**Lamina.**

Dorsiventral, hypostomatic.

The **upper epidermis** is single layered (Fig.32:1,4,5). Cells in surface view, are irregular in outline with sinuous thick walls, isodiametric to elongate, about 56 μ long and upto 35 μ broad. A number of cystoliths, usually spherical with tuberculate surface are scattered among the epidermal cells. Their subsidiary cells are conspicuous by their convergence towards the cystoliths, and their broader posterior end with sinuous walls and narrower anterior ends with comparatively smooth walls. In T.s. the cells are rectangular, to as wide as high, about 24 μ high and 13-28 (-60) μ broad with the outer walls convex, the inner concave and the lateral flat to undulate. The cuticle is thin nearly smooth and minutely cutinized.
The cystoliths in T. s. show a large body with obtusely lobed margin, hanging down by a short stalk from the dorsal wall of a sac-like cell usually as deep as to reach the lower epidermis.

The lower epidermis (Fig. 32:2,4,5), is also single layered. In surface view cells are irregular with sinuous walls, about 52 μ long and up to as broad, enclosing a large number of cystoliths similar to those occurring on the upper epidermis. In T. s. the cells are rectangular, 14-21(-24) μ high and 14-28 μ broad with the outer and inner walls convex to rounded and the lateral walls flat to undulate. The cuticle is thin, nearly smooth and thinly cutinized. The stomata are both anomocytic and bicollateral (ranunculaceous) and superficial (Fig. 32:2,3), the stomatal index is about 25.00.

The palisade (Fig. 32:4,5) is single layered of cylindrical cells, not very compactly arranged and narrower towards the apex and free to ½ of their length, 28-35 μ high and 7-10 μ broad at the base. They contain abundant peripheral chloroplasts. Within the palisade frequently occur spherical sac-like cells containing stellate sphaerocrystals of calcium oxalate (Fig. 32:4).

The spongy tissue (Fig. 32:4) is up to 35 μ in extent, comprising rounded cells, variously oriented and loosely arranged. In paradermal section, the cells are stellate. They contain fewer chloroplasts.

The mesophyll is characteristic in protruding deep into the midrib region, under the dorsal epidermis, where only a few collenchyma cells break its continuity.

Midrib (Fig. 32:6-3).

The midrib is roughly circular in outline. The epidermis is single layered; its dorsal region of few columnar cells
with thick walls, 13-24 μ high and 9-18 μ broad with the outer walls rounded to slightly protruding outwards, covered by a thinly cutinized, wavy and about 3.5 μ thick cuticle. The lower epidermis is of smaller rectangular cells, thick-walled up to 13 μ high and up to 21 μ broad with the outer walls convex rounded or papillate, and covered by a cuticle thinner than that of the upper epidermis.

The epidermis is followed by an angular collenchymatous tissue, 2-layered under the upper and 1-2 layered above the lower epidermis. The vascular structure is crescent shaped and embeded in a parenchymatous ground tissue of large cells with undulate contacting walls and with small intercellular spaces. The tissue is of unequal extent along the upper and the lower sides because of the location closer to the dorsal side of the vascular crescent.

The xylem lines the concave side of the vascular crescent and faces the dorsal side. Its vessel elements are arranged in radial rows about uniformly spaced from one another. The phloem occupies the convex side of the crescent and in its parenchyma cells occur sphaerocrystals resembling those of the mesophyll. Cells with dark contents also occur fairly distributed among the phloem elements.

**Bundle sheath extensions (Fig. 32:5).**

The veins and veinlets are surrounded by a parenchymatous bundle sheath of roughly oval cells containing one or few chloroplasts. The sheath, however, lacks extensions towards the two epidermis. The epidermal cells in these regions also do not show any appreciable variation from their sister cells.
Petiole (Fig. 32: 9, 10).

The petiole, in T.S., is + circular in outline with a deep dorsal notch. The epidermis is single layered, the cells broad, columnar, about 13 µ high and 13-22 µ broad, with the outer walls rounded to papillate. In the notch they are comparatively greater in height. The cuticle is thin and wavy.

The sub-epidermal collenchyma is of the angular type and usually several layered, but more massive on either side of the notch and about 2-layered under it.

The vascular bundles are discrete and embedded in a parenchymatous ground tissue comprising, with small inter-cellular spaces. Some of them contain sphaerocrystals.

The vascular bundles arranged in a deep-arc (Fig. 32: 10) are usually seven in number, three ventral larger and two on either side of the notch smaller. Usually two medullary bundles accompanied by a small amount of xylem lie interior to the arc opposite to notch. The xylem vessel elements are arranged in radial rows, phloem elements frequently contain sphaerocrystals.

Cells with mucilaginous contents are fairly distributed among the parenchymatous ground tissue. Smaller and round lumened cells containing dark contents are also of frequent occurrence in phloem but less so in xylem.

STEM

The young stem is circular in outline bound by a single layered epidermis of columnar to rectangular cells, about 13 µ high and 14 µ broad; followed by a usually 2-layered angular collenchymatous zone. The cortical parenchyma cells are compactly arranged, without intercellular spaces, and frequently contain rosette-like clustered crystals of calcium oxalate.
The vascular bundles are collateral and open, and arranged in a ring. The primary xylem vessel elements are arranged in radial rows; the secondary xylem forms a continuous cylinder traversed by narrow medullary rays, its vessel elements may be solitary, in pairs, or in uni- or bi-seriate radial rows of few to several elements. A large number of phloem elements contain sphaerocrystals similar to those of the cortex.

The pith is small and parenchymatous, cells polyhedral, compactly arranged without intercellular spaces, most cells, particularly in the peripheral region, containing sphaerocrystals.

Cells with mucilaginous contents are fairly distributed in the cortex and the peripheral portion of the pith. Cells smaller in lumen with darker contents are numerous in the phloem.

**Wood**

Vessels: Few, diffuse, 2-3 per sq. mm, usually solitary or in radial multiples of 2-4. The solitary vessels often predominant and angular in outline. The vessel members are 93 μ to 500 μ long and up to 70 μ wide. The end walls are usually oblique and occasionally transverse, with simple perforations. The intervascular pitting is alternate, the pits are medium sized, angular, 7-10 μ in diameter, with the pit apertures oval. The vessel to ray and vessel to parenchyma pitting is simple, oval to oblong, and larger than the intervascular pitting. Thin walled tyloses extend into the vessel lumen from the ray and axial parenchyma cells.
Rays: Predominantly bi- or tri-seriate. Some uniseriate are present and a few rays up to four cells wide are seen. The rays vary in height from 0.2 mm to 4.5 mm with an average height of about 2 mm. The shortest ray may be just 2-celled high. They are all heterocellular with its bulk composed of square and upright cells forming up to 10 or more marginal rows above and below the central few layered procumbent cells. The cells are thick-walled, minutely alternately pitted, the pits being simple. Some of the ray cells contain dark-staining granular contents.

Axial parenchyma: Paratrachial, vesicentric scanty. They are thick-walled and possess simple elongate oval, scalariform pitting.

Fibres: Thick walled and on an average 630 μ long, septate at 2 or 3 places at their entire length. Septa are thin. Pits few, simple.

Trichomes

The young vegetative organs are richly trichomatous, both glandular and non-glandular ones being met with, though the former are of greater frequency. The frequency of the trichomes gradually decreases with age. They are superficial in origin.

Glandular trichome. It is spherical head type. A mature glandular trichome has a pleuricellular head about 21-5 μ high and 24 μ wide, a unicellular stalk up to 32.5 μ long and about 6.5 μ broad, and a single celled foot which resembles the surrounding epidermal cells except its slight greater length (Fig. 32:16,17). It has a tendency to out-grow the surface of epidermis and the stalk is also much elongated. The initial
stages in development do not show any variance from the spherical head type (Fig. 32:11-14).

**Non-glandular hairs**: They are superficial, unicellular, simple structures of varied shapes and sizes. All conform to broadly bracket type, but are short.

1. **Conical**. These are either elongated or short.
   
   **(A) Elongated**. Born on the underside of the midrib and on the petiole and stem, they are wider at the base and gradually taper to the apex.
   
   (a) 1-cells high collar: 150-200 μ long and 30 μ broad (Fig. 32:18). The foot has a flat base or may be depressed (Fig. 32:20) and the collar cells are 1.5-2(Fig. 32:18) or 2-2.5 (Fig. 32:20) as high as the adjoining cells.

   (b) 2-3 cells high collar. The foot is much wider (40-50 μ), the collar is urn-shaped (Fig. 32:21).

   (c) Collar **absent**. The foot is 3-3.5 as wide as the adjacent cells and separated from the body of the trichome by a constriction (just above the epidermis). It is up to 550 μ long and 20-30 μ wide above the constriction (Fig. 32:31).

   **(B) Short, without collar**

   (a) Simple, the foot about twice as wide as the adjoining cells, hardly 50 μ long (Fig. 32:19).

   (b) Typical conical

   (1) "Prickly" in appearance, abruptly acute, foot dilated (50-60 μ wide), rather depressed base, insensibly collared, the adjacent cells 1.3-1.5 as high as the epidermal cells (Fig. 32:22).
(ii) Apex acuto - acuminate, foot dilated
(30-40 μ wide), without or with weak tendency
to form insensible collar (Fig. 32:25).

(iii) Hooked, foot 40-50 μ wide, flat bottomed,
the apex acute (Fig. 32:24).

(iv) Inclined. The foot is separated from the body
by a deep constriction over which the trichome
forms a belly (20-30 μ wide) abruptly ending in
an acute apex (Fig. 32:32). The foot is 1-0.75
as wide as the adjoining cells.

(2) Filiform (apex acute) these are straight or hooked, with
or without collar.

(a) Without collar, straight

(i) Trichome wide, the foot and body separated by a
constriction, the foot 2-2.5 as deep as the
epidermal cells, apparently hypodermal (Fig. 32:27,
28) widest in centre.

(ii) Trichome narrow, foot 0.5 as wide as adjacent
cell; body dilated in the lower ½ - 1/3 to give
fusiform appearance (Fig. 32:29,30).

(b) Without collar, hooked. Trichome narrow, the foot
as wide as the adjacent cells, apex acute - acuminate
(Fig. 32:33).

(c) Collared, trichome narrower, foot rounded, 4-6 as
wide as adjacent cells, collar 3-4(2) cells high,
3-5 cells across, ± columnar (Fig. 32:26).

(3) Acicular. The foot rounded, collar 1 cell high, 2-3 cells
across, low (Fig. 32:23).
**Parietaria** Tournef

Annual or perennial herbs without stinging hairs; leaves alternate, lacking stipules; flowers hermaphrodite or unisexual, in cymes.

Only trichomes could be studied in this genus. The observations made in various species are listed below.

**P. deblis** Forst (Fig. 33:1-4)

The nonglandular trichome are acicular (Fig. 33:4) and conical-acicular (Fig. 33:1-3). In the latter the foot is pseudopodial with base flat (Fig. 33:2) or insensibly forming two lateral wide pegs (Fig. 33:1,3).

**P. cretica** Linn. (Fig. 33:5-13).

The glandular trichome has either a peltate head (Fig. 33:9) or rarely may be oblong (Fig. 33:10). In the peltate type the stalk cell is either suppressed (Fig. 33:6-8,10) or present (Fig. 33:9). In the latter case both the foot and the stalk may be elongated equally. In the oblong type the foot is narrow and elongated.

The nonglandular trichome is unicellular, either of bracket type or dilated filiform. The bracket is either elongated with a dilated foot (Fig. 33:13) or it may be short and hooked (Fig. 33:12). The filiform are wider, shorter, with the foot nearly half as wide as the apex which is rounded to subrotund (Fig. 33:5). Such trichomes occur along the margin in the apical region of the leaf.

**P. judaica** Linn. (Fig. 33:14-17).

The glandular trichome is of peltate type (Fig. 33:14-16) with the stalk cell suppressed. The nonglandular trichome is simple, unicellular and of bracket type, short, conical with
the foot deeper than the adjacent cells and the surrounding cells forming a weak collar around it (Fig. 33:17).

P. vulgaris Linn. (Fig. 33:13-30).

The glandular trichome is peltate type with the stalk cell suppressed (Fig. 33:19,20) or present and the foot biseriate (Fig. 33:21). Spherical head type is also observed (Fig. 33:22,23). The nonglandular trichome is single, unicellular, acicular (Fig. 33:25,26), hooked (Fig. 33:27), without a collar; bracket with the foot pseudopodial having a flat base, without a collar (Fig. 33:23,30); short conical, the foot with a median peg (Fig. 33:29); or a large bracket, foot pseudopodial and collared (Fig. 33:24), the collar 1(-2) cell high and 3-10 cells across at the base.

P. charmonensis (Lang) Grecescu (Fig. 33:31-36).

The nonglandular trichome has usually a collar around its base, 1(-2) cell high (Fig. 33:31). They are simple, unicellular, acicular (Fig. 33:32), short conical (Fig. 33:35), hooked (Fig. 33:36), with bent apices (Fig. 33:34), or elongated (Fig. 33:33). The foot may be simply rounded, as wide (Fig. 33:32) or 2-3 as wide (Fig. 33:33-36) as the adjoining cells.
Fig. 33.


Fig. 34.

Forskohlea tenacissima Linn.

A small scabrous undershrub. Leaves 1-2.5 cm; alternate rhombis orbicular or obovate, obtuse, base cuneate, toothed, hispid or softly hairy above with hooked hairs, wooly beneath, triple nerved; petiole 0.6-1.2 cm; stipules lateral free.
Flowers in axillary androgyneuous wooly or silky involucres, males many in the periphery of the involucres, female solitary in the centre; stamen 1, inflexed in bud; achenes ovoid, compressed, wooly.

Leaf

Dorsiventral, hypostomatic.

The upper epidermis is single layered (Fig. 34:1) but few cells may rarely undergo a transverse division, but not increase in dimensions. The cells are rectangular, as wide as high or 1.5-2 wide, the outer walls are convex to flat, the inner also tend to be convex due to protruding palisade cells, and the lateral walls flat. The cuticle is thin and smooth.

The lower epidermis is also single layered, the cells short, rectangular to columnar, with the outer walls (flat) convex to rounded, covered over with a thin cuticle. Stomata are of ranunculaceous type. Epidermal cells along the margin are columnar, 3 as high as wide (Fig. 34:2) with a thick cuticle over them.

The mesophyll is clearly differentiated into palisade and spongy but does not protrude into the midrib. The palisade is two layered, cells unequal in size, cylindrical, often narrower towards the spongy and forming intercellular spaces. The layer occupies 0.5 to the thickness of leaf. The spongy tissue has a well developed aerechyma. The cells short, rounded and thin.
Aerenchyma is absent along the leaf margins. Cystoliths are quite common, mainly on the upper epidermis, large, spherical, with tuberculate surface and abutting on the spongy tissue. The characteristic beak above the epidermis is prominent (Fig. 33:3).

TRICHOMES

Glandular ones were not observed. The nonglandular are common both surface of the lamina and on the petiole. These are simple, unicellular and superficial in origin. Following types are met with.

1. Acicular and hooked (Fig. 34:3), the foot as wide as the adjoining cells with flat base.
2. Short conical, the foot dilated with flat base (Fig. 34:5)
3. Typical bracket, the foot separated from the body by a constriction and slipper like (Fig. 34:7 a); or the foot wide, the body forming a nipple at its base resting on the epidermis (Fig. 34:7 b) or the foot may have a median peg (Fig. 34:6); the tips in all are bent.
4. Collared. The trichome either is filiform. The collar 1-2 cells high, and the foot with irregular wall and flat base (Fig. 34:4); or the trichome may be much wider, the foot with urn shaped base, the collar 2-3 cells high and at least 16-20 cells across at the base (Fig. 34:9).

**Droseratia diffusa** Wedd.

A slender diffuse herb. Leaves 0.6-4 cm., very membranous, opposite, ovate, acuminate, serrate or toothed, hispidly hairy above and on the nerves beneath, nerves faint; petiole 0.2-2.5 cm., slender; stipules small, ovate, ciliate.
Flowers very minute, males several or solitary in the same involucre with the female, pedicled; stamen 1; female flowers few, shortly pedicelled or sessile; achene obliquely ovoid, compressed, hispid or glabrate.

LEAF

Lamina.

Dorsiventral, hypostomatic.

The upper epidermis is three layered (Fig. 34:10,11), cells in the outer layer are rectangular, narrow, with the outer walls flat to convex; in the second layer similar; but in the third layer columnar, 1-1.5-2 as high as wide. The lower epidermis is single layered of columnar cells. The cuticle is thin and smooth. Stomata are of ranunculaceous type.

The palisade is one layered, cells, short, to columnar, hardly to not longer than the lower epidermis and densely chlorophyllous. The spongy tissue is just a layer of cells, round to rectangular in shape without intercellular spaces.

Cystoliths are common in upper epidermis, contained in spherical-oblory cavities but not deeper than the second layer of epidermis.

Midrib (Fig. 34:12,13).

The midrib is hemispherical in outline. The upper epidermal cells (Fig. 34:12) are wide, rectangular to columnar with convex to rounded outer walls and densely trichomatous. This is followed by angular collenchymatous tissue, 3-4 layered dorsally and ventrally, and 5-6 laterally.

The ventral epidermal cells (Fig. 34:13) are strongly thickened, basically collenchymatous with the outer walls rounded to papillate, often strongly so.
TRICHOMES

Both glandular and nonglandular trichomes are common on the leaf. They are superficial in origin.

Glandular. It is both peltate (Fig. 34:14, 15) with the stalk cell suppressed, and the foot elongated; and oblong (Fig. 34:17, 18). In the latter case the 3 cell stage becomes as much as 11 cells long. The terminal cell follows the divisions usual in spherical head, and the head may assume spherical shape (Fig. 34:16).

Nonglandular. It is simple, unicellular and the following types:

1. Short conical (Fig. 34:20), with broad bulbous foot
2. Bracket (Fig. 34:22, 23). Either typical bracket (Fig. 34:23), the foot separated from the body by a constriction and with 1-2 pegs at base, a 1-cell high collar, and the body dilated just above the collar; or short, the foot rounded, constriction weak and the body dilated in lower 1/3, giving the trichome spindle shape (Fig. 34:22).
3. Slipper shaped bracket (Fig. 34:19), the body is triangular at an acute angle with the surface, ending abruptly in a point, the foot pseudopodial with flat base.
FOLIAR VEINATURE

**Urtica**

Midrib upto 1 mm wide, ending in a knob-like or subrotund head. Polygons with or without free included veinlets. Vasculature between lobes is formed by two veinlets given off from the mid-veins of the adjoining lobes.

*U. dioica* (Fig. 35 A: 1-3). Leaf apex is acute, the midrib 1/2-3/4 mm wide ending in a short knob. Polygons 1.1 x 1.2 mm with free included veinlets. The marginal veinlet towards the apex forms a close net work but elsewhere bears free marginal tracheids. The marginal vein is 1/10 mm from the leaf margin.

*U. parviflora* (Fig. 35 A: 4-6). Leaf apex acute-acuminate, the midrib 1 mm wide, ending in a ± wide conical subrotundate head. Polygons 1.5 x 1.6 mm without free included veinlets. The marginal vein is thin, 1/3 mm from leaf margin, without free marginal tracheids.

**Laportea**

Midrib ending in a subrotundate head. Polygons without free included veinlets. Marginal veinlet without free marginal tracheids and thinner, 1/3 mm from leaf margin.

*L. decurrens* (Fig. 35 A: 7-9). Leaf apex acute-acuminate, midrib 1/2-1 mm wide, apex columnar. Polygons 1.2 x 1.5 (2.5) mm with numerous veinlet islands.

*L. microstigma* (Fig. 35 A:10-14). Leaf apex ± acute. Polygons 1.3 x 1.6 mm.

Vasculature between enations is formed by a lateral veinlet which becomes thicker, subtended by a short or long branch.
**Fleurya interrupta** (Fig. 35A: 15-17).

Leaf apex acuminate. Midrib 1/6 mm wide ending in a short subrotundate knob. The marginal vein is thin, 1/20 mm from leaf margin and with free marginal tracheids. The reticulation along margin is close. The polygons are 1 x 1.2 mm, with few closed veinlets.

**Girardinia heterophylla** (Fig. 35 A: 13, 19).

Leaf apex acuminate. The midrib 1/2-3/4 mm wide and ends in a subrotundate head. The marginal vein is thin, 1/3 mm from leaf margin. The reticulation along the margin are ± wide, free marginal tracheids are absent. Polygons 1.2 x 1.6 mm to 1.5 x 2.5 mm with few veinlet islands and without free included veinlets.

Vasculation between the lobes is formed by a veinlet arising from the midrib, midway between the lobes. It bifurcates just below the wedge forming a narrow dept, the branches continue into veinlets which meet the midveins of lobes; or each branch may fork, the outer fusing with the marginal veins and the inner passing into the lateral vein.

**Pilea**

Polygons without free included veinlets. Marginal veinlet thin, without free marginal tracheids.

**P. scripta** (Fig. 35 A: 20-22). Leaf apex acuminate.

Midrib 1 mm wide ending in a ± wide subrotundate head. Polygons 1.5 x 1.6 mm, few to many reticulate with mostly unequal veinlet islands. The marginal veinlet 1/3 mm from leaf margin, forming a wide reticulum.

Vasculation between lobes is as in Girardinia with the modification that on one side the final forking may pass into the midvein of lobe and on the
opposite side it may divide into two-outer passing into marginal vein and inner into the next veinlet.

*P. umbrosa* (Fig. 35 A: 23-24). Leaf apex acute-subrotundate. Midrib is 1-1.2 mm wide, ending in a conical head. The marginal veinlet is 1/3 mm from leaf margin. Polygons are large, 1.2 x 2.5 mm.

Vasculature between the lobes is a thick, hemispherical saddle formed by a number of veinlets arising from the midribs as well as from mid-veins of lobes, each end of the saddle passes into the marginal veins.

*P. rapens* (Fig. 35 B: 25-27). Leaf apex subrotundate, midrib 1/15 mm wide ending in a network of tracheids. Polygons 1/15 x 1/10 mm with occasional free included veinlets. The marginal vein is very thin.

Vasculature between lobes is formed by two lateral veins from the mid- and the marginal veins of adjoining lobes.

*Lecanthus*

Midrib ending in a short felt head. Marginal veinlet without free marginal tracheids. Polygons without free included veinlets.

*L. wightii* (Fig. 35 B: 23, 29). Leaf apex acuminate-caudate, midrib is .5 mm wide. The marginal veinlet 1/12 mm from leaf margin. Polygons 0.75 x 0.90 mm.

*L. wallichii* (Fig. 35 B: 30, 31). Leaf apex acuminate-caudate. Midrib is 1/2-1 mm wide, marginal veinlet 1/3 mm from leaf margin. Polygons 1.2 x 1.5 mm, with few reticulations.
Fig. 35a, 35b. Foliar venation in Urticaceae.

1-3. *Urtica dioica.*
15-17. *Fleurya interrupta.*
30-31. *L. allichii.*
34-35. *Pouzolzia pentendra.*
44-46. *Villebrunea frutescens.*
51-53. *P. deblis.*
57-58. *P. judaica.*

4-6. *U. parviflora.*
36-38. *P. hirta.*
42-43. *Debregeasia hypoleuca.*
47-50. *Parisotia cretica.*
54-46. *P. charnemensis.*
59-60. *P. vulgaris.*
63. *Forstolea tenacissima.*
Boehmeria platyphylla (Fig. 35 B:32-33).

Leaf apex acuminate. The midrib is 1/6 mm wide ending in a short knob. Polygons 1.5 x 1.3 mm with free included veinlets. The marginal vein is thin, 1/10 mm from leaf margin with few to occasional marginal free tracheids.

In vasculature between lobes a branch is given off from the midrib and midway between the lobes which on reaching the wedge forks, the branch towards the base of leaf "passes" as the mid-vein of the lobe, and the other forks into two, each passing into marginal veinlets of the adjoining lobe.

Pouzolzia

Polygons large, 1-2 x 2.5 mm, without free included veinlets. Marginal vein very thin, 1/6 mm from the leaf margin and without marginal tracheids.

P. pentandra (Fig. 35 B:34-35). Leaf apex is acute, the midrib 1/6 mm wide ending in a short knob.

P. hirta (Fig. 35 B:36-38) Leaf apex is acuminate, the midrib 1/2-3/4 mm wide ending in a short columnar head.

Pipturus rependus (Fig. 35 B:39-41).

Leaf apex is acute-acuminate, the midrib 3/4 mm wide, ending a wide columnar head. Polygons 1.2 x 2.5 mm without included free veinlets. The marginal vein is thin 1/3 mm from leaf margin and without free marginal tracheids.

Debregeasia hypoleuca (Fig. 35 B:42-43).

Leaf apex is acute, the midrib 3/4-1 mm wide, ending in a small knob-head. Polygons 1 x 1.2 mm with free included veinlets frequent. The marginal veinlets are very thin.
1/10–1/12 mm from leaf margin and without free marginal tracheids. Rarely a few free tracheids are discernible.

Vasculation between the lobes as in **Villebrunea**.

**Villebrunea frutescens** (Fig. 35 B:44-46).

Leaf apex acuminate, the midrib 1/4 mm wide, ending in a subrotundate short head. Polygons 1.1 x 1.2 mm with free included veinlets mostly ending in bases of nonglandular and cystolith trichomes. Marginal veins, thin 1/10 mm from leaf margin and with infrequent free marginal tracheids.

Vasculation between lobes formed by two veinlets arising from mid-veins of adjacent lobes. The ends of the short veinlet thus formed pass into marginal veins.

**Parietaria**

Midrib thin to very thin, polygons with or without free included veinlets. Usually marginal veinlet without free marginal tracheids.

**P. cretica** (Fig. 35 B:47-50). Leaf apex subrotundate. Midrib 1/6 mm wide, forks just below the apex, each branch merging into marginal vein, no regular head formed. Polygons 2.5 x 3.5 mm, without free included veinlets. Marginal vein 1/3 mm from leaf margin with free marginal tracheids.

**P. deblica** (Fig. 35 B:51-53). Leaf apex sub-rotundate midrib 1/15 mm wide ending in a triangular network of tracheids; often on reaching the apex of leaf forking unequally, one of the main laterals before reaching the apex divides into two, one ending in a knob just below the apex and the other merging into the adjacent marginal
vein. The other main lateral passes outwards at right angles to the midrib, giving off a lateral to the apex and another branch passing forwards as the marginal vein. Polygons 1.6 x 1.7 mm with free included veinlets. Marginal 1/13 mm from leaf margin.

P. cheronensis (Fig. 35 B:54-56). Leaf apex rotundate, midrib 1/4 mm wide losing its identity in the apical 1/3rd of the leaf, the only indication being a wedge formed by the marginal vein towards the apex, thus as in Ficus nitida, the marginal vein runs "through" the apex of leaf. Both marginal and "apical" vein infrequently show free marginal tracheidal lumps on either side with dense reticulation. Polygons 0.7 x 0.8 mm, free included veinlets absent. Marginal vein 1/10 mm from leaf apex.

P. judaica (Fig. 35 B:57,53). Leaf apex narrowly or broadly acute. Midrib 1/10 mm wide ending in a subrotundate felt head. Polygons 1.7 x 1.6 mm, without free included veinlets. Marginal vein 1/15 mm from leaf apex.

P. vulgaris (Fig. 35 B:59-60). Leaf apex subrotundate to ± emarginate. Midrib 1/15 mm wide, ending in a broad saddle shaped network of tracheids; into the sides of the saddle merge the marginals. Polygons 1.2 x 1.3 mm without free included veinlets. Marginal vein 1/13 mm from leaf margin.

Forskohelea tenassima (Fig. 35 B:63 + 64). Leaf apex acute, midrib 1/4 mm wide ending in a short rotundate head. Polygons 1.2 x 1.6 mm without free included veinlets. Marginal vein 1/8 mm from leaf margin and without free marginal tracheids
Drosera diffusa (Fig. 35 B: 61, 62).

Leaf apex acute acuminate; midrib 1/8 mm wide ending in a spherical head. Polygons 1.1 x 1 or 0.75 x 0.90 mm without included veinlets; those towards margin small and narrow. Marginal vein 1/3-1/10 mm from leaf margin without free marginal tracheids.

Vasculature between lobes is formed by a lateral vein given off from the midrib just near the wedge which passes outwards obliquely and is joined by the marginal vein of the adjacent lobe.