

Chapter 14

**Medicinal plants of the Onagraceae, Alangiaceae,
Melastomataceae and Lecythidaceae: *Ludwigia* (1), *Alangium*
(1), *Melastoma* (1), *Barringtonia* (1) and *Careya* (1).**

11. *Ludwigia octovalvis* (Jacq.) Raven

Local name: *Panlavang*

Sanskrit name: *Upodika*

Distribution: It is distributed in North America, tropical Africa, tropical Asia and Australia and India.

L. octovalvis is an erect, much branched perennial suffructicose undershrub upto 1.2m in height with stiff, terete, striate branches. Leaves are alternate, nearly sessile, broadly elliptic to lanceolate, acute or more or less woolly, main nerves numerous. Flowers are yellow, tetramerous, axillary and solitary. Fruits are subquadrangular, truncate, 8-ribbed, capsules breaking up between the ribs, clove-like in appearance, seeds numerous, minute, ovoid.

History:- Upodika is considered as specific for burns. Leaf juice mixed with butter is a soothing and cooling application for burns and scalds. It is cooling, diuretic and a mild laxative. It is easily digestible. Leaf paste is applied to boils, ulcers and abscesses to hasten suppuration. Juice of leaves together with sugar candy is useful in catarrhal affections of children and is administered with great benefit in gonorrhoea and balanites. It overcomes vitiated vata and pitta, promotes good sleep, helps easy delivery, improved strength and semen and cures raktapitta. It is an ingredient of *Sukhaprasavadaghrtam*. (Sivarajan and Balachandran, 1994)

Part Used: - Leaves

Detailed medicinal properties:-

Leaves are astringent, carminative, vermifuge, laxative, diuretic, anti-inflammatory, expectorant and febrifuge. It is also useful in dyspepsia, flatulence, dropsy, cough, asthma, vitiated conditions of vata, diarrhoea, dysentery, leucorrhoea and fever.

Previous reports:-

No information is available about the chemical constituents or pharmacognostic data of any part of the plant.

In the **present work**, the plant has been screened for the phytochemicals both in stem and leaves. Pharmacognostic studies have been done only on leaf.

Materials and Methods:

L. octovalvis was collected from Baroda. The voucher specimen of the plant has been deposited in the Herbarium, Department of Botany, The Maharaja Sayajirao University of Baroda (BARO), Vadodara. Standard methods, elaborated in chapter 2 were followed for the extraction, isolation and identification of the phytochemicals. Pharmacognosy has been done by standard methods mentioned in chapter 2.

Results:-

Phytochemistry:-

Leaves contained only quercetin as flavonoid. Vanillic, syringic and gallic acids were the phenolic acids identified. Quinones and steroid were found to be present. In stem also the only flavonoid identified was quercetin. Phenolic acids in stem were vanillic, syringic, gallic acids and *p*-hydroxy benzoic acids. Quinones and steroid were present in stem also.

Phytochemical biomarkers of leaves : Only quercetin as flavonoid alongwith quinone

Stem : Quercetin with *p*-hydroxy benzoic acid and

Quinones.

Pharmacognosy of leaf:-

Leaf micromorphology

Stomata were anomocytic found only on lower epidermis. Stomatal index was 34-36. Trichome index for unicellular trichomes were 20-23 in the lower epidermis.

Leaf - T.S. (Fig. 43)

Leaf was found to be dorsiventral. In midrib region, upper portion was raised to a ridge. Cells of upper epidermis (17-23 x 17-20 μ m) were square to barrel shaped covered with a wavy cuticle. Hypodermis consisted of one to two layered angular collenchyma (17-30 x 17-34 μ m). Below the collenchyma there were 20-22 layers of round to oval shaped parenchyma (27-95 μ m). Vascular bundle was crescent shaped in the middle of mid-rib region with included phloem. Endodermis and pericycle were absent. Included phloem cells (10-17 μ m) were in patches, distributed irregularly, separated by large parenchyma cells and consisted of small polygonal sieve tubes. Parenchyma cells present above xylem and below phloem were found to contain large raphides (10-17 x 4-7 μ m). Xylem consisted of oval shaped tracheids (32-35 μ m) in longitudinal rows. Thick walled xylem rays (13-17 x 13-20 μ m) were found in between tracheids in radial rows. Outer phloem was in a continuous patch below the xylem. Parenchyma cells below the vascular bundle were of eight to nine layers. Two layers of collenchyma cells were seen inner to the lower epidermis. Lower epidermal cells were similar to the upper epidermal cells except for the unicellular conical shaped trichomes (37-51 x 14-20 μ m).

In lamina portion (Fig. 44a), upper as well as lower epidermal cells were similar to those of midrib region. Mesophyll was differentiated into upper single layered palisade (31-41 x 10-14 μ m) and lower closely packed spongy cells (34-48 x 17-27 μ m) of three to four layers. Each palisade cell contained two to eight big chloroplasts (6-7 μ m) which filled the cells completely while the spongy cells had two to four chloroplasts. Many pairs of empty canals which were attached to each other were found in spongy tissue. Cuticle was straight in both the epidermises. Sunken stomata were observed in lower epidermis.

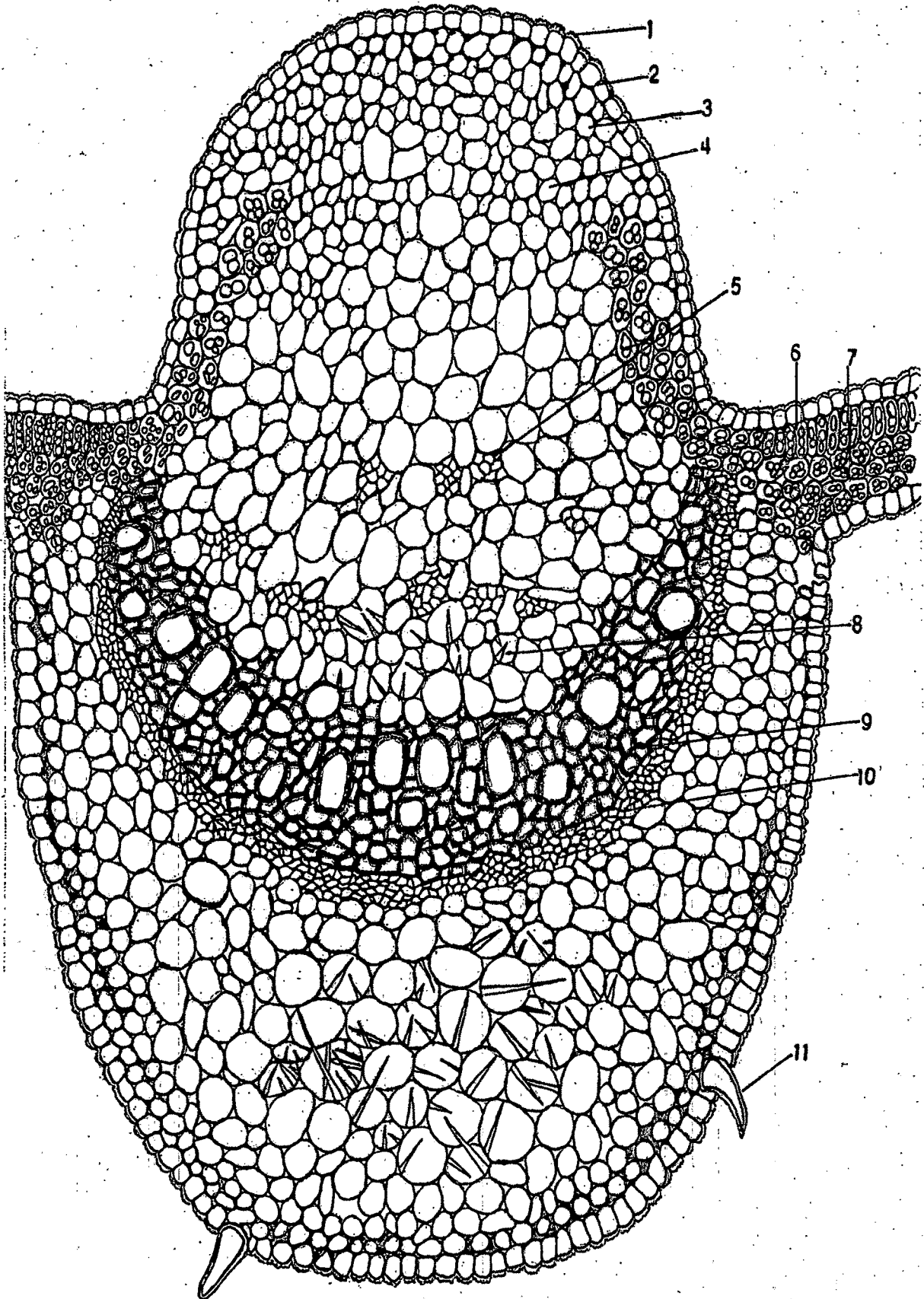


Fig. 43 *Ludwigia octovalvis* Leaf, Midrib-T.S.: 1. Cuticle, 2. Epidermis, 3. Angular Collenchyma, 4. Parenchyma, 5. included Phloem, 6. Palisade tissue with big chloroplasts, 7. Spongy tissue with big chloroplasts, 8. Parenchyma containing raphides, 9. Xylem, 10. Phloem, 11. Unicellular trichome

Powder study (Fig. 44b)

Powder of leaf consisted of raphides (10-17 x 4-7 μ m), cuticle with ridges and furrows, unicellular trichomes (37-51 x 14-20 μ m), spongy tissue with chloroplasts (34-48 x 17-27 μ m), angular collenchyma (17-30 x 17-34 μ m), palisade tissues with big chloroplasts (31-41 x 10-14 μ m) and parenchyma cells (27-95 μ m).

Pharmacognostic markers: Large raphides in parenchyma

: Unicellular conical hairs

: Wavy and ridged cuticle.

: Large chloroplasts in palisade and spongy tissue.

: Empty canals in mesophyll

12. *Alangium salvifolium* (Linn.f.) Wang

Synonyms: *A. lamarckii* Thw.; *Grewia salvifolia* Linn.f

Beng. - *Akar-kanta*; **Guj. & Hindi-** *Ankol*; **Kan.-** *Ankolimara, Ansaroli, Arinjil, Lucki*; **Mal.-** *Ankolam, Azhinni*; **Oriya-** *Ankula*; **Sans.-** *Ankola*; **Tam.-** *Alangi*; **Tel.-** *Ankolamu, Udagu, Uргу. Bihar & Kol-* *Ankol*; **Kumaun-** *Bismar, Kuilu*; **Sadri-** *Dhela*; **Santal-** *Ankol, Dela*

Distribution: The plant is distributed in dry regions, in the plains and lower hills in India and also in Indochina, Africa, Sri Lanka and China

A. salvifolium is a medium sized deciduous tree. Bark is pale brown, aromatic and rough with shallow cracks as well as is exfoliating in sub-corky scales. Leaves are alternate, oblong or elliptic-oblong, acuminate. Base of the leaf is rounded or acute, glabrous above and sparsely pubescent below. It is about 15cm long with a long petiole. Flowers are white, fragrant in axillary fascicles. Fruit is an ellipsoid drupe, black in color which is crowned by persistent calyx and is edible too. Seeds are large and enclosed in red, mucilaginous, sweet and astringent pulp.

History: The roots of this plant have been in use in Ayurvedic medicine. The root bark is very bitter and is known as a cure for skin diseases. It is astringent, bitter, alterative, laxative, pungent, anthelmintic, purgative and emetic. It is used as a substitute for Ipecac

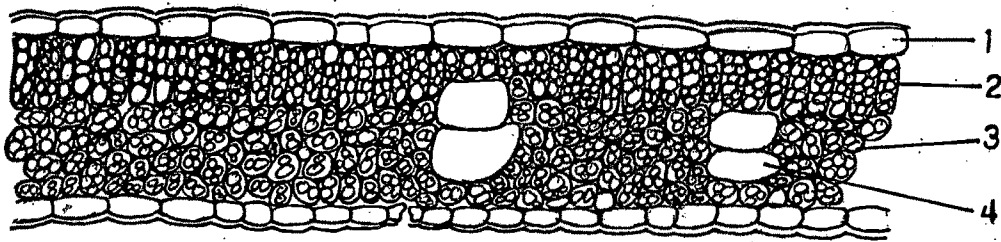


Fig. 44(a) *Ludwigia octovalvis* Leaf, Lamina-T.S.: 1. Epidermis, 2. Palisade tissue with big chloroplasts, 3. Spongy tissue with big chloroplasts, 4. Empty canals

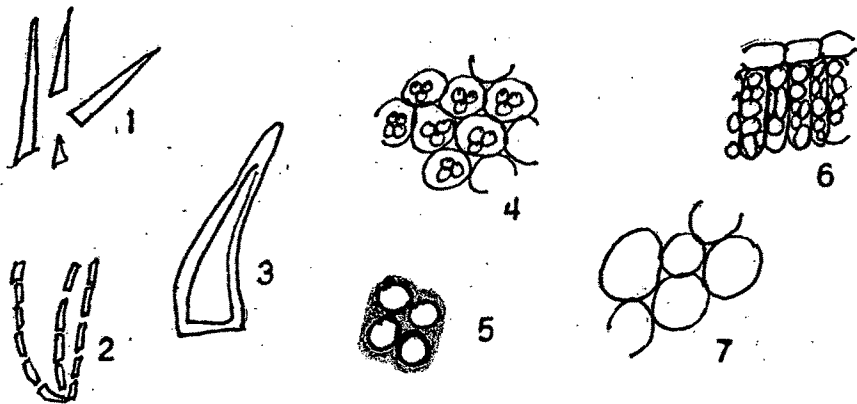


Fig. 44(b) *Ludwigia octovalvis* Leaf, Powder study: 1. Raphides, 2. Cuticle, 3. Unicellular trichome, 4. Spongy tissue with chloroplast, 5. Angular Collenchyma, 6. Palisade tissue 7. Parenchyma

and is useful as a diaphoretic and antipyretic; as a decoction or powder. When given in small doses cause a fall in blood pressure which is followed by a rise, depression of heart and irregular respiration. The peristaltic movement of the intestine is found increased by it. The bark showed anti-tubercular activity and is active against gram-positive organisms and *Helminthosporium sativum*. Fruits are sweet, cooling, purgative, and useful in treating burning sensation, emaciation, stangury and hemorrhages. They are relished by children even though they are astringent and acidic. They also have antiphlegmatic, laxative, tonic and refrigerant properties. They are eaten to cure eye troubles. **Seeds** are known in the indigenous system of medicine for their cooling and tonic properties and also for their use in the treatment of haemorrhage (Anon. 1985).

According to Sivarajan and Balachandran (1994), it is a reputed single drug in Ayurveda for the treatment of rabies. The **root bark** is given both internally and externally in cases of rabid dog-bites and as antidote for other poisonous bites including snake bites. The drug is helpful in diarrhoea, simple continued fevers, worms, colic, hemopathy and inflammations. It is a known medicine for leprosy, other skin diseases and syphilis. **Fruit** is laxative, antiphlegmatic, tonic and is useful in burning sensation, haemorrhages and morbidity of tridosas – vata, pitta and kapha. It is an ingredient of *Mahabhutaravaghtam*.

Parts used in medicine: All parts (roots, fruits, leaves, bark, seeds)

Detailed medicinal properties:

Bark extract is taken orally for lowering blood pressure. It is also useful in diarrhoea, fever, worms, colic and inflammations and is a reputed remedy for leprosy and other skin diseases, syphilis, diuretic, emmenagogue and purgative. An **amorphous alkaloid mixture**, named **AL-60** present in stem, in small doses, reduces blood pressure temporarily, depresses heart and produces irregular respiration. It increases peristaltic movement of intestine. It also helps in treatment of diarrhoea, piles and vomiting. Leaves are used as poultice in rheumatic pains and are analgesic. **Alkaloidal extract of leaves** is mild, adrenolytic, antispasmodic, hypotensive and shows anticholinesterase activity. A quaternary base, isolated from the water soluble fraction of the alcoholic extract, produces a fall in carotid blood pressure of anaesthetized dogs. An alcoholic extract of the leaves showed hypoglycaemic activity in albino rats. **Roots** are acrid, astringent,

emollient, anthelmintic, thermogenic, diuretic and purgative. It is useful for external application in acute case of rheumatism, leprosy, inflammation and for external and internal application in case of bites of rabid dogs. Root bark is used as antidote for several poisons. The extract of **root bark** exhibits anthelmintic effect against poultry ascarids. The alkaloid **alagine** shows selective action on the parasympathetic mechanism. The action shows most prominence in gastro-intestinal tract. Seeds are used as a cure for boils. They yield oil which is used as an illuminant. The total alkaloids from the seeds exhibit a sustained and prolonged hypertensive and hypotensive effect in cats at lower and higher doses, respectively (Anon., 1985). The plant extract possesses antineoplastic and antihypotensive properties. In Andhra Pradesh, a paste of the stem bark alongwith salt is given for cough in cattle (Anon., 2000).

Previous phytochemical reports:-

Alkaloids of all the parts and steroids of some parts of this plant are studied in detail. **Stem bark** is found to contain isoquinoline alkaloids such as alagine A and B, alangicine, marckine and marckidine, emetine, cephaeline, demethylcephaeline, tubulosine and psychotrine. β -Sitosterol and stigmasterol have been reported in the non-alkaloidal extract of the stem bark. **Root bark** also contains isoquinoline alkaloids like alagine A and B, alangicine, desmethylpsychotrine, marckine, marckidine, lamarckinine, emetine, tubulosine, isotubulosine, AL-64, psychotrine, cephaeline, protoemetinol and alangiosterol. It also contains wax. β -Sitosterol and stigmasterol are reported in wax. **Fruit** contains alkaloids such as cephaeline, N-methylcephaeline, deoxytubulosine and alangiside. **Leaves** contain alkaloids like alangimarckine, ankorine, deoxytubulosine, alangiside, 3'-*epi*tubulosine (stereoisomer of tubulosine), stigmasta-5,22,25-trien- β -ol, β -sitosterol, friedelin, and N-benzoyl-L-phenyl-alaninol, myristic acid, triterpenoids like triterpene A, isoalangidiol and alangidiol as well as choline chloride (cholinergic principle) (Anon., 1985).

The leaves (on dry matter basis) contain crude protein (15%) and tannins (2%). **Flowers** contain deoxytubulosine, a potent antiplatelet aggregation component which has a strong binding with DNA. The dried fruits contain tetrahydroisoquinoline monoterpene glucosides, isoalangiside, 3-O-de-methyl-2-O-methylisoalangiside and 7-O-

methylpecoside. The dried seeds contain lacinilene C, a rare sesquiterpene (Anon., 2000).

It is evident from the above data, that only alkaloids and steroids have been studied for certain parts of this plant. No data on phenolics, flavonoids or any other constituents on any of the parts are available.

Previous pharmacognostic studies:-

Data on a few characters of bark only are available. Though the young stems and leaves are used in medicine, no pharmacognostic study was conducted on them so far

In the **present work**, the leaves, bark and young stem have been screened for the phytochemicals such as flavonoids, quinones, simple phenols, etc. and pharmacognosy of all these parts have been conducted.

Materials and Methods:

All the plant parts were collected from Baroda and environs. The voucher specimen of this plant has been deposited in the Herbarium, Department of Botany, The Maharaja Sayajirao University of Baroda (BARO), Vadodara. Standard methods, presented in chapter 2 were followed for the extraction, isolation and identification of the phytochemicals. Pharmacognostic studies were conducted by standard methods mentioned in chapter 2.

Results:

Phytochemistry: -

Alangium leaves contained flavonols like kaempferol, 4'-OMe kaempferol and quercetin. Vanillic, syringic, melilotic, *p*-coumaric, *o*-coumaric and ferulic acids were the phenolic acids present. In **stem**, quercetin was the only flavonoid present alongwith phenolic acids like vanillic, syringic and melilotic acids. In **bark**, kaempferol alongwith vanillic, syringic, protocatechuic and *o*-coumaric acids were identified. Quinones, steroids and alkaloids were found in all the three parts of the plant. Glycoflavones were absent in all the parts.

Phytochemical biomarkers of leaves: Kaempferol, quercetin and alkaloids

Bark : Alkaloids kaempferol and o-coumaric acid.

Stem : Only quercetin with alkaloids

Pharmacognosy of leaf, bark and stem:

Leaf micromorphology

Stomata were anomocytic found only on lower epidermis. Stomatal index was 34-36. Trichome index for unicellular trichomes were 1-3 in the upper epidermis.

Leaf - T.S. (Fig. 45)

Leaf was dorsiventral in nature. Cells of epidermis were barrel shaped (14-24 x 10-27 μ m) and were interrupted by unicellular thick walled trichomes (102-210 x 6-19 μ m). In the mid rib region the hypodermis was of a triangular patch of collenchyma (6-20 μ m), below which was a single layered parenchyma (10-37 x 7-34 μ m) followed by layers of chlorenchymatous cells (6-13 μ m) containing single chloroplast each. The vascular bundle was encircled by endodermis, some of the cells of which contained crystals (19.04 μ m-l, 12.92 μ m-b). Pericycle was 3-4 layered in the lower region and single layered on the upper side and consisted of sclerenchyma cells (10-20 x 10-17 μ m). Rhomboidal crystals were found in some of the pericyclic fibers. Two sets of xylem were seen forming a ring surrounding an oval patch of parenchyma in the centre and this was surrounded by phloem (4-14 μ m) all around. Sphaeraphides (4-13 μ m) and crystals were present in phloem ray cells. Rhomboidal crystals were found in xylem rays also. The vascular bundle was surrounded by mostly by parenchymatous cells containing similar crystals on the lower and lateral sides. One to two layers of collenchyma were seen above lower epidermis.

In lamina (Fig. 46a), mesophyll was differentiated into two-layered palisade (20-37 x 7-10 μ m) and spongy (7-16 μ m). Palisade cells of these two layers were of unequal length and contained comparatively big chloroplasts (4-10 μ m) and oil globules (4-10 μ m). Elongated spongy cells were seen towards upper epidermis and spherical cells towards lower epidermis. Spongy cells were with single chloroplast or oil globule each. Stomata were seen sunken in lower epidermis. The cells of lower epidermis were smaller (10-17 x 7-17 μ m) compared with those of the upper epidermis.

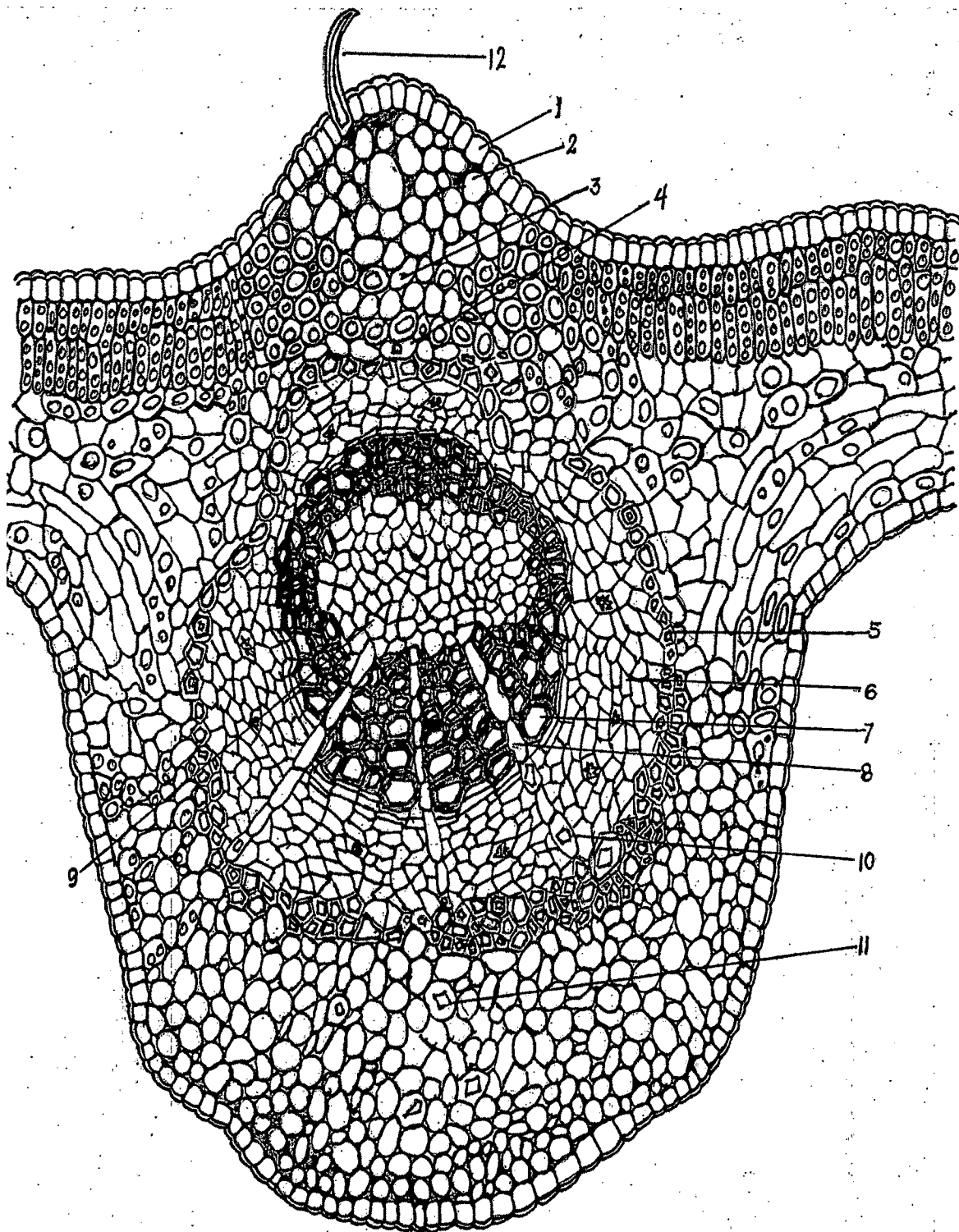


Fig. 45 *Alangium salvifolium* Leaf, Midrib-T.S.: 1. Epidermis, 2. Angular Collenchyma, 3. Parenchyma, 4. Endodermis, 5. Sclerenchyma, 6. Phloem, 7. Xylem, 8. Xylem rays, 9. Parenchyma, 10. Phloem rays, 11. Parenchyma containing rhomboidal crystals, 12. Unicellular trichome

Powder study (Fig.46b)

Powder of the leaf showed the following characters: - palisade tissues (20-37 x 7-10 μ m), rhomboidal crystals (19.04 μ m-l, 12.92 μ m-b), unicellular trichomes (102-210 x 6-19 μ m), double spiral thickening, sclerenchyma fibres, parenchyma cells with oil globules and sphaeraphides.

Pharmacognostic markers: Unicellular thick walled trichomes

- : Chlorenchyma with single large chloroplast
- : Prismatic crystals in fibres and parenchyma
- : Palisade two layered – upper small in size, lower longer

Bark - T.S. (Fig.47)

In **transverse section** of the bark, the cork was seen differentiated to two regions. The outer part consisted of thick walled rectangular cells (27-44 x 14-20 μ m) and inner region of comparatively thin walled cells. There was a single layer of cork cambium and inner to the same was the parenchymatous secondary cortex (27-48 x 10-17 μ m). The outer cells of this region were irregular in shape (17-54 μ m) and contained sphaeraphides (14-24 μ m) and starch grains of simple type (4-7 μ m). The inner cortical region contained square to rectangular clusters of 9- 12 sclereids (31-78 μ m x 27-37 μ m). The sclereids also were almost rectangular in shape with 5-8 pits.

Bark- L.S. (Fig.48)

In **longitudinal section** of bark, the cork cells were found to be rectangular (14-20 μ m x 31-48 μ m). Parenchymatous cells (54-72 x 17-31 μ m) of secondary cortex were observed as oval, elongate or spherical with sphaeraphides and starch grains. Sclereids (245-979 μ m x 41-54 μ m) were found to be very long and rectangular.

Powder study (Fig.51a)

Powder of bark is reddish in color. Sclerieds (245-979 μ m x 41-54 μ m), starch grains (4-7 μ m), sphaeraphides (14-24 μ m), cork cells (14-20 μ m x 31-48 μ m), parenchyma cells with starch grains (27-48 x 10-17 μ m) and sphaeraphides were observed.

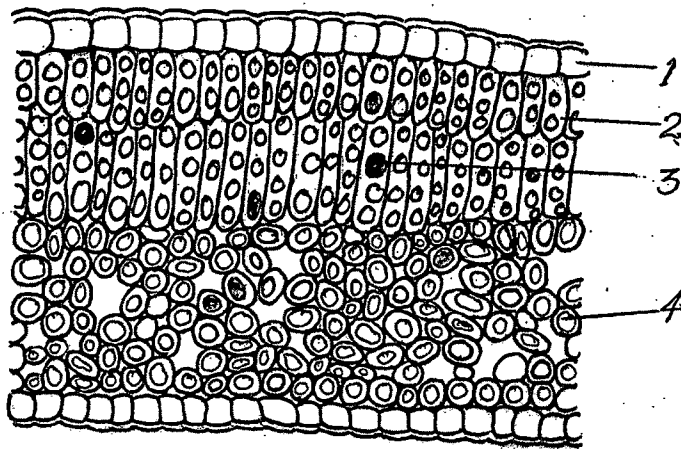


Fig. 46(a) *Alangium salvifolium* Leaf, Lamina-T.S: 1. Epidermis, 2. Palisade tissue with chloroplast and oil globules, 3. Oil globules, 4. Spongy tissue

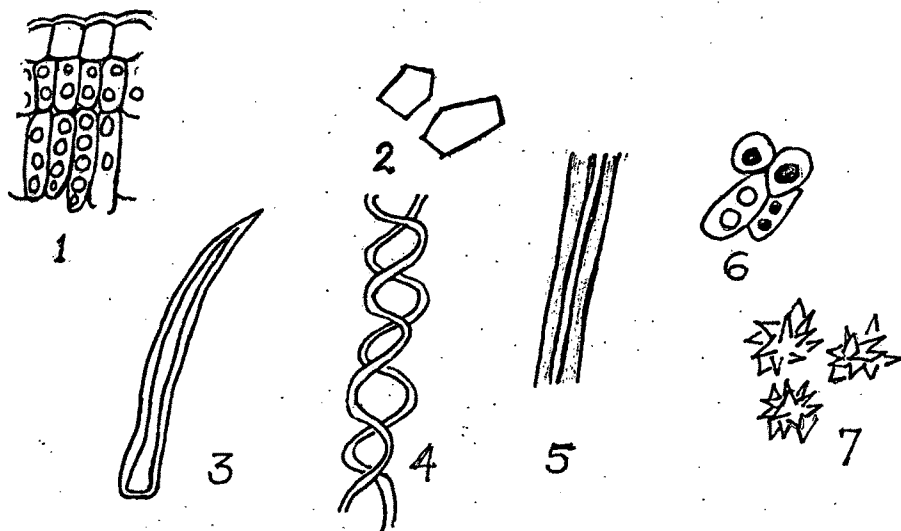


Fig. 46(b) *Alangium salvifolium* Leaf, Powder study: 1. Palisade tissue, 2. Crystal, 3. Unicellular trichome, 4. Double spiral thickening, 5. Sclerenchyma, 6. Parenchyma cells with oil globules, 7. Sphaeraphides

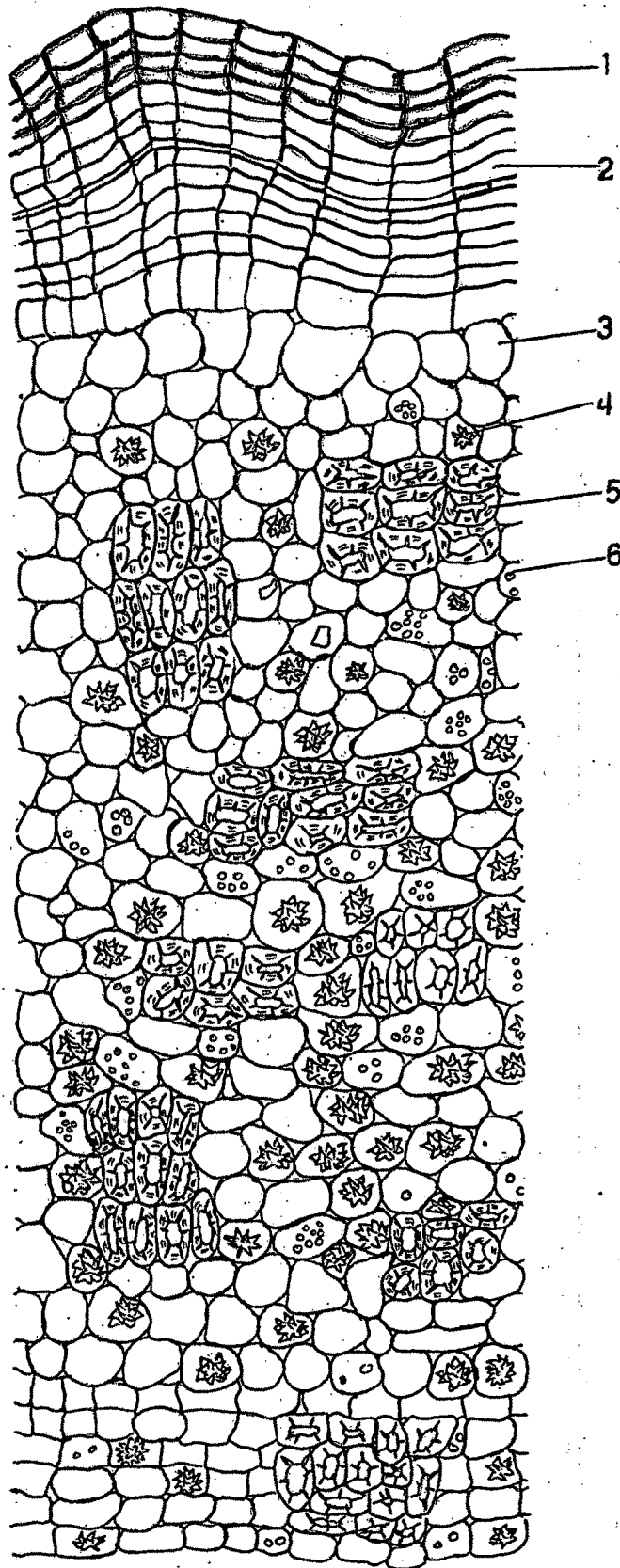


Fig. 47 *Alangium salvifolium* Bark, T.S.: 1. Thick walled cork, 2. Thin walled cork, 3. Parenchymatous cortex, 4. Sphaeraphide, 5. Sclereid, 6. Starch grains

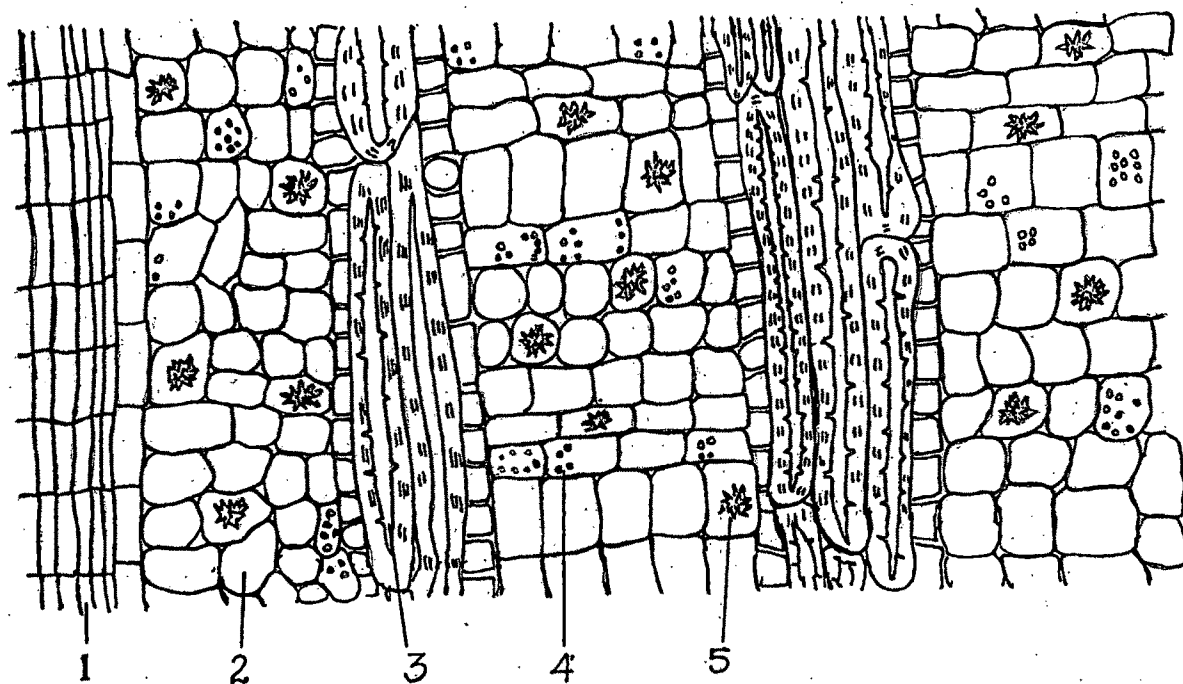


Fig. 48 *Alangium salvifolium* Bark, L.S.: 1. Cork, 2. Parenchyma cells, 3. Sclereids, 4. Parenchyma containing starch grains, 5. Parenchyma containing Sphaeraphides

Pharmacognostic markers: Two types of cork cells

- : Oval sclerieds in rectangular patches
- : Absence of vessels and tracheids
- : Abundance of sphaeraphides
- : Absence of tannin cells.

Stem -T.S. (Fig.49)

In **transverse section**, stem was circular in outline. The cork cells (10-17 x 24-38 μ m) were uniform followed by cork cambium. Cortex consisted of parenchymatous (14-38 x 20-42 μ m) as well as chlorenchymatous (14-38 x 20-41 μ m) cells. Endodermal cells contained crystals of calcium oxalate (10-24 μ m) followed by two layered sclerenchymatous pericycle (10-20 x 10-24 μ m) cells. Inner to the pericycle was a broad band of phloem. The phloem rays (14-27 x 7-10 μ m) were of uniseriate parenchyma cells, each containing a single crystal of sphaeraphide (7-10 μ m). Secondary xylem consisted of vessels (18-25 μ m), tracheids (6-13 μ m) and sclerenchyma (10-20 μ m). The xylem rays (6-10 μ m) were uniseriate and bi- or triseriate and contained sphaeraphides and starch grains. The primary xylem was surrounded by thick walled, pitted cells (41-90 μ m). Pith consisted of outer region of small thick walled cells and central region of thin walled large parenchyma cells.

Stem- T.L.S. (Fig.50a)

In **T.L.S**, cork cells (10-17 x 24-38 μ m) were seen elongated and thick walled. Secondary cortex showed oval and elongated parenchymatous cells. The sclerenchyma of the pericycle was found to have narrow lumen (lumen: 6 μ m). Phloem rays (19-25 μ m) were uniseriate with sphaeraphides in them. Xylem rays were both uniseriate and bi- or triseriate with pitted thick walls. Tracheids were more common and were with simple pits and also scalariform pitting. Xylem sclerenchyma were comparatively few, thick walled with a narrow lumen (lumen: 5 μ m). Vessels (55-90 μ m) were broad with loosely arranged bordered pits.

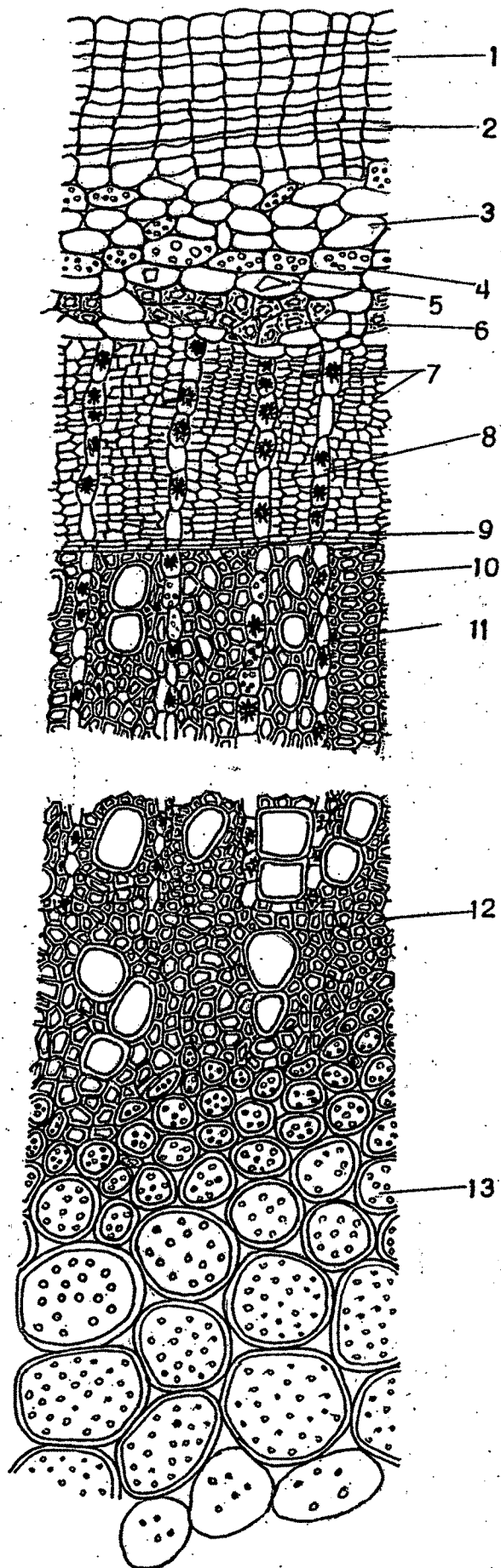


Fig. 49 *Alangium salvifolium* Stem, T.S.: 1. Cork, 2. Cork cambium, 3. Parenchyma, 4. Chlorenchyma, 5. Endodermis, 6. Sclerenchyma, 7. Phloem, 8. Phloem ray containing sphaeraphides, 9. Cambium, 10. Secondary xylem, 11. Xylem rays containing starch grains and sphaeraphides, 12. Primary xylem, 13. Pith

Stem- R.L.S. (Fig.50b)

In R.L.S, xylem vessels were seen with bordered pits in 4-5 rows. In tracheids, pits were in 1-2 rows. Ray cells were upright. Among the xylem ray cells some were filled with starch grains. The walls of ray cells were thick with simple pits. Primary xylem (24-40 μ m) consisted of both scalariform and spiral tracheids. Primary xylem was followed immediately by rectangle to polygonal shaped cells with pitting. The central portion of the pith consisted of thin walled parenchyma cells containing sphaeraphides.

Powder study (Fig.51b)

Powder of stem consisted of sclerenchymatous fibres (8-10 μ m), parenchyma cells with starch grains (14-38 x 20-42 μ m), cork cells (10-17 x 24-38 μ m), endodermal cells, rhomboidal crystals, sphaeraphides (7-10 μ m), vessel with scalariform thickening (40-50 μ m), phloem rays with phloem cells, medullary rays with tracheids, vessels with bordered pits alongwith tracheids and thick walled pitted parenchyma cells (41-90 μ m).

Pharmacognostic markers: Same characters of bark

: Xylem elements present.

: Large thick walled and pitted parenchyma cells.

13. *Melastoma malabathricum* Linn.

Synonyms: - *M. polyanthum* Blume, *M. normale* D.Don

Sans. - *Tinisah*; **Mar.** - *Palore*; **Tel.** - *Pattuda*; **Tam.** - *Nakkukaruppan*; **Mal.** - *Kalampatti*; *Totukara*; **Kan.** - *Ankerki*; **Oriya** - *Gongai*, *Koroti*; **Nepal** - *Tulasi*, *Choulisy*; **Lepcha**; - *Tungbram*; **Assam** - *Phutuka*

Distribution: - Humid places of India, Andaman Islands

M. malabathricum is a shrub. Bark is reddish brown and thin. Leaves are lanceolate to oblong. Flowers are in terminal corymbose panicles of mauve purple in color. Fruit is broadly ovoid and truncate. Pulp is present within the fruit.

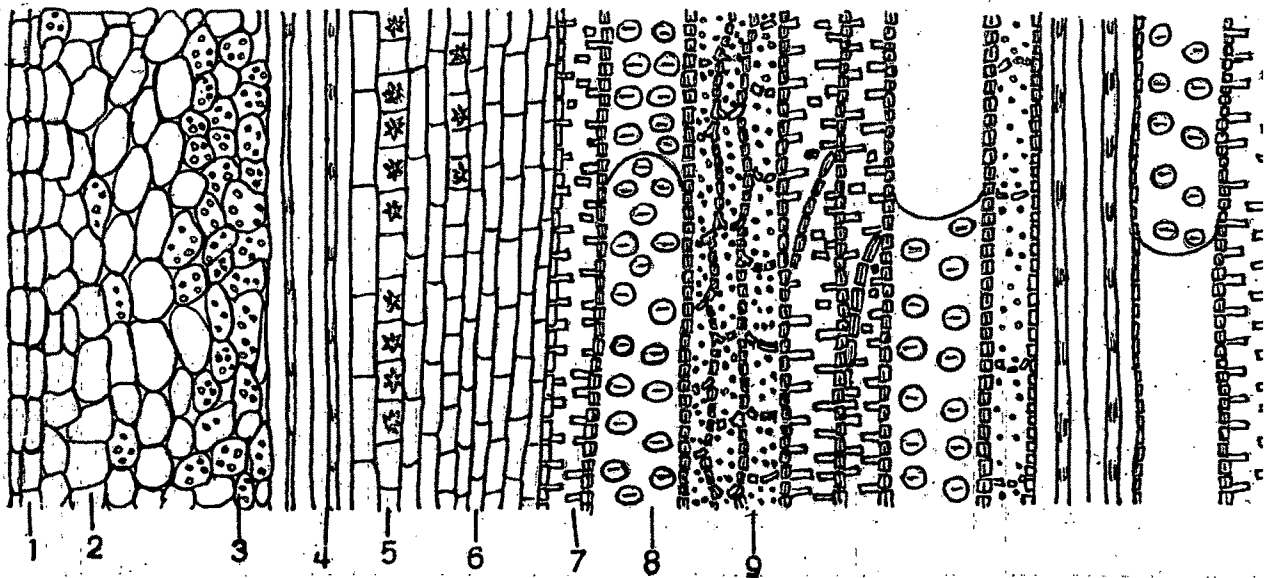


Fig. 50(a) *Alangium salvifolium* Stem, T.L.S.: 1. Cork, 2. Secondary cortex, 3. Primary cortex, 4. Sclerenchyma, 5. Phloem ray, 6. Phloem, 7. Tracheid, 8. Vessel, 9. Medullary ray

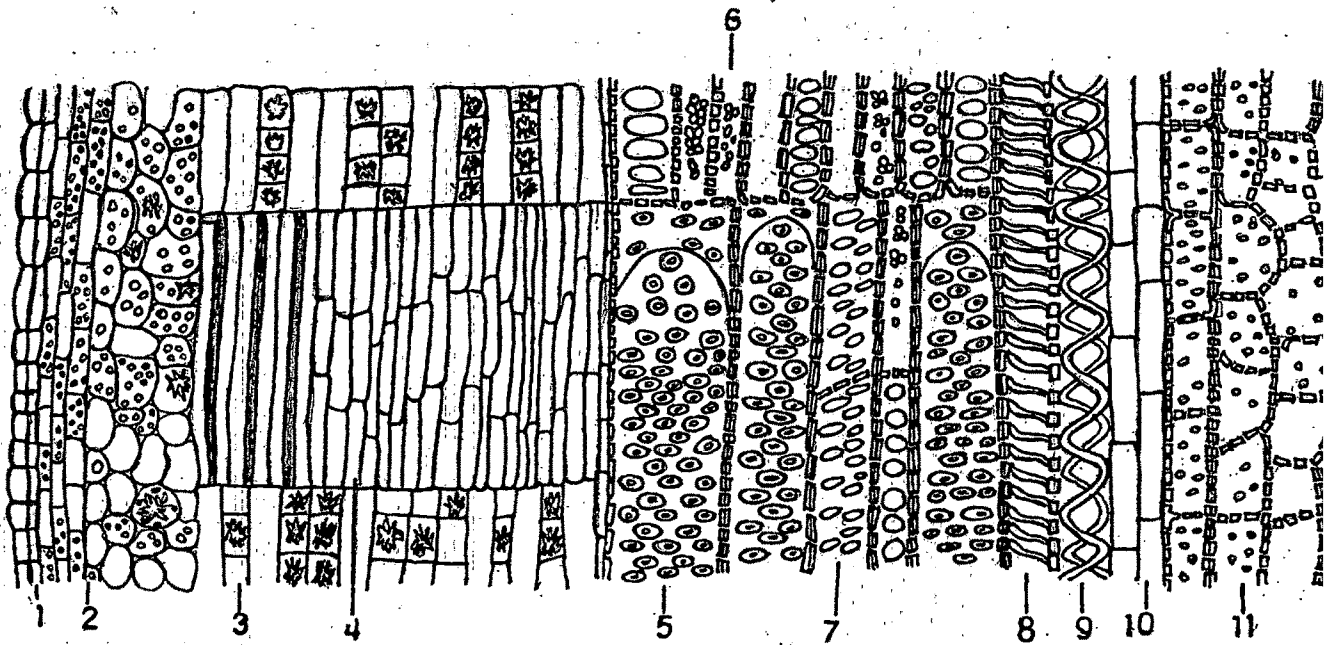


Fig. 50(b) *Alangium salvifolium* Stem, R.L.S.: 1. Cork, 2. cortex, 3. Phloem ray, 4. Phloem, 5. Vessels with bordered pits, 6. Xylem rays, 7. Tracheid, 8. Vessel with scalariform Thickening, 9. Protoxylem with double spiral Thickening, 10. Phloem, 11. Pith.

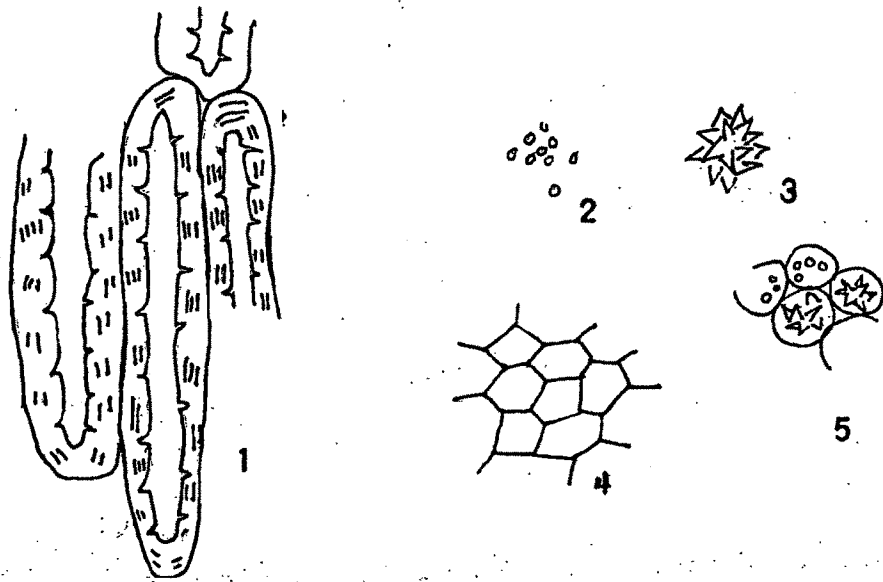


Fig. 51(a) *Alangium salvifolium* Bark, Powder study: 1. Sclereid, 2. Starch grain, 3. Sphaeraphide, 4. Cork, 5. Parenchyma cells with starch grain and Sphaeraphide

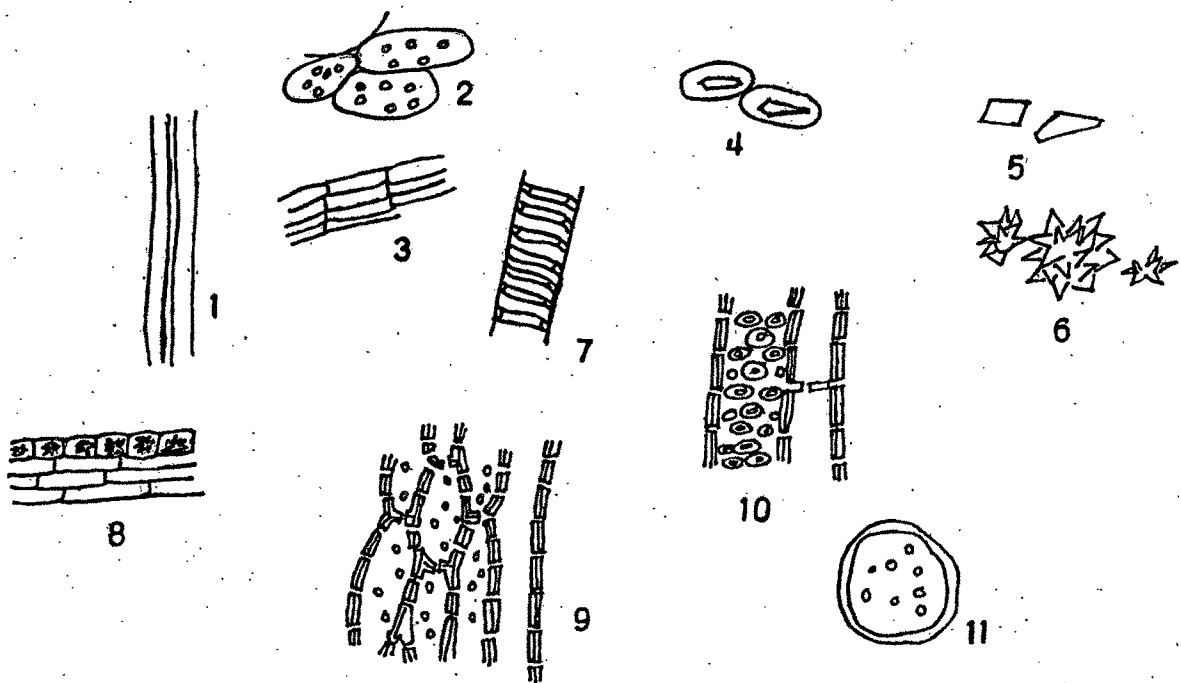


Fig. 51(b) *Alangium salvifolium* Stem, Powder study: 1. Sclerenchyma, 2. Parenchyma cells with starch grain, 3. Cork, 4. Endodermis, 5. Crystals, 6. Sphaeraphides, 7. Protoxylem with scalariform thickening, 8. Phloem rays along with phloem, 9. Medullary rays with tracheids, 10. Vessels with bordered pits along with tracheids, 11. Pitted thick walled cell

History: - *M. malabathricum* was one of the 23 drugs that constitute the *Asanadi gana* of *Vagbhata* which cures leucoderma and other skin diseases, morbid kapha, worms, anaemia, diabetes and disorders due to deranged fat. It was light, cooling, astringent and tonic and is useful in the vitiated conditions of kapha and pitta, ulcers, inflammatory swellings, leprosy, leucoderma and general debility. The bark and the heartwood were used medicinally. The drug formed an ingredient of *Ayaskrti*. (Sivarajan and Balachandran, 1994)

Parts used in medicine: - Leaves, bark, fruits

Detailed medicinal properties: - Leaves are astringent and used in diarrhoea, dysentery and leucorrhoea. Bark and roots are used for healing wounds and other skin diseases. They are also used in preparation of gargles.

Previous phytochemical reports: - Ellagitannins like Pedunculagin, casuarictin, pterocaryanin C, strictinin; 1,4,6-trigalloylglucose, nobotanin B, nobotanin G, nobotanin H, nobotanin J, malabathrins B, malabathrins C, malabathrins D are reported from leaves.

Previous pharmacognostic studies: - Pharmacognostic data on this plant is not available.

In the present work, leaves and stem were analysed for their flavonoids, phenolic acids, quinones, etc in. Pharmacognostic studies of leaves and stem were also carried out.

Materials and Methods:

The plant was collected from Kerala. The voucher specimen of the plant has been deposited in the Herbarium, Department of Botany, The Maharaja Sayajirao University of Baroda (BARO). Standard procedures described in chapter 2 were followed for the extraction, isolation and identification of the phytochemicals. Pharmacognosy has been conducted by standard methods mentioned in chapter 2.

Results: -

Phytochemistry: - Leaves contained flavonoids such as quercetin, 3'-OMe quercetin; 3', 4'-diOMe quercetin and 7, 3', 4'- triOMe quercetin. Vanillic and syringic acids were the only phenolic acids present. Quinones and steroids were present. Alkaloids and

glycoflavones were absent. In stem, 3'-OMe quercetin; 4'-OMe quercetin and 3', 4' - diOMe quercetin were located. Phenolic acids were the same as the leaves. Quinones and steroids were found to be present. Alkaloids and glycoflavones were absent.

Phytochemical biomarkers of leaves: Only quercetin derivatives and two phenolic acids
vanillic and syringic acids

stem: Same as leaves

Pharmacognosy of leaf and stem: -

Leaf micromorphology

Stomata were anomocytic found only on lower epidermis. Stomatal index was 28-30. Trichome index for non-glandular complex trichomes was 5-7 in the lower epidermis.

Leaf -T.S. (Fig.52)

Leaf was dorsiventral in nature. The upper portion of the midrib was slightly ridged. Cells of upper epidermis (17-24 x 17-20 μ m) were barrel shaped covered by a thin cuticle. A single sphaeraphide (9-13 μ m) was seen in the epidermal cell at the centre of the ridge below which was a patch of seven to eight gelatinous fibres (10-14 x 14-17 μ m). The ground tissue (27-58 μ m) was very broad in the lower region and thin on the upper side. The cells here contained sphaeraphides. Vascular bundle was U-shaped. Two to three small vascular bundles were seen in the ground tissue. Endodermis and pericycle were not differentiated. Intraxylary phloem (9-16 μ m) was smaller in size than the outer phloem. Xylem tracheids (32-38 μ m) were about two to three in radial rows separated by two to three rows of xylem rays (14-40 x 13-19 μ m). The lower hypodermis consisted of two to three layered lacunar collenchyma (13-19 μ m). Lower epidermal cells were oval to round in shape containing sphaeraphides in almost every cell. At some regions on the inner side of the epidermis, the cells containing sphaeraphides were surrounded by sclerenchyma (10-14 x 14-17 μ m). Non glandular complex i.e. multicellular, uniseriate trichomes (250-320 x 37-48 μ m) were observed in lower epidermis.

In lamina portion, upper epidermal cells (17-31 x 17-41 μ m) were barrel shaped and bigger in size than those of the midrib region. Mesophyll was differentiated into single layered palisade and four to five layers of spongy cells (24-27 x 17-27 μ m). Non

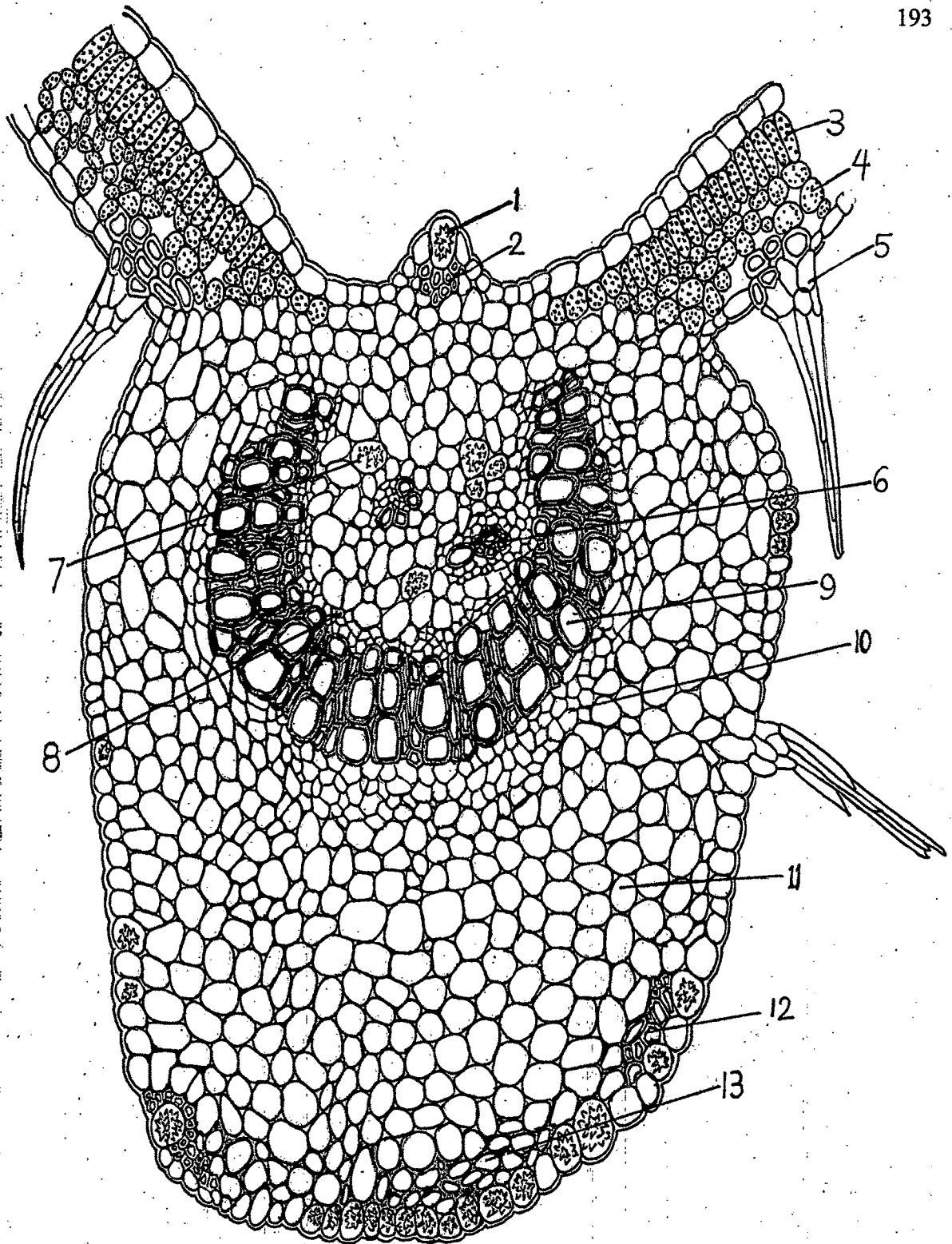


Fig. 52 *Melastoma malabathricum* Leaf, T.S: 1. Epidermal cells containing Sphaeraphides, 2. Gelatinous fibre, 3. Palisade tissue, 4. Spongy tissue, 5. Non glandular complex trichomes, 6. Vascular bundle, 7. Parenchyma containing Sphaeraphides, 8. Intraxylary phloem, 9. Xylem, 10. Phloem, 11. Parenchyma, 12. Sclerenchyma, 13. Lacunar Collenchyma

glandular multicellular trichomes which had sclerenchymatous base were seen on the lower side of leaf. Lower epidermal cells (17-24 x 17-19 μ m) were smaller in size than the cells of upper epidermis and were rectangular in shape.

Powder study (Fig.55a)

Leaf powder had the following components: - epidermal cells (17-24 x 17-20 μ m) with single sphaeraphides in each cell (9-13 μ m), non glandular multicellular trichomes (250-320 x 37-48 μ m), sclerenchyma cells (10-14 x 14-17 μ m) surrounded by parenchyma cells, lacunar collenchyma cells (13-19 μ m), sphaeraphides (9-13 μ m) and tracheids with annular thickening (40-60 μ m).

Pharmacognostic markers: U shaped vascular bundle

- : Multicellular, multiseriate trichome with a sclerenchymatous base
- : Epidermal cells, large and containing a single large cluster crystal
- : Epidermal cells in association with fibres
- : Gelatinous fibres

Stem - T.S. (Fig.53)

Cork cells (10-20 x 23-36 μ m) of rectangular shape were in five to six layers. Secondary cortex consisted of two to three layered irregular shaped parenchyma (14-37 x 14-44 μ m). The primary cortex inside consisted of small brachysclerieds (10-17 x 7-37 μ m) in a continuous ring. Endodermis and pericycle were not clearly differentiated. Phloem elements (7-10 x 10-17 μ m) were of six to seven layers of polygonal shaped cells. Xylem cylinder was very broad. Xylem vessels (20-27 μ m) were of irregular shape and arranged in radial or tangential pairs or in threes. Tracheids (7-17 μ m) were found in radial rows. Medullary rays (20-27 x 7-14 μ m) were uniseriate. Internal phloem was of two to three layers. Pith consisted of parenchyma cells (17-31 μ m) containing resin canals and patches of small angular cells which resembled the phloem (7-10 x 10-14 μ m).

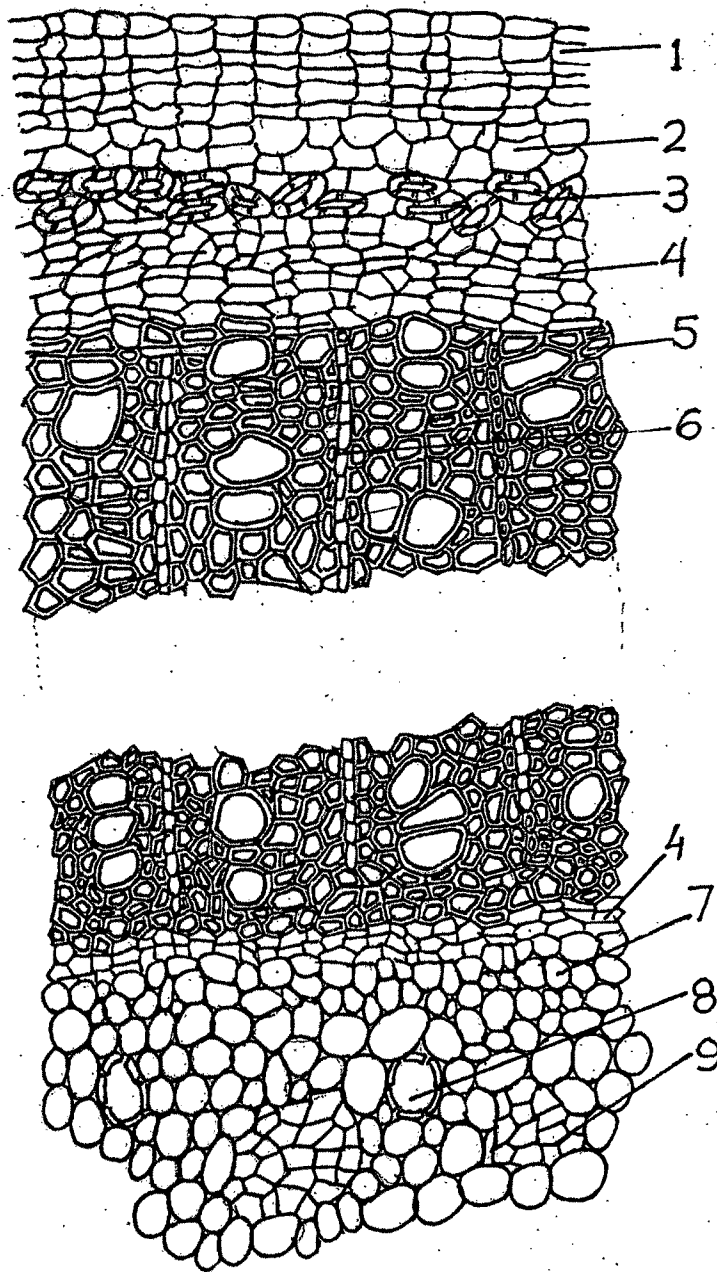


Fig. 53 *Melastoma malabathricum* Stem, T.S: 1. Cork, 2. Parenchymatous cortex, 3. Brachysclereid, 4. Phloem, 5. Xylem, 6. Medullary rays, 7. Parenchyma, 8. Resin canals, 9. Angular cells like phloem

Stem - T.L.S. (Fig.54a)

In T.L.S., cork cells were seen elongated. Brachysclereids (17-34 x 80-95 μ m) were rectangular in shape. Some of the cortical cells contained large sphaeraphides. Phloem cells were long and elongated. Tracheids (17-29 μ m) were simple. Xylem rays (10-27 x 125-336 μ m) were uniseriate with starch grains. Vessels were observed with five to six rows of closely packed bordered pits alongwith perforation plates.

Stem- R.L.S. (Fig.54b)

In R.L.S., all the cells appeared same as T.L.S. Ray cells were upright with starch grains. Primary xylem consisted of spiral and annular thickening. Intraxylary phloem of long and flattened cells was seen. Pith was composed of isodiametric parenchymatous cells.

Powder study (Fig.55b)

Powder of stem consisted of brachysclereids (9-13 μ m), cork cells (10-20 x 23-36 μ m), medullary rays, sphaeraphides, tracheids (17-29 μ m) with spiral thickening, cortical cells with sphaeraphides, vessels with bordered pits alongwith tracheids and phloem ray cells.

Pharmacognostic markers: Brachysclereids

: Resin canals

: Xylem vessels in three's

: Xylem rays with brown contents

14. *Barringtonia acutangula* Gaertn.

English name: Indian Oak

Beng. - *Hijal, Kumia*; **Guj.** - *Samudraphal*; **Hindi** - *Hijjal, Ijal, Ingar*; **Kan.** - *Holekauva, Mavinkubia*; **Mal.** - *Attampu, Attuperu*; **Mar.** - *Dattephal, Samudraphal*; **Oriya** - *Hinjolo, Nijhira*; **Sans.** - *Samudraphal*; **Tam.** - *Adampa, Kadappai, Sengadambu*; **Tel.** - *Kadappa, Kanapachettu, Punnagachettu*; **Assam** - *Kanapa*

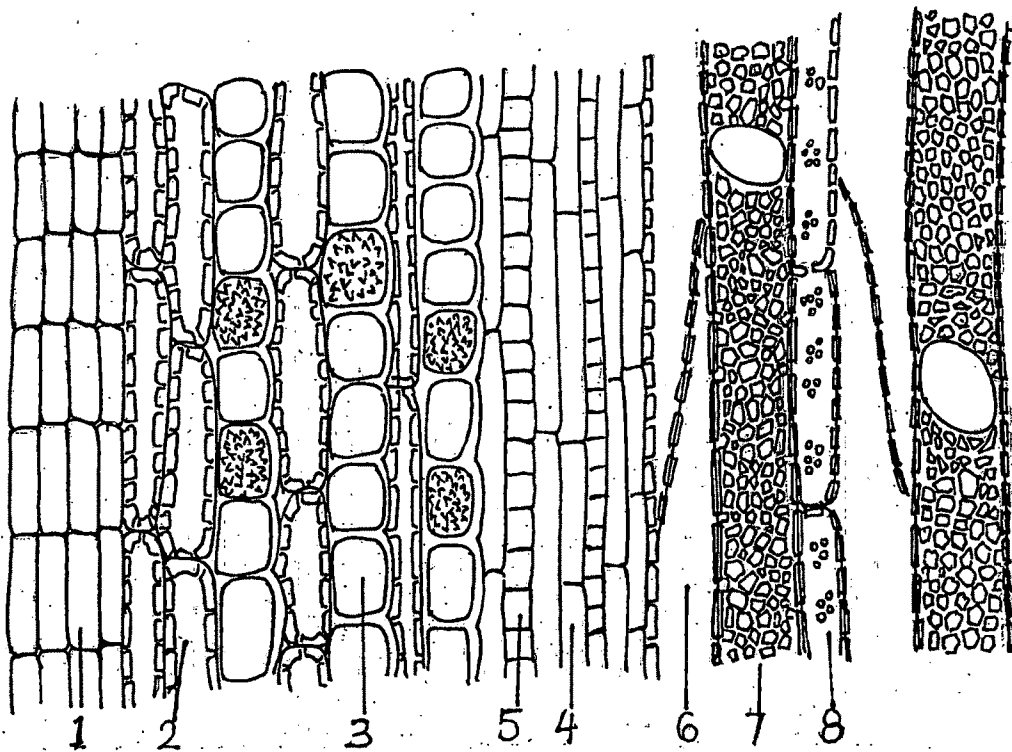


Fig. 54(a) *Melastoma malabathricum* Stem, T.L.S: 1. Cork, 2. Brachysclereid, 3. Cortical cells, 4. Phloem, 5. Phloem rays, 6. Tracheids, 7. Vessels with closely packed bordered pits, 8. Xylem ray

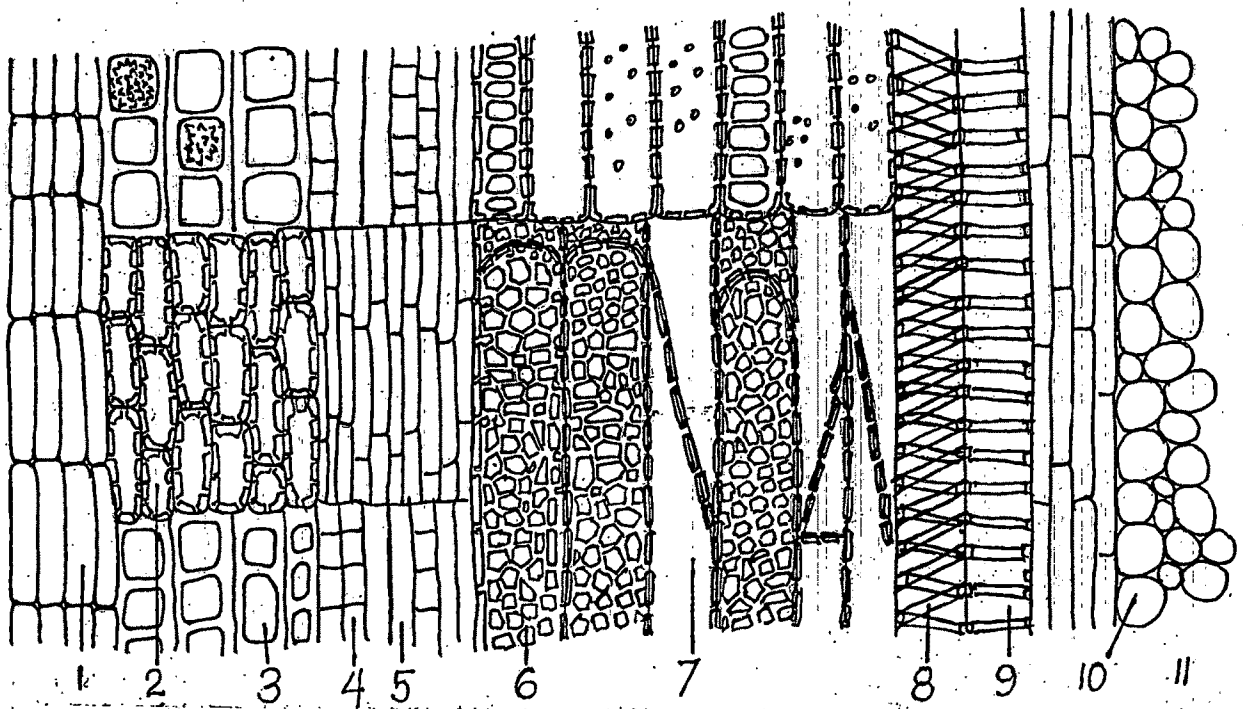


Fig. 54(b) *Melastoma malabathricum* Stem, R.L.S: 1. Cork, 2. Brachysclereid, 3. Cortical cells, 4. Phloem ray, 5. Phloem, 6. Vessels with bordered pits, 7. Tracheids, 8. Protoxylem with spiral thickening, 9. Protoxylem with annular thickening, 10. Pith

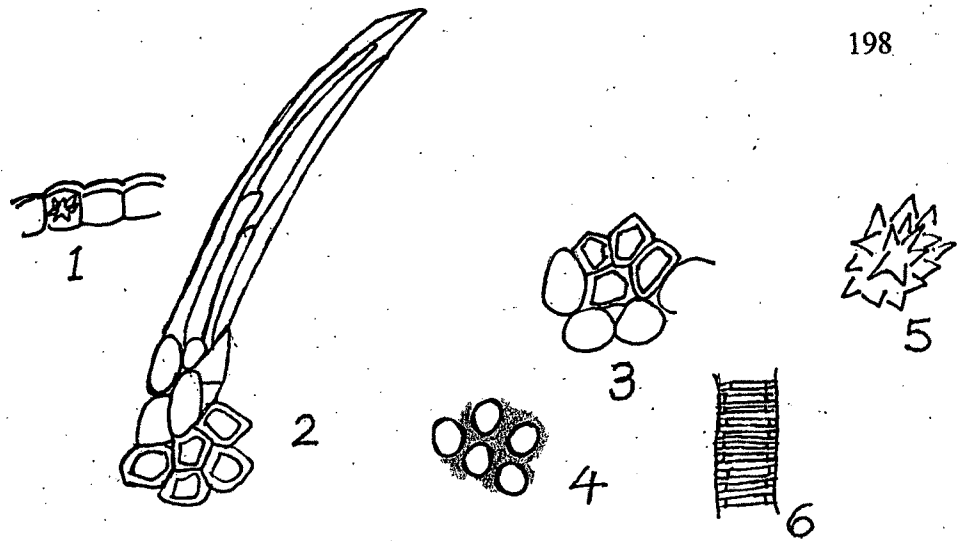


Fig. 55(a) *Melastoma malabathricum* Leaf, Powder study: 1. Epidermal cells with Sphaeraphide, 2. Non glandular complex trichomes, 3. Sclerenchyma surrounded by Parenchyma, 4. Lacunar Collenchyma, 5. Sphaeraphide 6. Protoxylem with annular Thickening,

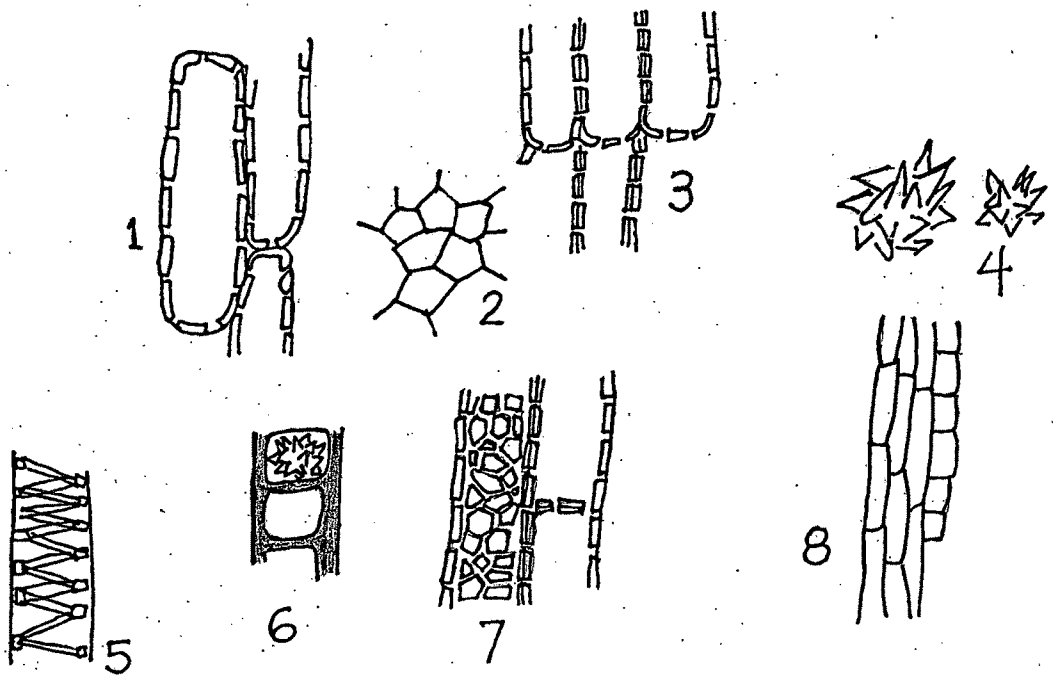


Fig. 55(b) *Melastoma malabathricum* Stem, Powder study: 1. Brachysclereid, 2. Cork, 3. medullary ray, 4. Sphaeraphide, 5. Protoxylem with spiral thickening, 6. Cortical cells with sphaeraphide, 7. Vessels with bordered pits alongwith tracheids, 8. Phloem ray cells

Distribution: - Common in the sub-Himalayan tracts from the Ganges eastwards to Assam, and in Madhya Pradesh, extending into peninsular India.

B. acutangula is an evergreen tree of 9-12 m in height. Bark is dark brown and rough. Minute leaves are found with denticulate-crenate margin which are narrowed into the petiole. Flowers are in long pendulous racemes and fragrant with bright red stamens. Fruits are bluntly quadrangular of 2.5-4.0 cm long which is broadest in the middle with broad, rounded angles.

Parts used in medicine: - Leaves, root, fruit, seeds, bark

Medicinal properties: - Leaf juice is given in diarrhoea. Root is bitter and is cooling. Fruit is bitter, acrid, anthelmintic, emetic, expectorant and vulnerary. It is prescribed in gingivitis, as an astringent and tonic. It shows antibiotic activity against *Escherichia coli* Castell. & Chalm. and *Micrococcus pyogenes* var. *aureus*. The fruit saponins have haemolytic properties and are toxic to fish. Powdered seeds are given to children as expectorant and emetic. It is inhaled as snuff for relief in headache. Seeds are also used as fish-poison. Bark is astringent. It is used in diarrhoea and blennorrhoea and also given as a febrifuge. It is applied for relieving pain from bites and stings of insects and also used as fish poison. A decoction of bark is used as a mouthwash for relieving toothache and against gum trouble (Anon., 1996). An aqueous extract of the bark was reported to be used in pneumonia, diarrhoea and asthma in Papua New Guinea, and in malaria and contraceptive in Indo-China (Anon., 2000).

Previous phytochemical reports: - Leaves were reported to possess barringtogenic acid, stigmasterol-3 β -O-D-glucoside, β -sitosterol, β -amyrin, oleanolic acid, tangulic and acutangulic acids. It also contained small amount of a saponin. The ethanolic extract of dry and defatted fruits gave saponins, which, on acid hydrolysis, gave three triterpenoids sapogenins, barringtogenol B, C and D, and two triterpenoids acid sapogenins through their methyl esters, methyl barringtogenate and methyl acutagenate. Barrigenic acid, another triterpene acid sapogenin, was also isolated. From seeds, barringtogenin and barringtogentin have been isolated (Anon., 1996). The monodesmosidic glucuronide saponins of barringtogenol C, barringtoside A, barringtoside B and barringtoside C had been isolated from seeds (Anon., 2000). Bark contained tannin (16%) and small amounts

of a sapogenin. Ellagic acid and 3-O-methyl, 3, 3'-di-O-methyl derivatives were also reported (Anon., 1996). Heartwood contained tanginol (triterpenoid), barringtogenic acid, β - and γ -sitosterols, a triterpene dicarboxylic acid and barringtogenic acid. It also possessed a triterpenoids sapogenol, barringtogenol E, a monoarabinoside of barringtogenol C monobenzoate and a new triterpene diacid, barrinic acid (Anon., 1996).

In the present work, the plant has been screened for the phytochemicals in leaves, bark and stem and pharmacognosy of all the three parts have been studied.

Materials and Methods:

B. acutangula was collected from Botanical Gardens, Baroda. The voucher specimen of the plant has been deposited in the Herbarium, Department of Botany, The Maharaja Sayajirao University of Baroda (BARO), Vadodara. Standard methods, elaborated in chapter 2 were followed for the extraction, isolation and identification of the phytochemicals. Pharmacognosy has been done by standard methods mentioned in chapter 2.

Results: -

Phytochemistry: - *Barringtonia* leaf contained flavonols like 3', 4'-diOMe quercetin, gossypetin and 3'-OMe gossypetin. Vanillic, syringic, gallic, melilotic and *p*-coumaric acids were the phenolic acids present. In stem, gossypetin and 3'-OMe gossypetin were present alongwith phenolic acids like vanillic and syringic acids. In bark, gossypetin and myricetin alongwith vanillic and syringic acids were identified. Quinones were found in all the three parts of the plant. Glycoflavones and alkaloids were absent in all the parts.

Phytochemical biomarkers of leaves: gossypetin and 3',4' di OMe quercetin

Bark : gossypetin, myricetin

Stem : only gossypetin

Pharmacognosy of bark and leaf:**Bark - T.S. (Fig. 56)**

Cork cells were of two types- outer region of thick walled (24-31 x 10-17 μ m, lumen: 8-15 μ m) and inner thin walled cells (24-31 x 10-17 μ m), both rectangular in shape. In between the thin walled cork cells were tangential rows of rectangular sclereids (10-31 x 10-17 μ m). Bast was composed of square, oval or spherical shaped parenchyma cells (24-58 x 14-51 μ m) and tangential patches of gelatinous fibres (10-17 x 13-34 μ m, lumen: 10-32 μ m). These fibres were of very small diameter. Some of the parenchyma cells contained tannin or sphaeraphides (10-41 μ m). Those cells with tannin were thick walled.

Bark- L.S. (Fig. 57)

In L.S., cork cells were hexagonal in shape. These cells were of two types- thick walled (17-31 x 17-38 μ m, lumen: 15-35 μ m) as well as thin walled (17-31 x 17-38 μ m). Some of the thick walled cork cells contained simple pits within them. Sclerieds were hexagonal to oval (20-37 x 17-31 μ m). The rays were multiseriate and contained large sphaeraphides (17-33 μ m) in some of the cells. Phloem parenchyma cells (31-54 x 24-51 μ m) were polygonal to irregular shape. Some of the parenchyma cells which contained tannin were thick walled. Elongated gelatinous fibres (1088-1292 x 10-17 μ m, lumen: 7 μ m) were also seen in the parenchymatous cortex.

Powder study (Fig. 59a)

Cork cells of two types were seen- thick walled (17-31 x 17-38 μ m, lumen: 15-35 μ m) as well as thin walled (17-31 x 17-38 μ m), sclereids (20-37 x 17-31 μ m), sphaeraphides, parenchyma containing sphaeraphides, gelatinous fibres (1088-1292 x 10-17 μ m, lumen: 7 μ m), thick walled tannin cells as well as parenchyma cells containing thick walled tannin cells (24-58 x 14-51 μ m, lumen: 10-40 μ m)

Pharmacognostic markers: Two types of rectangular cork cells

- : Rows of square cells containing red deposits.
- : Very narrow gelatinous fibres
- : Thick walled tannin cells.

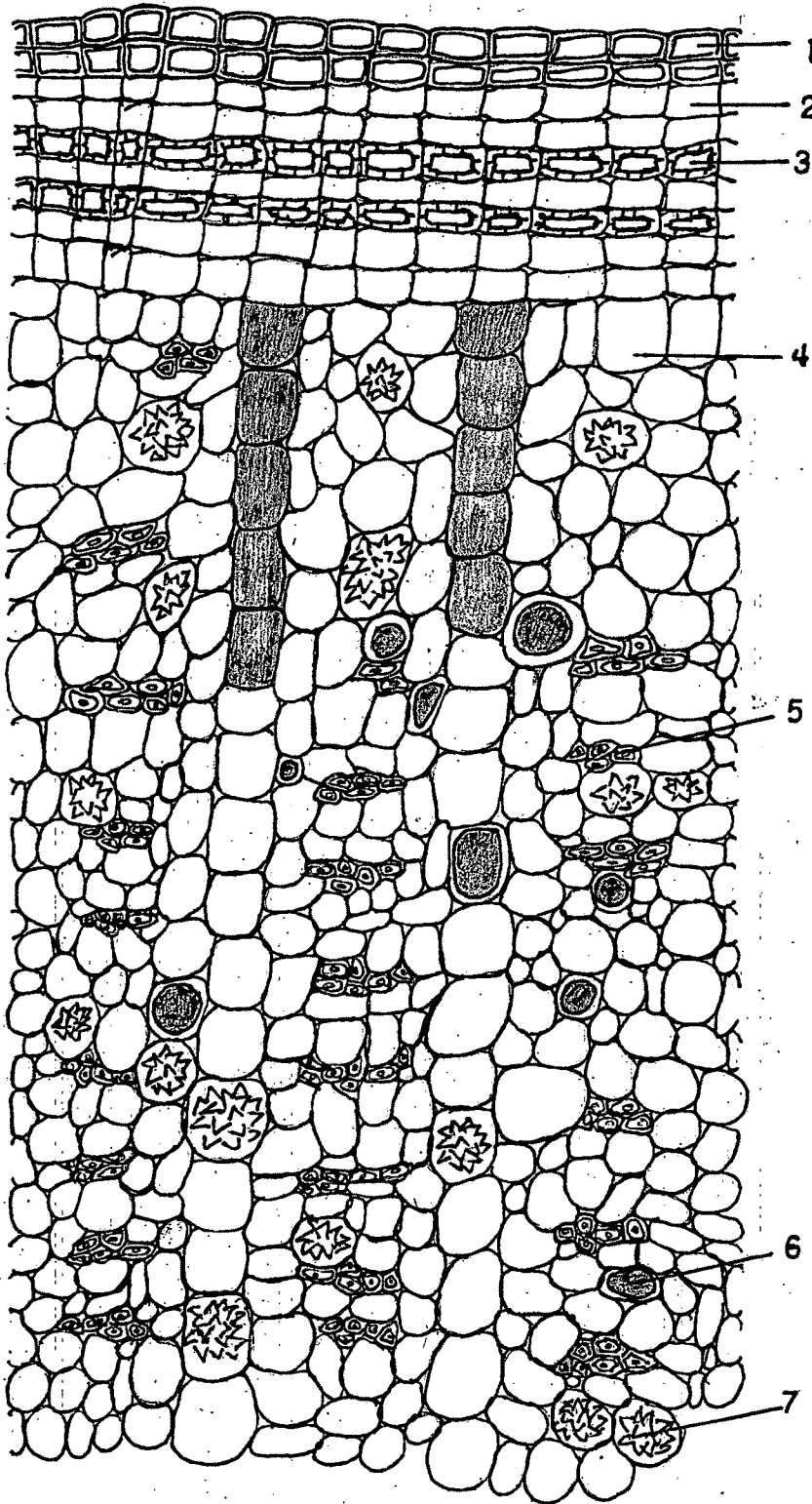


Fig. 56 *Barringtonia acutangula* Bark, T.S.: 1. Thick walled cork, 2. Thin walled cork, 3. Sclereid, 4. Parenchyma, 5. Gelatinous Fibres, 6. Thick walled Tannin cells, 7. Sphaeraphide

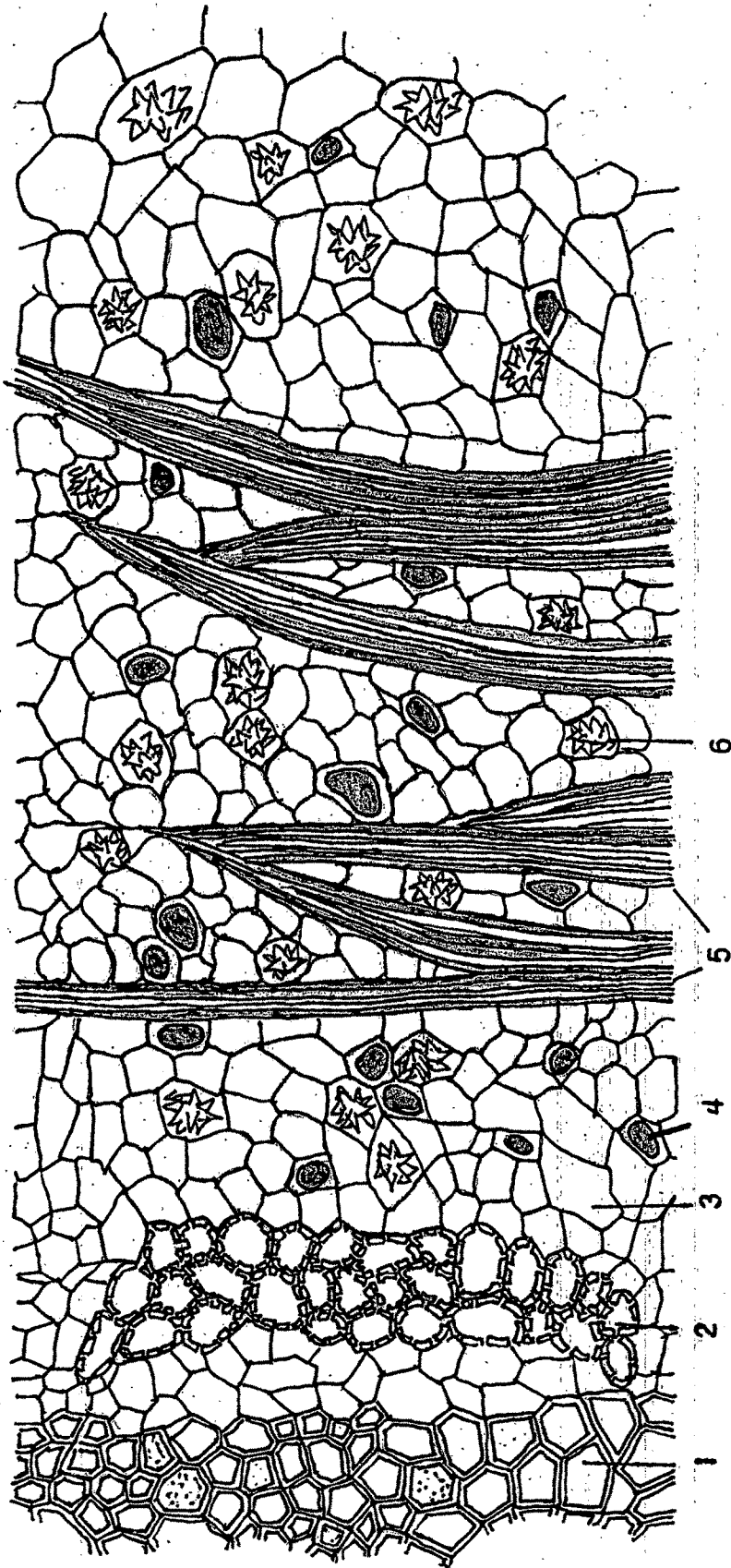


Fig. 57 *Barringtonia acutangula* Bark, L.S.: 1. Cork cells with pits, 2. Sclereids, 3. Parenchyma, 4. Thick walled tannin cells, 5. Gelatinous fibres, 6. Parenchyma containing sphaeraphide

Leaf micromorphology

Stomata were anomocytic found only on lower epidermis. Stomatal index was 16-19. Trichomes were absent in both the epidermises.

Leaf - T.S. (Fig. 58)

Leaf was dorsiventral with a ridged midrib. In the **midrib** region, cells of upper epidermal cells (17-24 x 17-20 μ m) were rectangular in shape covered by a thin cuticle. Hypodermis consisted of nine to ten layers of lacunar collenchyma (20-34 x 17-20 μ m). Next to the hypodermis was the ground tissue of five to six layered parenchyma cells (27-58 μ m). Vascular bundle was flask shaped with a swollen base and a neck. Endodermis was not clearly seen. Pericycle consisted of one to two layers of stone cells (14-20 x 13-17 μ m) mingled with parenchyma cells of isodiametric shape. Outer phloem between stone cells and xylem were of seven to eight layers which contained many rhomboidal crystals (13-17 μ m). Xylem tracheids (32-37 μ m) were of spherical shape and in radial rows separated by uniseriate xylem rays (14-17 x 14-20 μ m). Xylem tissues were more on the lower side of the bundle. There was a small vascular bundle in the region of the neck. This vascular bundle consisted of xylem on the upper side and phloem towards the inner side. At the centre of the main vascular bundle was ground tissue of large isodiametric parenchyma (34-60 μ m). The ground tissue below the pericycle was of seven to eight layers of large spherical parenchyma cells surrounded by four to five layers of lacunar collenchyma. Lower epidermal cells were barrel shaped covered by a thin cuticle.

In the **lamina** portion, upper epidermal cells were larger and barrel shaped covered by a thin cuticle. Mesophyll was differentiated into single layered palisade (24-31 x 10-14 μ m) of small size and 13-14 layers of spongy cells (21-27 x 17-27 μ m) with large intercellular spaces. Each palisade cell contained three to four chloroplasts and the spongy cells contained four to six chloroplasts. Sphaeraphides were observed in spongy cells. Cells of lower epidermis were of rectangular shape with sunken stomata.

Powder study (Fig. 59b)

Leaf powder consisted of sphaeraphides, spongy cells (21-27 x 17-27 μ m), palisade cells (24-31 x 10-14 μ m) and anomocytic stomata.

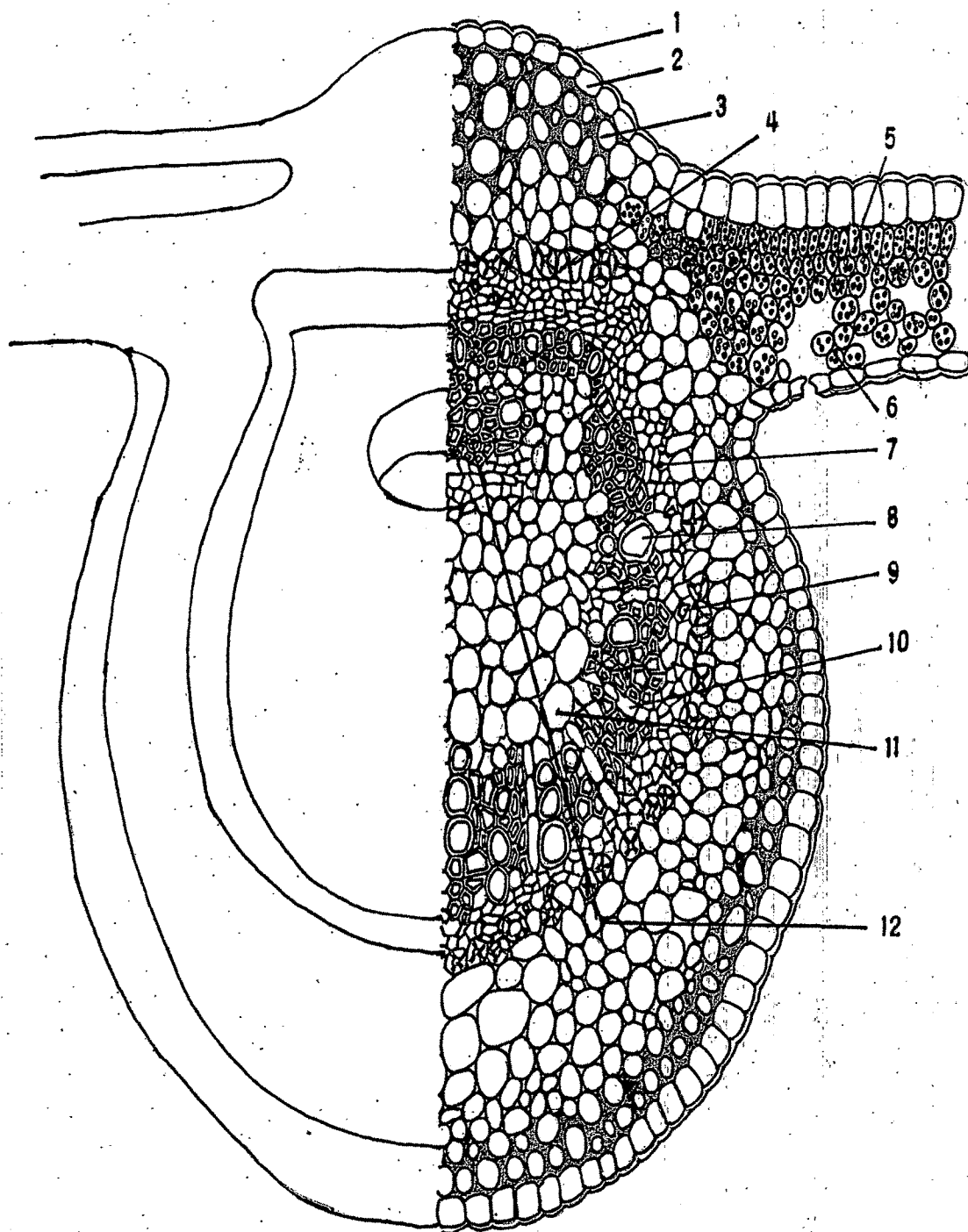


Fig. 58 *Barringtonia acutangula* Leaf, T.S: 1. Cuticle, 2. Epidermal cell, 3. Lacunar collenchyma, 4. Stone cells, 5. Palisade tissue, 6. Spongy tissue, 7. Phloem, 8. Xylem, 9. Phloem containing crystal, 10. Xylem rays, 11. Parenchyma, 12. Small vascular bundle

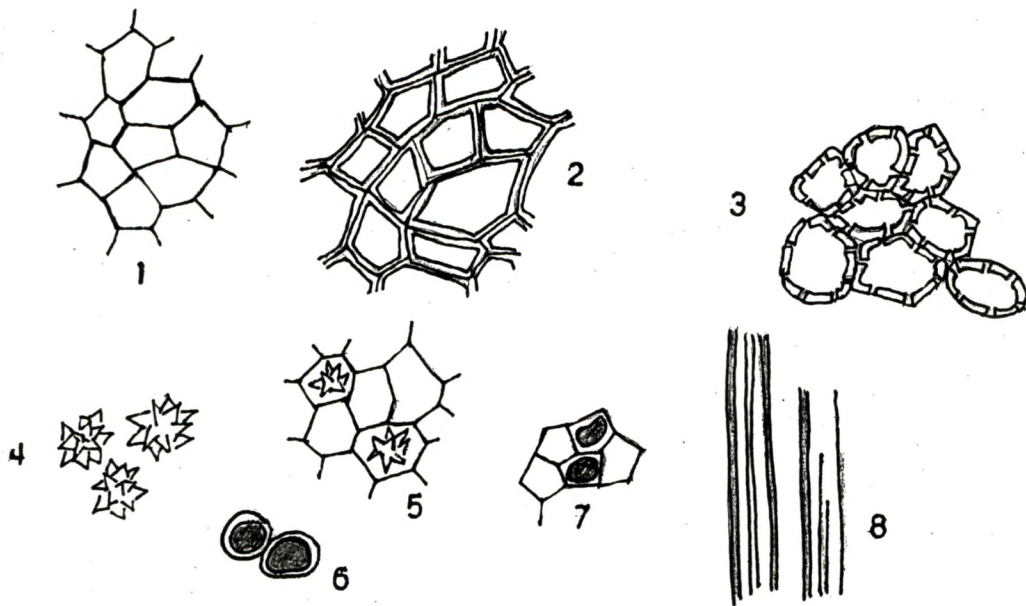


Fig. 59(a) *Barringtonia acutangula* Bark, Powder study: 1. Thin walled cork, 2. Thick walled cork, 3. Sclereid, 4. Sphaeraphide, 5. Parenchyma containing sphaeraphide, 6. Thick walled Tannin cells, 7. Parenchyma containing Thick walled Tannin cells, 8. Gelatinous Fibres

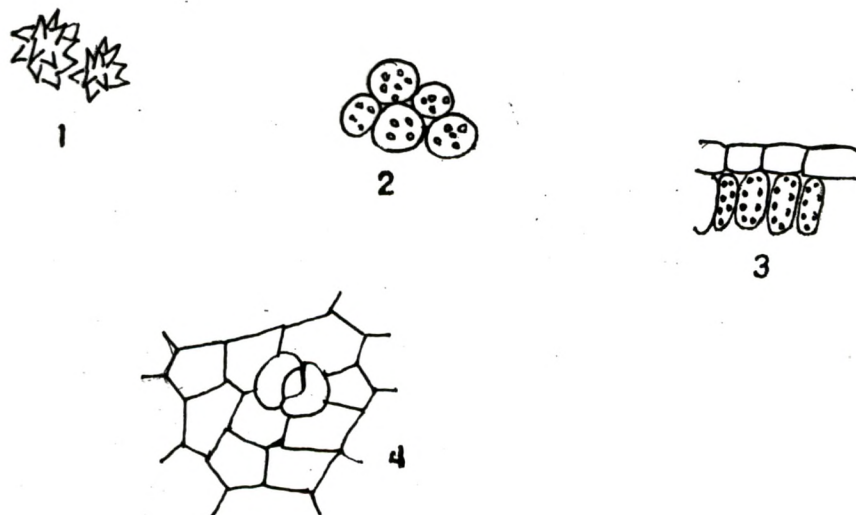


Fig. 59(b) *Barringtonia acutangula* Leaf, Powder study: 1. Sphaeraphide, 2. Spongy cells, 3. Palisade tissue, 4. Anomocytic stomata

Pharmacognostic markers: Palisade single layered each cell with 3-4 chloroplasts

: Sclereids

: No indumentum

: Vascular bundle flask shaped

15. *Careya arborea* Roxb.

English name: - Patana Oak, Slow-Match Tree, Wild Guava

Beng., Guj. & Hindi – *Kumbi*; **Kan.** – *Doddala, Kaval, Pilu*; **Mal.** - *Alam, Pelu, Pezha*;

Mar. – *Kumbia*; **Sans.:** - *Kumbi*; **Tam.** – *Ayama*; **Tel.** – *Araya, Duddippa, Govadi,*

Kumbhi; **Kol.** – *Asanda*; **Mundari** – *Asanda daru, Kumbir*; **Sadri** – *Kumbi*;

Santhal - *Kambir*

Distribution: - Throughout Indian peninsula and Andaman Islands

It is a deciduous tree of 9-18 m in height. Bark is 1 cm thick, dark grey and exfoliating in thin rectangular flakes. Leaves are upto 30 cm long, obovate or oblong-ovate with margin crenate – denticulate. Flowers are large, showy, white, pink or yellowish white, foetid in terminal spikes. Berries are globose or ovoid, 5.0-7.5 cm in diameter, foetid, and crowned with persistent calyx. Seeds are numerous of one centimeter long, pale brown embedded in fleshy edible pulp.

History: Various parts of the tree (known as *padmaka* in Ayurvedic system of medicine) are reputed in indigenous medicine.

Part Used: - Leaves, Stem bark, Fruits, Flowers

Detailed Medicinal Properties:

Stem bark and leaves are used as demulcent in coughs and colds, as antipyretic and antipruritic in eruptive fevers and as an anthelmintic. Decoction of bark is used in

diarrhoea and also for washing eyes in eye complaints. Dried calyces are tonic and demulcent. **Flowers** are used as an aphrodisiac and their infusion is given after child birth. **Fruits** are aromatic, astringent and demulcent and promote digestion. Stem yields an astringent gum. (Anon., 1998) Plant is good for wounds and toothache.

Previous phytochemical reports:

Leaves contain barringtogenol B, careaborin, careyagenolide, valoneic acid, dilactone, ellagic acid, ellagic acid 4,4'-dimethyl ether, β -sitosterol, α -spinasterol, n-hexacosanol, taraxerol and its acetate, β -amyrin, quercetin, careyic acid and its methyl ester, careyagenic acid, maslinic acid, ellagic acid, 2 α -hydroxyursolic acid and tannin (19%).

Seeds contain saponins on hydrolysis, gave 5 sapogenols, viz. careyagenol A,B,C,D and E. Sapogenols A,B and C were earlier identified as barringtogenol C, 16-deoxybarringtogenol and barringtogenol D respectively. Sterols, α -spinasterol and α -spinasterone are also present. (Anon., 1998). Seed oil is rich in palmitic, oleic & linoleic acids (Anon., 2000). **Bark** contained lupeol, betulin, betulinic acid, β -sitosterol. A saponin, flavonoid and an alkaloid has been reported from the bark (Anon., 1998).

Previous Pharmacognostic studies:

No data have been reported on this plant.

In the **present work**, the plant has been studied for its chemical constituents like flavonoids, phenolic acid, quinones, etc. Pharmacognosy of only leaf has been studied.

Materials and Methods:-

The plant material was obtained from Kerala. Voucher specimen of the plant has been deposited in the Herbarium, Department of Botany, The Maharaja Sayajirao University of Baroda (BARO), Vadodara. Standard procedures are described in chapter 2 were followed for the extraction, isolation and identification of the phytochemicals. Pharmacognosy has been performed by standard methods mentioned in Chapter 2.

Results: -**Phytochemistry: -**

In leaves, kaempferol and 3'-OMe quercetin have been identified. Vanillic, syringic, *p*-hydroxy benzoic, gallic and *p*-coumaric acids have been observed. In stem, flavonoids were absent and phenolic acids were similar to that of the leaves except *p*-hydroxy benzoic acid. Quinones and steroids were present in both while glycoflavones and alkaloids were absent.

Phytochemical biomarkers in leaves: Kaempferol and 3'-OMe quercetin
stem: Absence of flavonoids

Pharmacognosy of leaf:-**Leaf micromorphology**

Leaf was amphistomatic. Stomata were anomocytic found on both upper and lower epidermis. Stomatal index of upper epidermis was 2-4 and that of lower epidermis was 15-17. Both the epidermises were devoid of trichomes.

Leaf- T.S. (Fig. 60)

Leaf was dorsiventral. The midrib region was raised to a broad ridge. The upper epidermal cells (6-17 μ m) were rectangular in shape with a thin cuticle. Hypodermis of midrib was of angular collenchyma (10-24 μ m) of four to five layers, below which were irregular parenchyma cells (17-34 x 27-44 μ m) containing sphaeraphides. Below the hypodermis were oval to spherical patches of sclereids (7-17 x 10-27 μ m). Vascular bundles were five in number and of varying sizes. The central bundle was the largest and the bundles towards both sides were smaller. These bundles were separated by each other by oval to spherical shaped parenchyma cells of ground tissue. Each vascular bundle was surrounded by one to two layered fibres. The fibres of upper and lower sides were heavily thickened with a narrow lumen and those at both sides were thin walled with larger lumen. Both xylem and phloem were concentric enclosing a pith-like region in the centre. Phloem elements (7-17 x 10-20 μ m) of five to nine layers surrounded xylem. Xylem vessels (25-42 μ m) were oval in shape. They were separated by xylem rays (7-14 μ m) in radial rows. Medullary rays were uniseriate. In the centre of the bundle, parenchyma cells

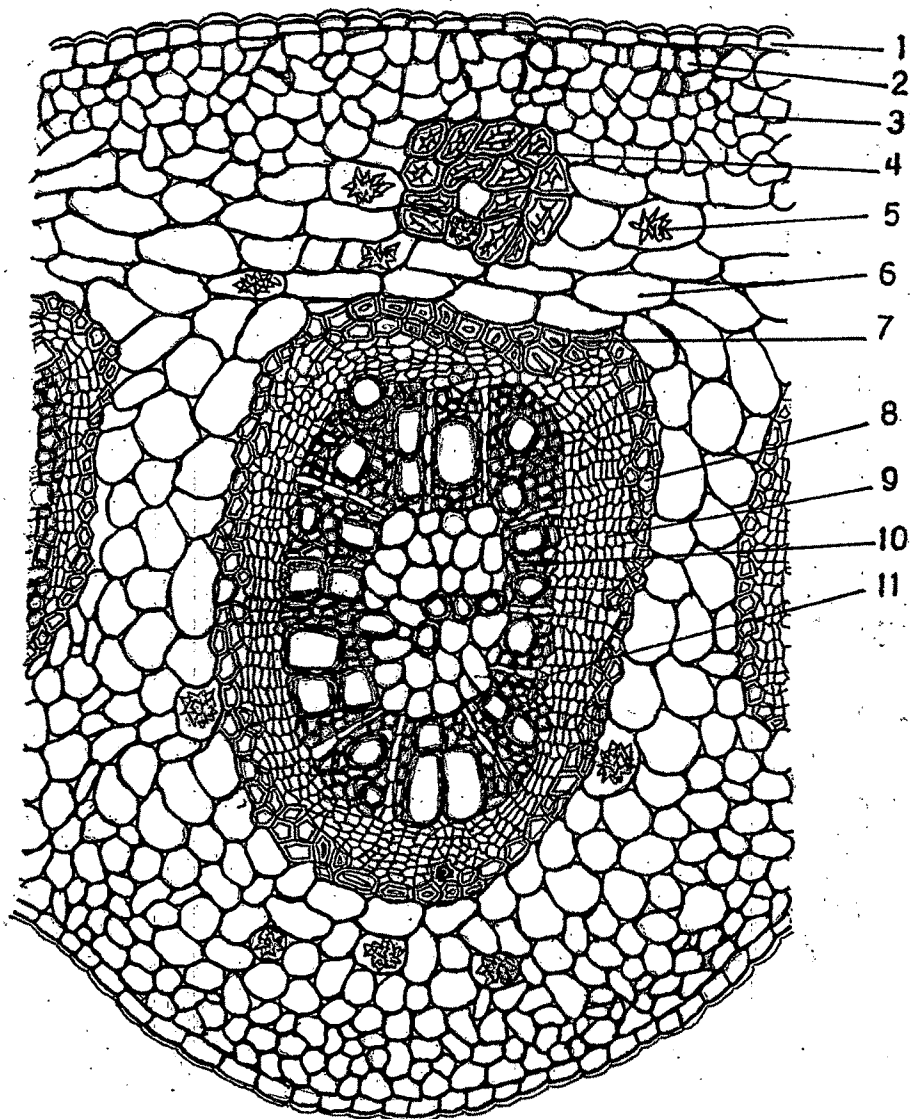


Fig. 60 *Careya arborea* Leaf, Midrib-T.S.: 1. Epidermis, 2. Angular Collenchyma, 3. Parenchyma, 4. Gelatinous Fibres, 5. Sphaeraphide, 6. Parenchyma, 7. Gelatinous Fibres, 8. Sclerenchyma, 9. Phloem, 10. Xylem, 11. Medullary ray

(14-38 μm) were observed in which some tracheids also were seen. Lower hypodermis consisted of two to three layers of collenchyma cells. Lower epidermis was similar to the upper epidermis.

In the **lamina** portion (**Fig. 61a**), upper and lower epidermises were similar to that of the midrib region. Mesophyll was differentiated into two layered palisade and five to six layers of spongy cells. Length of both palisade layers were different in that the cells of the first layer (17-31 x 7-17 μm) were small filled with five to six chloroplasts and those of the second layer (20-41 x 6-13 μm) were long and filled with eight to nine chloroplasts. Empty spaces were seen among the first layers of palisade cells. Spongy cells showed three to five chloroplasts in each cell. The leaves were glabrous throughout.

Powder study (Fig. 62)

Anomocytic stomata, sphaeraphides, two layered palisade cells, epidermal cells showing palisade cells, tracheids (17-26 μm) with annular thickening, gelatinous fibres, epidermal cells and sclerenchyma fibres (lumen: 9 μm) are the features of the powder.

Pharmacognostic markers: Vascular bundles 4-5 of differing shape

- : 2- Layered palisade tissue
- : Air spaces between palisade tissue
- : Absence of indumentum
- : Gelatinous fibres & libriform fibres
- : Sclerieds

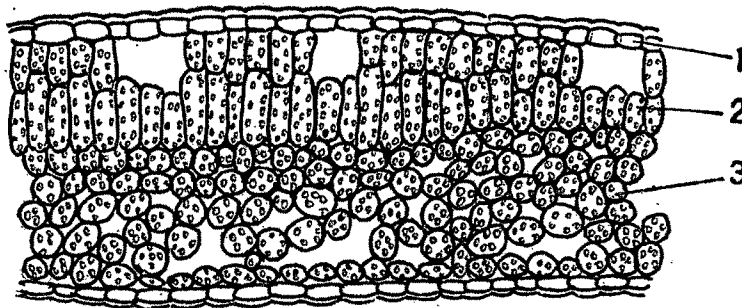


Fig. 61(a) *Careya arborea* Leaf, Lamina-T.S.: 1. Epidermis, 2. Two layered Palisade tissue, 3. Spongy tissue

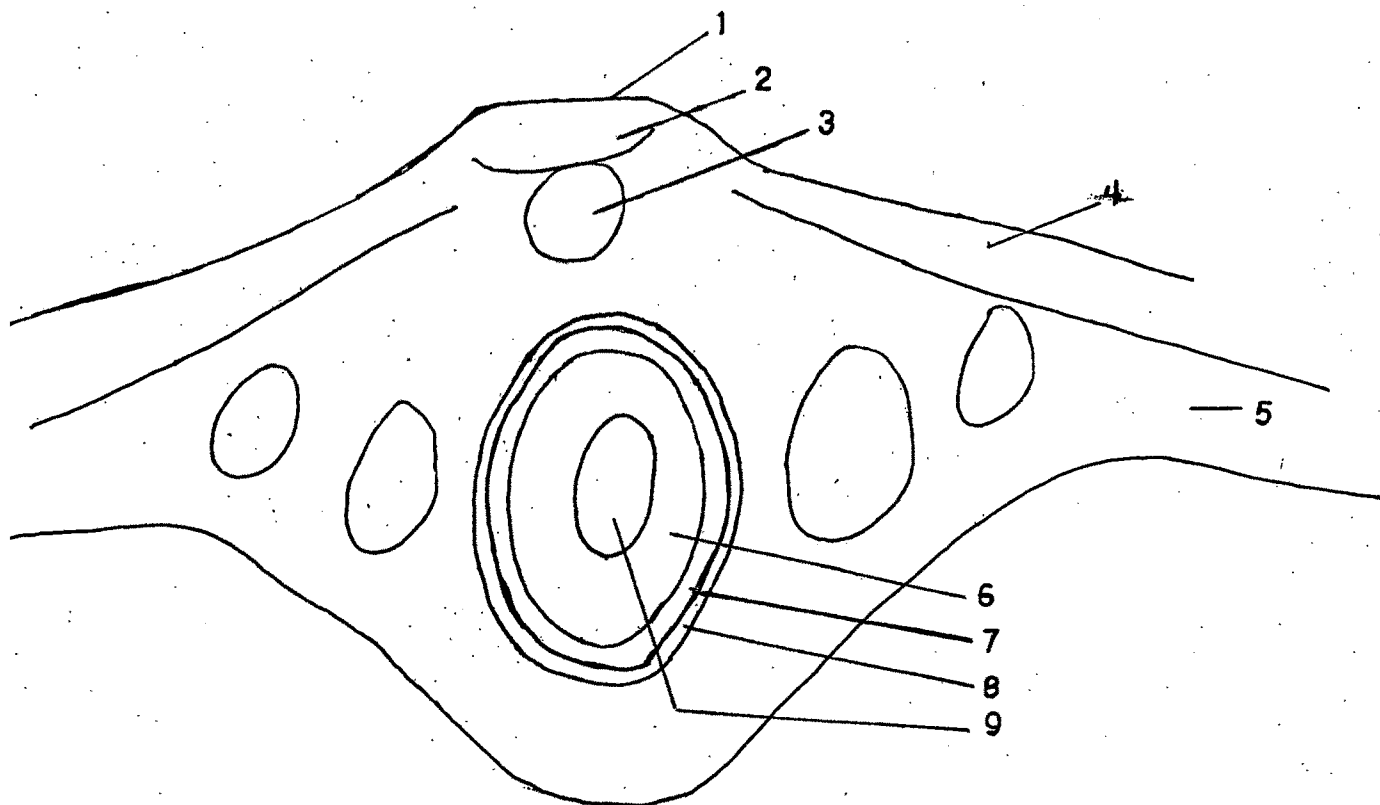


Fig. 61(b) *Careya arborea* Leaf, Schematic representation: 1. Epidermis, 2. Collenchyma, 3. Stone cells, 4. Double layered palisade tissue, 5. Spongy tissue, 6. Xylem, 7. Phloem, 8. Pericycle, 9. Parenchyma

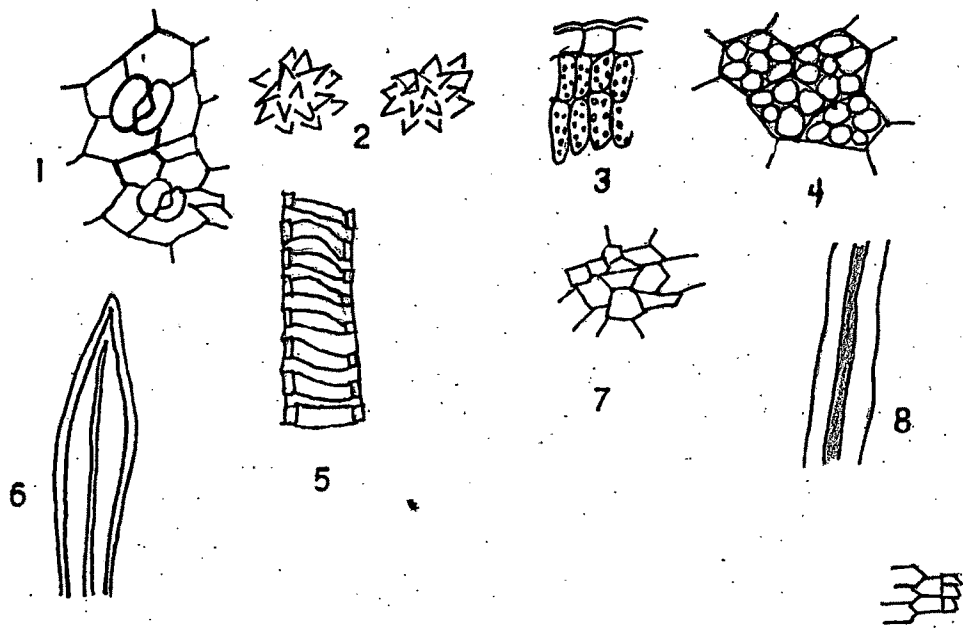


Fig. 62 *Careya arborea* Leaf, Powder study: 1. Anomocytic stomata, 2. Sphaeraphides, 3. Two layered palisade tissue, 4. Epidermal cells with palisade cells, 5. Protoxylem with annular thickening, 6. Gelatinous fibre, 7. Epidermal cell, 8. Sclerenchyma fibre, 9. Phloem