
OBSERVATIONS

A] MORPHOLOGY

I) External morphology

1. Ceropegia attenuata Hook ~~f~~ (Plate I, Figs. 1-3, Text Fig. I, Figs. 1-7)

Erect herb, 14-30 cm. high, roots tuberous; tubers 1.5 - 2 x 2 - 3 cm, globose, ovoid or depressed. Stem more or less pubescent when young, (when mature glabrous), usually 1 from each tuber, unbranched, terete. Leaves sessile, 5-14 x 0.8-1 cm, linear, acute, narrowed at base, the young more or less pubescent, midrib prominent. Flowers usually solitary at apex of pubescent pedicel. Pedicel 0.6 - 1 cm long which arise ^{es} from ~~in~~ between the petioles; bracts subulate 1-3 mm. long. Sepals 6-7 mm long, pubescent, subulate, divided to base. Corolla 4-9 cm long, straight, erect; tube 3-5 cm long, cylindrical, slightly inflated at base, closely striately veined greenish-yellow; corolla lobes 3-4 cm long, deltoid for 0.5 cm, then narrowly linear, united at tips, yellowish-green to reddish-yellow. Corona biseriate; outer coronalobes deltoid-oblong, deeply bifid, the segments very acute, ciliate with long hairs; inner corona lobes linear, erect to divergent. Pollinia yellow. Follicles in pairs, 6-7 cm long, straight or slightly curved, tapering into a fine point. Seeds 3.7 x 2.2 mm, ovoid oblong with thick margin, coma 1-1.5 cm long.

Flowering : July - August

Fruiting : August - October.

Field note : It is widely distributed in Maharashtra and

seems to be more common than other species of Ceropegia. The species has been collected from Kanheri caves growing among grasses on rocky substratum and bushes of Euphorbia ^G Antiquorum, ~~Species~~.

It is also collected from Malwan, Deogad and Ratnagiri growing among grasses on laterite soil. It shows great variation in flower length ranging from 4 to 9 cm and needs biosystematic considerations.

Herbarium specimens observed : Malwan P - 3276

Places of collection : Kanheri caves; Malwan; Deogad; Dapoli; Ratnagiri.

Endemic to Maharashtra.

2. Ceropegia bulbosa Roxb. var. bulbosa (Text Fig. II, Figs. 1-6)

A perennial twinning tuberous herb, tubers 7-8 x 3-4 cm, globose, ovoid or depressed. Stem slender, glabrous, usually reddish in colour, leaves petiolate, the lower leaves almost orbicular, the upper leaves elliptic oblong or obovate to elliptic lanceolate, apiculate, base rounded, truncate, subcordate or acute, 5-6 x 1.5-4cm, glabrous, thick, fleshy. Flowers in pedunculate umbellate cymes, peduncles 1-3 cm long arising between the petioles, pedicels 3-6mm long, slender. Bracts linear, 2-3 mm long, linear. Calyx divided to the base, sepals 2-3 mm long, lanceolate, acute. Corolla 1-2.5 cm long, greyish-purple, tube 1-2 cm long, inflated at base, narrowed into middle, funnel shaped above, violet purple and glabrous inside, lobes 5-8 mm long linear above from ovate deltoid base, hairy inside

and along margins in linear part, connate at tips. Corolla biseriate, outer corona lobes - 5, minute, saucer - shaped, entire or broadly shallow, inner corona lobes narrowly linear, 2 mm long, sickle shaped or divergent. Pollen masses erect, attached to pollen carrier by very short caudicles. Follicles 8-10 cm long, cylindric, tapering towards an acute apex, glabrous. Seeds 8 x 3 mm long, ovate-oblong, flattened with a broad submembranous margins, coma 2.5 - 3 cm long.

Flowering : July to September but extended upto October under cultivation.

Fruiting : September - October.

Field-note : It is widely distributed species in Maharashtra. The tubers as well as leaves are edible and thus exploited by local peoples. However it grows in thorny shrubs and bushes from where it can not be easily exploited.

Vernacular name : Kharpudi

Herbarium specimen examined : Appachiwadi P-3277

Places of collection : Kolhapur, Appachiwadi, Aurangabad, Kartiki-swami (Pusegaon), Khatav, Saikade (Patan), Panhala.

3. Ceropegia bulbosa Roxb. var. lushii (Grah.) Hook. f. (Plate I, Figs. 4-5, Text Fig. III, Figs. 1-5)

The C. bulbosa var. lushii is similar to C. bulbosa var. bulbosa in morphology except the leaves. In former variety the leaves are subsessile, fleshy, 6-12 x 0.5-1 cm, lanceolate to narrowley

linear, acuminate. These two varieties grow side by side and also breed true in nature. No intermediate forms of leaves are seen in nature.

Field Note : As compared to C. bulbosa var. bulbosa, the C. bulbosa var. lusii is rare. Usually it is found growing with former variety. The leaves are fleshy. Both leaves and tubers are edible.

Flowering : August - September

Fruiting : September - October

Herbarium specimen examined : Kolhapur P-3278.

Places of collection : Kolhapur, Kagal, Aurangabad, Pusegaon, Karad, Panhala.

4. Ceropegia hirsuta Wt. et Arn. (Plate II, Fig. 6, Text Fig. IV, Figs. 1-5)

A perennial coarse twinner with tuberous roots, tubers 2-4 x 2-3 cm, globose, ovoid or depressed. Stem usually unbranched, hirsute, terete. Leaves very variable, petiolate, membranous, varying from ovate-to cordate, obtusely acuminate to narrowly lanceolate, acute. Petioles 0.5-1 cm long, hairy. Flowers in few flowered umbellate cymes; peduncles 1-1.5 cm long with long hairs, reddish. Bracts subulate 4-5 mm long, hispid. Calyx divided to the base, sepals 0.8-1 cm long, linear subulate, very acute, hirsute with rigid hairs. Corolla greenish, blotched with purple, 2.8-6 cm long, tube

2-4 cm long depressed, inflated at base, funnel shaped above, hairy in lower part by downwardly pointed hairs, lobes 0.8-2 cm long, broadly oblong or oblong-obovate, connate at tips, hairy inside and along margins. Corona biseriate; outer corona of 5 bifid hairy lobes; inner corona lobes linear, erect, curved or hooked at the slightly clavate apex. Pollen masses oblong, sessile, attached to a pollen-carrier by caudicle. Follicles in pair, 6-12 cm long, finely pointed, glabrous. Seeds 0.8 x 0.2 cm long, narrowly oblong, coma 2.5-3 cm long.

Flowering : July to November

Fruiting : September - October

Field Note : It is the most common species occurring in Maharashtra. The tubers are edible. It grows among grasses and in bushes. The species shows great variations in vegetative morphology, flower measurements and colour of flower. Ansari (1984) has rightly said that the species needs biosystematic considerations.

Vernacular names : Khaloola (Hindi, Urdu), Hamana, Kharpudi (Mar.), Khilora (Raj.)

Herbarium specimen examined : Appachiwadi P-3279.

Katyani^{ya} C-3279.

Places of collection : Kolhapur, Appachiwadi, Panhala, Saikade, Surli-ghat, Pusegaon, Aurangabad.

5. Ceropegia huberi Ans. (Plate II, Figs. 7-8, Text Fig. V, Figs. 1-8)

A perennial twining herb with tuberous roots. Tubers 2-4.5 x 2-4 cm, subglobose. Stem usually unbranched, glabrous, terete, 2 mm in diameter, leaves 4-10 x 4.5-5 cm, petiolate; petioles 1-3.5 cm long, glabrous, grooved on the upper side, lower leaves ovate-acuminate, upper leaves lanceolate, acuminate, lamina membranous, margins ciliolate. Flowers in lateral subumbellate cymes; peduncles hirsute, 4-8 cm long; bracts small, subulate, 2-3 mm long; pedicels pubescent, 1-1.5 cm long. Calyx divided to the base; sepals 2-2.5 mm long, linear, subulate, acute, hirsute. Corolla white with purplish tinge on tube region, 0.9-1 cm long, straight; tube 5 mm long, pale pinkish outside, pinkish-purple inside, inflated in middle; lobes 6-7 x 8-10 mm, ovate, deeply cordate, broader than long, connate at tips forming a circular flattened, slightly inclined head, 1.5-1.7 cm in diameter. Corona biseriate; outer corona cupular, 5-lobed, entire, glabrous; inner corona of 5 elongated conical creamy yellow process, densely hairy on dorsal side, convergent incumbent on the anthers. Pollen masses erect, minute, yellow, conical, attached to pollen carrier by short caudicles. Follicles in pairs, 5-6 cm long, tapering at both ends, glabrous; seeds 3-4 x 2-3 mm, ovate, oblong, prominently margined, coma 1 cm long.

Flowering : August - September.

Fruiting : September.

Field Note : A very curious species growing on hanging rocks among Tripogon jacquemontii Stapf. It's flowers are pure white and unlike other Ceropegia of Maharashtra.

Vernacular name : Kharpudi.

Herbarium specimen examined : Amba ghat P-3280, Y-3280
Gaganbawada T-3280.

Places of collection : Gaganbawada, Amba ghat. Endemic to Maharashtra.

6. Ceropegia jainii ^{author?} (Plate II, Fig. 9, Plate III, Fig. 10, Text Fig. VI, Figs. 1-4)

An erect perennial herb, 5-12 cm in height with subglobose or depressed tubers, tubers 3-5 x 2-4 cm. Stem branched, cylindrical, 2-3 mm in diameter, hirsute. Leaves subsessile to petiolate, lower leaves elliptic, upper elliptic linear, 2-5 x 0.5-1 cm glabrous beneath except the nerves, hirsute above; petioles 1-2 mm long, hairy. Flowers axillary, solitary. Pedicels 4-6 mm long, hairy; bracts small, subulate 1-2 mm long. Calyx divided to the base, sepals 2-2.5 mm long, glabrous, subulate. Corolla purplish above, greenish below, upto 2 cm long, curved; tube 9-10 mm long, subcylindric, pale greenish inside with longitudinal purple lines, base inflated in lower half part, glabrous inside and outside; lobes 9-10 mm long, purple or reddish, linear oblong, glabrous outside, densely hairy inside at ovate-deltoid base, acute and connate at apex. Corona biseriate; outer corona cupular of 5 deeply bifid, deltoid lobes, hairy along margins; inner corona of 5 linear subspathulate erect lobes. Pollen masses ascending, minute, yellow. Follicles not seen.

Flowers : August - September.

Fruiting : Not seen.

Field Note : It is small erect perennial herb growing on plateaus of Kas area among grasses in open situations. It is common plant of the area. In spite of extensive and careful search for follicles, follicles could not be obtained. It raises its problem of propagation and survival. Ansari (1980) also could not collect the follicles. It propagates probably by vegetative multiplication by formation of tubers on fibrous roots.

Vernacular name : Gallya.

Places of collection : Kas Plateau, Chaukul (Amboli), Endemic to Maharashtra.

7. Ceropegia juncea Roxb. (Plate VI, Fig. 24, Text Fig. VII, Figs.1-6)

A twinning and prostrate, perennial, succulent, glabrous herb, when prostrate rooting at nodes. Tubers very much reduced, small with many branched roots. Stem with distinct nodes and internodes, internodes 5-12 cm long and 3-5 mm in diameter, thick fleshy, green, glabrous. Leaves scale-like, 0.5-1 cm x 2 mm or absent. Flowers in lateral umbellate cyme, cyme pedunculate, 2-3 flowered, peduncles 1.5-2.5 cm long, stout, terete, glabrous. Calyx divided to the base, sepals 3-4 mm long, lanceolate, acute, glabrous. Corolla 3.5-4.5 cm

long strikingly coloured yellow, blotched with purple, tube 2.5 cm long, inflated at base, funnel shaped above curved at middle, variegated with purple dots outside, dark purple inside, hairy inside at base; corolla lobes linear, 2 cm long, greenish-yellow, hairy within above, from deltoid base, connate at tip. Corona biseriate; outer corona of 5-bidentate deltoid ciliate lobes, 4 mm in diameter; inner corona of linear erect hooked lobes, 3.5 mm long. Pollen masses minute, waxy, erect. Follicles in pairs, 4 cm long. Seeds comose.

Flowering : August - December.

Fruiting : Rare. Under cultivation the species flowers throughout year.

Field Note : It is an extremely rare species in Maharashtra. It was collected twice from Patan taluka. It is twinner but some branches grow prostrate and root at nodes. This probably indicates vegetative propagation as there is rare fruiting. It is fleshy species of Ceropegia.

Vernacular name : Kanvel, Bella gada (Tel.)

Herbarium specimen examined : Saikade (Patan) Y-4020.

Places of collection : Saikade, Manewadi (Patan).

8. Ceropegia maccannii Ans. (Plate III, Fig. 11, Text Fig. VIII, Figs. 1-6).

Erect perennial tuberous herb, 30-100 cm in height. Tubers 2.5-3 x 2-3 cm, subglobose or depressed. Stem erect, unbranched, terete, stout, pubescent. Leaves 9-12 x 4-6 cm, ovate-lanceolate,

acute or acuminate, base mostly acute or rounded hairy above, glabrous beneath except nerves, membranous, petiole 0.8-2 cm long, hairy, grooved above. Flowers 6-10 in lateral subumbellate cymes; peduncles upto 3.5 cm long, hirsute; bracts 2-3 mm long hairy; pedicels 0.5-1 cm long. Calyx divided to the base, sepals 4-5 mm long, hairy. Corolla 1.6-2 cm long, curved; tube 1.5-1.9 cm long, base inflated in lower half, narrowed, cylindric above, purplish-gray outside, dark purple with inconspicuous greenish-white streaks inside, glabrous inside except for a ring of hairs at the bottom of inflated base; lobes minute, 2-3 x 2 mm, obovate or obconic, head 2-3 mm in diameter. Corona biseriate, outer Corona cupular, 5-lobed, each lobe notched in the middle or slightly bifid, hairy; inner corona thick fleshy, hairy, subclavate, white, erect to divergent. Pollen masses yellow, attached to pollen carrier by short caudicles. Follicles in pairs, 10-15 cm long, glabrous. Seeds small, comose.

Flowering : July - August.

Fruiting : September.

Field Note : It is an erect and rare species growing on rocky slopes among grasses. The flowers resemble ^{e those of} ~~to~~ C. lawii and the slits for insect entrance are very small.

Vernacular name : Kharpudi.

Herbarium specimen examined : Singhgad P-1789.

Places of collection : Singhgad (Pune) Endemic to Maharashtra.

9. Ceropegia media (Huber) Ansari. (Text. Fig. IX, Figs. 1-4)

Twinning perennial herb. Tubers spherical or subspherical, 2 cm in diameter. Stem unbranched, terete, glabrous. Leaves petiolate, 5-15 x 1-5 cm, subcoriaceous, linear lanceolate or lanceolate, acute or acuminate, hispid above, glabrous or nearly so on the lower side; petioles 0.4-3 cm long grooved on the upper side, glabrous. Flowers 2-4, in lateral umbellate cymes; peduncles arising in between the petioles, 1-2 cm long, terete, pubescent; bracts and bractlets 1-4mm long, linear lanceolate or subulate, acute, glabrous, pedicels upto 1 cm long, terete, hairy. Calyx divided to the base; sepals 4 mm long, subulate, hairy. Corolla 2.5-2.8 cm long, slightly curved; tube upto 2 cm long, glabrous inside and outside, pale green to white outside, green to greenish purple inside near the base, inflated at base; lobes linear, spatulate, 8 x 2.5 mm glabrous, greenish-white to white, faintly purplish above, margins reflexed above, connate at tip forming head. Corona biseriate, outer corona cupular, fleshy, dark purple, glabrous outside, hairy inside, lobes emarginate; inner corona of 5 linear thin lobes, 1 mm long, procumbent and then erect, Pollen masses minute, yellow.

Flowering : July - September.

Fruiting : October - November.

Field Note : It grows in Carvia callosa (Nees) Bre. vegetation. It is of rare occurrence.

Places of collection : Amba ghat.

10. Ceropegia noorjahaniae Ans. (Plate III, Figs. 12-13; Text Fig. X, Figs. 1-5)

Usually erect, sometimes climbing herb, 15-40 cm in height when erect. Tubers subglobose, 2-3 cm in diameter, spherical to subspherical. Stem, terete, puberulous, 2-3 mm in diameter. Leaves sessile to petiolate; petioles 0.4-1 cm long, glabrous. Leaves 4-10 x 0.5-1.5 cm, linear, linear-lanceolate or lanceolate, glabrous beneath except midrib, hairy on the upper side, margins minutely hairy. Flowers usually 3, in axillary or extra-axillary umbellate cyme; peduncels 4-8 mm long, terete, bracts 1.5-2 mm long, subulate; pedicels 0.5-1 cm long, glabrous. Calyx divided to base; sepals 3-4 mm long, linear, glabrous. Corolla 2-3 cm long, slightly curved; tube 1.2-1.4 cm long, inflated at base, externally pale green in lower part and pale to dark purplish in upper part, green inside with longitudinal purple lines; lobes 1-1.3 cm long linear oblong with acute apex and deltoid base, greenish above, pale to dark purplish brown near the base, margins reflexed all along, glabrous, connate at tips forming an ovoid head. Corona biseriate; outer corona cupular, lobes bifid or deeply emarginate, purple, glabrous outside and along the margins; inner corona of 5 erect, pale purple processes 3 mm long, glabrous, straight at tips. Pollen masses erect, minute yellow attached to pollen carrier by very short caudicles. Follicles in pairs, 9-10 cm long, tapering at both ends, glabrous. Seeds many, 3.5 x 2.5 mm, ovate, margined, coma 2.5 cm long.

Flowering : July - August.

Fruiting : August - September.

Field Note : it grows in dry areas of Satara district on hill slopes. Fruiting is abundant.

Herbarium specimen examined : Kartikiswami P-3281.

Places of collection : Rethare

Kartikiswami (Khatav)

11. Ceropegia oculata Hook. (Plate V, Figs. 16-17, Text Fig. XI, Figs. 1-5)

A twinning perennial herb with tuberous roots. Tubers spherical, subspherical, depressed, 3-5 cm in diameter. Stem usually unbranched, terete, glabrous. Leaves petiolate, 8-12 x 5-7 cm broadly ovate or ovate oblong, acute, rounded or cordate at base, sparingly pubescent above; glabrous beneath; petioles 3-4 cm long, glabrous, grooved on upper side. Flowers in lateral umbellate cymes, umbel few flowered; peduncles arising from between the petioles, terete, hairy bracts 6-8 mm long, lanceolate or linear-subulate, glabrous; pedicels 1.5-2 cm long, terete glabrous. Calyx divided to the base; sepals 0.8-1 cm long, linear-subulate, glabrous. Corolla 5-6.5 cm long, much dilated at base, tube 4-5 cm long, narrowed in the middle, widening into a funnel shaped mouth, glabrous inside, dilated portion faintly purple inside, white out side, tube dark purple inside with dark purple longitudinal lines, lobes 1.5-2 cm long, connate at tips to form beak, linear, obtuse, glabrous outside, pubescent inside, ciliate on margins, green above greenish-yellow below, curiously variegated. Corona biseriate, outer corona cupular of 5 bifid lobes, glabrous; inner corona lobes 3 mm long, linear-clavate, erect, glabrous. Pollen

masses kidney-shaped, attached to yellow-carriers by short caudicles. Follicles in pairs, 10-13 cm long, tapering at apex, glabrous, stripled with purple lines. Seeds many, 6x4 mm, margined, comose, coma 1.5-3 cm long white.

Flowering : July - August.

Fruiting : August - September.

Field Note : It grows in hilly regions taking shelter of shrubs. The flowers are very curious and beautiful. The fruiting in this species is common.

Herbarium specimen examined : Radhanagari P-3282.

Places of collection : Malwan, Ratnagiri, Panhala, Petlond, Radhanagari.

12. Ceropegia sahyadrica Ansari et/ Kulkarni (Plate IV, Figs. 14-15, Text Fig. XII, Figs. 1-5)

An erect, perennial herb, 30-100 cm high with tuberous roots. Tuber subglobose or depressed, 3-6 cm in diameter. Stem usually unbranched, pubescent, clindric, thick 0.5-1 cm in diameter. Leaves petiolate, 5-10 x 4-8 cm, lower leaves larger, ovate rounded or cordate at base, upper leaves ovate, lanceolate, glabrous beneath, sparsely hairy above; petioles 2-3 cm long, hairy, grooved on above side. Flower in lateral umbellate cymes, umbels many flowered; peduncles 3-8 cm long, hairy; pedicels 1-2 cm long hairy; bracts 5-7 mm linear. Calyx divided to the base; sepals 5-7 mm long, glabrous. Corolla 3.5-5.5 cm long; tube upto 4.4 mm long, ash

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Flowering : July - August.

Fruiting : August - September.

Field Note : It grows in hilly regions taking shelter of shrubs. The flowers are very curious and beautiful. The fruiting in this species is common.

Herbarium specimen examined : Radhanagari P-3282.

Places of collection : Malwan, Ratnagiri, Panhala, Petlond, Radhanagari.

12. Ceropegia sahyadrica Ansari et / Kulkarni (Plate IV, Figs. 14-15, Text Fig. XII, Figs. 1-5)

An erect, perennial herb, 30-100 cm high with tuberous roots. Tuber subglobose or depressed, 3-6 cm in diameter. Stem usually unbranched, pubescent, clindric, thick 0.5-1 cm in diameter. Leaves petiolate, 5-10 x 4-8 cm, lower leaves larger, ovate rounded or cordate at base, upper leaves ovate, lanceolate, glabrous beneath, sparsely hairy above; petioles 2-3 cm long, hairy, grooved on above side. Flower in lateral umbellate cymes, umbels many flowered; peduncles 3-8 cm long, hairy; pedicels 1-2 cm long hairy; bracts 5-7 mm linear. Calyx divided to the base; sepals 5-7 mm long, glabrous. Corolla 3.5-5.5 cm long; tube upto 4.4 mm long, ash

coloured to white externally with 10 distinct veins, inside dark purple in lower part and minutely hairy at slightly inflated part and white or ash-grey in the upper part, glabrous, funnel shaped; lobes 0.6-1 cm long, glabrous, connate at tips forming an obovate or obconic head. Corona biseriate; outer corona saucer shaped, 5-lobed, creamy-yellow, hairy along the margins; inner corona of 5 erect terete, yellow processes, slightly hairy at base. Pollen masses erect, yellow, minute. Follicles in pairs, 7-14 cm x 0.4 0.5 mm, terete, tapering at apex, glabrous green. Seeds 7x4 mm, margined; coma 2-2.5 cm long, white.

Flowering : August - September.

Fruiting : September - October.

Field Note : It grows in ghat areas on difficult inaccessible slopes. It is erect and probably most robust species in Maharashtra. It survives in difficult places away from human influence. It is endemic to Maharashtra. It grows well under cultivation. Overall increase in all attributes was observed under cultivation. It has sweet scented flowers.

Herbarium specimen examined : Gaganbawada P-3283.

Places of collection : Gaganbawada.

13. Ceropegia vincaefolia Hook. (Plate V, Figs. 18-19, Text Fig. XIII, Figs. 1-5)

A perennial twinning herb with tuberous roots, tubers subglobose, 3-4 cm in diameter. Stems long, branched or unbranched,

terete, glabrous purple in colour. Leaves petiolate 6-19 x 4-10 cm, ovate to ovate-lanceolate acute, cordate at base, membranous, slightly hairy above and along margins, glabrous beneath except nerves. Flower in lateral umbellate cymes, umbels usually many flowered; peduncle 1-1.5 cm long from between the petioles terete, hirsute, dark purple, bracts, 0.6-0.7 cm long, linear, subulate, glabrescent; pedicels 1.2 cm long; terete, thick glabrescent to glabrous. Calyx divided to the base; sepals 1-1.4 cm long, linear-subulate. Sparingly hairy. Corolla 5-7 cm long, slightly curved; tube 2-4 cm long dilated at base, purple variegated with green dots outside, dark purple with light window and hairy inside, narrowed in the middle, funnel shaped at mouth; lobes 1.5-3.5 cm long, connate at the tip forming an avoid-oblong or ovoid head, pubescent inside, ciliate along the margins variegated variously. Corona biseriate; outer cupular of 5 lobes, lobes emarginate to bifid, purple, hairy inside and along margins; inner corona erect, lobes spatulate, lanceolate, rhomboidal, divergent at tips, glabrous, dark brown. Pollen masses yellow, ovoid, attached to the pollen carrier by minute caudicles. Follicles 10-15 x 0.4-0.5 cm; cylindric tapering towards apex, glabrous, greenish purple. Seeds 5-7 x 4 mm, ovate-oblong, margined, coma about 3 cm long.

Flowering : July - September.

Fruiting : September - October.

Field Note : It grows in hilly regions in small bushes. The flowers are beautifully variegated.

Herbarium specimens observed : Kas 3284 P-3284

Place of collection : Kas, Radhanagari, Sinhgad, Kanheri
caves.

Key to the Ceropegia species collected

1. Stem erect.

2. Leaves linear or linear lanceolate, less than 1.5 cm broad.

3. Cymes usually one flowered.

4. Herbs 10-50 cm. tall, corolla more than 3 cm
long

...C. attenuata

4. Herbs 5-10 cm. tall, corolla less than 3 cm long

... C. jainii

3. Cymes usually 2-4 flowered. ... C. noorjahaniae

2. Leaves ovate or ovate lanceolate, more than 1.5 cm broad

4. Corolla tube subcylindric, slightly enlarging at
mouth, corolla 3.5-5.5 cm long.

... C. sahyadrica

4. Corolla tube narrow, cylindric, not enlarging at
mouth corolla less than 4 cm long

... C. maccannii

1. Stem twinning.

5. Leaves fleshy.

6. Leaves reduced or absent, corolla more than 3 cm long

... C. juncea

Is it a constant feature?
6. Leaves over 2 cm long, corolla less than 3 cm long.

7. Leaves orbicular, ovate, emarginate or apiculate,
long petioled

... C. bulbosa var.
bulbosa.

7. Leaves linear to lanceolate, subsessile.

... C. bulbosa var.
lushii

5. Leaves membranous

8. Leaves linear to lanceolate, less than 1.5 cm broad.

... C. noorjahaniae

8. Leaves ovate to lanceolate more than 1.5 cm broad.

9. Corolla lobes equal or longer than tube.

10. Corolla tube funnel shaped above corolla
more than 3 cm long ..C. vincaefolia

10. Corolla tube subcylindric, hardly dilated
above, corolla less than 2 cm long.

... C. huberi.

9. Corolla lobes shorter than tube.

11. Corolla tube funnel shaped above.

12: Stem hirsute corolla tube hairy inside,
inner corona hooked at tips

... C. hirsuta

12. Stem glabrous, corolla tube glabrous inside,
inner corona not hooked at tips

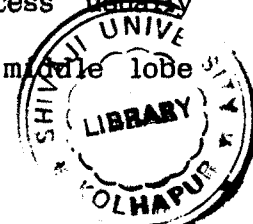
... C. oculata.

11. Corolla tube subcylindric, hardly dilated above

... C. media.

14. Brachystelma edulis , Coll. ^{et} ~~and~~ Helmsl. (Plate VI, Figs. 20-23;
Text Fig. XIV, Figs. 1)

An erect perennial dwarf herb, 5-12 cm in height with subglobose or depressed tuberous root, tubers 2-15 cm. in diameter. Stem terete, 2-3 mm in diameter, branched or unbranched, covered with short downwardly pointed hairs. Leaves sessile or subsessile, linear to linear-lanceolate to narrowly elliptic, 3.8 x 0.4-1 cm acute, margins ciliate. Flowers 1-2 on lateral side of scaly or foliaceous leaves, bracteate, small; pedicel 3.8 mm, puberulous, bract subulate, 1-2 mm. Calyx 5-partite, sepals 1.3-1.5 x 0.4-0.5 mm perberulous. Corolla 0.6-1.2 cm long, straight, divided almost to the base, dark purple and variously variegated on inner side, pale-green-purple outside corolla tube short ca. 1.5 mm, corolla lobes, broad at base tapering and filiform at apex, connate and twisted at tips, usually glabrous or sparsely hairy on inner side. Corona biseriate, 2-2.5 mm in diameter, outer corona cupular of 5-bifid lobes, lobes glabrous outside, hairy on margins and inner side rarely entirely hairy; inner corona of 5 dark purple procumbent processes which bent upon stigma, usually glabrous or sparsely hairy, each process usually trifid at apex with 2 small lateral lobe and one large middle lobe



procumbent on stigma. Pollinia erect, minute, yellow attached to brown carriers by short caudicles. Pistil 1-2 mm long, style indistinct, stigma pentangular and fleshy. Follicles usually in pairs 1-5 x 0.2-0.3 cm hornshaped, tapering at apex. Seeds 8-12 x 2-3 mm, elongated, margined, coma 1-1.5 cm long white.

Note : The species grows on borders of slopes on hillocks and in grasslands. Flowering of the species is very peculiar. After first showers of premonsoon in mid-May, the plant sprout^s out and initially produce scaly leaves. On lateral side of each leaf 1-2 flowers are produced, usually one on each side of scaly leaf. After flowering and fruiting, the plants produce foliaceous leaves. Rarely flowers, fruits and foliaceous leaves are produced simultaneously. Main flowering season is May to June. Then vegetative growth is continued upto August and then the leaves and above ground parts of stem die off.

^{like} B. edulis is recorded from Thailand. This species is recorded for first time from Maharashtra and forms a new record for India (Yadav et. al. 1989).

15. Brachystelma species (Plate VI, Figs. 25-28, Text Fig XV, Figs. 1-8)

An erect perennial herb, 9-30 cm. in height with subglobose tuberous root, tubers 2-5 cm. in diameter, stem terete, 0.2-0.4 cm in diameter, branched or unbranched, hispid. Leaves sessile or subsessile, ovate lanceolate or narrowly elliptic, 4-9 x 0.5-2.5 cm

acute. Hysteranthus, flowering axis with long internodes, 1-3 cm long bearing flowers in whorls at each node. Flowering nodes with two opposite subulate scaly leaves, flowers 2 on either side of each scaly leaf, flower 3-5 usually 4 at each node flowering nodes 3-7. Flowers small brown-black, bracteate. Pedicel 0.3-0.5 cm long, puberulous. Bracts subulate, 1-2 mm long. Calyx 5-partite, sepals 1-2 mm long, puberulous. Corolla divided almost to base, dark purple and variously variegated on inner-side, greenish purple outside, corolla tube short ca 1.5 mm long; corolla-lobes broad at base, tapering at apex, connate or free, hairy on inner side, 0.6-1 cm long, corolla hairs purple, corolla margins recurved. Corona biseriate, staminal; outer corona ca 2.2 mm in diameter, cupular of 5 lobes, lobes hairy; inner corona of 5 dark purple procumbent processes which bent upon stigma, glabrous, entire. Pollinia erect, minute, yellow attached to brown carriers by short caudicles. Pistil ca 2 mm long, styles indistinct, stigma pentangular. Follicles in pairs 10-15 cm long, tapering at apex. Seeds comose.

Note : The species was collected in rainy-season in vegetative phase. The tubers were planted in earthen pots. The plants flowered in the months of February-March. It is a hysteranthus species. Flowering is during February-March while leaves are produced in rainy-season (June onwards). It grows in crevices of laterite of Kokan around Malwan (Maharashtra).

A comparative account of morphological characters of Indian species of Bachystelma is given in table 5.

Table : 5 Comparative account of Morphological characters of India Brachystelma species.

Sr. No.	Name of the species	Habit/ Height	Leaf size	Flowers/ whorl	Flower size length	Chrolla lobes	Corola lobes	Flowering	Pedicels	Corona
1.	<u>B. attenuatum</u> Hook.f.	+	+	+	0.9-1 cm	glabrous	free	+	+	+
2.	<u>B. ciliatum</u> Arekal Ramakrishna	Erect 6-40 cm	Filiform 2-6x 0.1-0.2 um	2-4 flowered	1.5-2x1mm	Ciliate at apex	free	Synanthus	1.5-2 cm. drooping	glabrous
3.	<u>B. bourmese</u> Gamble	Erect	filiform very narrow 10-16 cm	3 flowered	0.8-1.3 cm	with purple coloured hairs	free	Synanthus	+	with purple hairs.
4.	<u>B. brevityubulatum</u> Gamble	Twining	lanceolate 11 x 0.7 cm	3-4 flowered	1.9-2.5 cm	glabrous	Cohering at apex	Synanthus	+	+
5.	<u>B. edulis</u> Coll. & Hems.	Erect 5-12 cm	elliptic-lanceolate 3-8x 0.4-1 cm	2 flowered	0.6-1.2 cm	glabrous or rarely hairy	fre e	Hysteranthus & Synanthus	+	hairy
6.	<u>B. elenoduenis</u> M.B. Schar.	Erect 5-10 cm	filiform. 1-4 x 0.2-0.4cm	Usually solitary or 1-4 flowered	0.4-0.8 cm	glabrous	free	Hyysteranthus	+	hairy
7.	<u>B. glabrum</u> Hook.f.	Erect 15-22 cm	filiform 9 x 0.3 cm	few flowered	0.5-0.8 cm	glabrous	free	Synanthus	+	+
8.	<u>B. kolarensis</u> Arka ^l & K ^l	Erect 8-15 cm	Ovate-oblong to ovate-lanceolate 2-5 x 0.8-1.5 cm	2 flowered	0.4-0.5 cm	puberulous within	free	Synanthus	0.4 mm erect	hairy
9.	<u>B. laevigatum</u> Hook.f	Erect 30-45 cm	Minute subulate	2-4 flowered	0.6-0.7 cm	glabrous or puberulous	free	Synanthus	+	+
10.	<u>B. maculatum</u> Hook.f.	Erect 25-30 cm	filiform 7-10x 0.25 cm	3-5 flowered	0.5 cm	Glabrous except few hairs	free	Synanthus	+	+
11.	<u>B. parviflorum</u> Hook.f.	Erect	filiform 10 x 0.25 cm	Solitary	1 cm	Villous within	free	Synanthus	2-5 cm	+
12.	<u>B. rangachari</u> Gamble	Erect	filiform. very narrow 7-8 cm	5 more flowered	1.3-1.8 cm	white villous within	free	Synanthus	+	+
13.	<u>B. volubile</u> Hook.f.	Twining several feet long	filiform very narrow 13 cm	3-4 flowered	1 cm	white villous within	free	Synanthus	+	+
14.	<u>B. species from Maharashtra</u>	Erect 10-30 cm	elliptic-lanceolate 4-9x 0.5-2.5 cm	4 flowered rarely 3-5 flowered	0.5-1 cm	with purple hairs	free or cohering	Hysteranthus	0.3-0.5cm	biseriate hairy

Analysis : From Table 5, it is clear that the present species differs from all other Indian species of Brachystelma. Important differences are as follows :

1. Brachystelma species differs from B. brevitubulatum and B. volubile in its erect habit.
2. It differs from B. attenuatum, B. ciliatum, B. elenoduensis, B. glabrum, B. laevigatum, B. maculatum, B. parviflorum, B. rangachari in having broader leaves (5-2.5 cm) while the above mentioned species have breadth of leaf less than 0.5cm.
3. It is similar to B. edulis and B. kolarens^{se} in having broad leaves but differs from B. edulis in having long flowering internodes, usually 4 flowers at each node and broader leaves. It differs from B. kolarens^{se} in its hystranthus nature, broader leaves, long internodes larger length of stem, there is no peduncle, flowers arise directly on either side of scaly leaf of Brachystelma.

The specimens along with description, photoplate and figures were sent to Kew for identification. Dr. D. J. Goyder, a botanist working on Asclepiadaceae in Kew has determined it as a new species allied to B. edulis Coll. & Hemsl. It will be published as a new species in short time.

Key to the Indian species of Brachystelma based partly on published literature and partly on own observations.

1. Twinning herbs.

2. Leaves lanceolate 11x0.7 cm, Flowers 3-4 per whorl
1.9-2.5 cm long, glabrous, corolla lobes cohering at
apex ..B. brevitubulatum
2. Leaves filiform, ca 13 cm long; flowers 3-4 per whorl
ca 0.9 cm. long, white villous within corolla lobes free
.. B. volubile

1. Erect herbs.

3. Leaves are more than 0.5 cm broad, linear,
elliptic-lanceolate
4. Herbs 5-12 cm in height, leaves elliptic-lanceolate,
3.8 x 0.4-1 cm, flowers 2 per whorl, 0.6-1.2 cm
long, glabrous or rarely hairy, corolla lobes free
synanthus as well as hysterenthus ..B. edulis
4. Herbs 8-15 cm. in height, leaves ovate oblong to ovate
lanceolate, 2-5 x 0.8-1.5 cm, flowers 2 per whorl,
0.4-0.5 cm long, puberulous within, corolla lobes free,
synanthus .. B. kolarense
3. Leaves less than 0.5 cm broad, filiform
5. Leaves 10 x 0.25 cm, flowers solitary, ± 1 cm long,
villous within, corolla lobes free, pedicel 2-5 cm long
..B. parviflorum

5. Leaves filiform, flowers 2-4 per whorl.

6. Herbs, 6-4 cm height, leaves filiform 2-6x 0.1-0.2 cm, flowers 2-3 whorl, 1.5-2 cm long corolla lobes ciliate at apex and free

..B. ciliatum

6. Herbs, leaves filiform, corolla ciliated at apex.

7. Corolla villous within, 0.8-1.8 cm long.

8. Leaves 7-8 cm, filiform, flower 5 or more per whorl. Corolla 1.3-1.8 cm long, white villous within

..B. rangachari

8. Leaves 10-16 cm, long, filiform, flowers 3 per whorl, corolla 0.8-1.3 cm long with purple coloured hairs within, corolla lobes free at apex ..B. bourneae

7. Corolla glabrous within, upto 0.8 cm long.

9. Herbs 5-10cm height, leaves filiform, 1-4x0.2-0.4 cm, flower usually solitary rarely-4-7 per whorl, corolla 0.4-0.8 cm long glabrous, Hysteranthus.

.. B. elenoduensis.

9. Herbs, . . . high, leaves filiform
7.1 x 0.25cm, flowers 3-5 per whorl,
corolla \pm 0.5cm long glabrous except
few hairs, free, synanthus

..B. maculatum

9. Herbs, 15-22cm high, leaves filiform,
 \pm 9x0.3cm, 2-4 flowers per whorl,
corolla 0.5-0.8 cm long, glabrous,
corolla lobes free, synanthus

..B. glabrum

9. Herbs, minute, subulate, flowers
2-4 per whorl, corolla 0.6-0.7 cm
glabrous or puberulous, corolla lobes
free at apex, synanthus.

..B. laevigatum

9. Flowers 0.9-1 cm long, glabrous

..B. attenuatum



Figs.1-3: *C. attenuata* Fig.4: *C. bulbosa* var. *lushii*
Fig 5: *C. bulbosa* var. *bulbosa*



Fig.6:C.hirsuta,Figs.7-8:C.huberi, Fig.9: C.jainii

Text figure-1

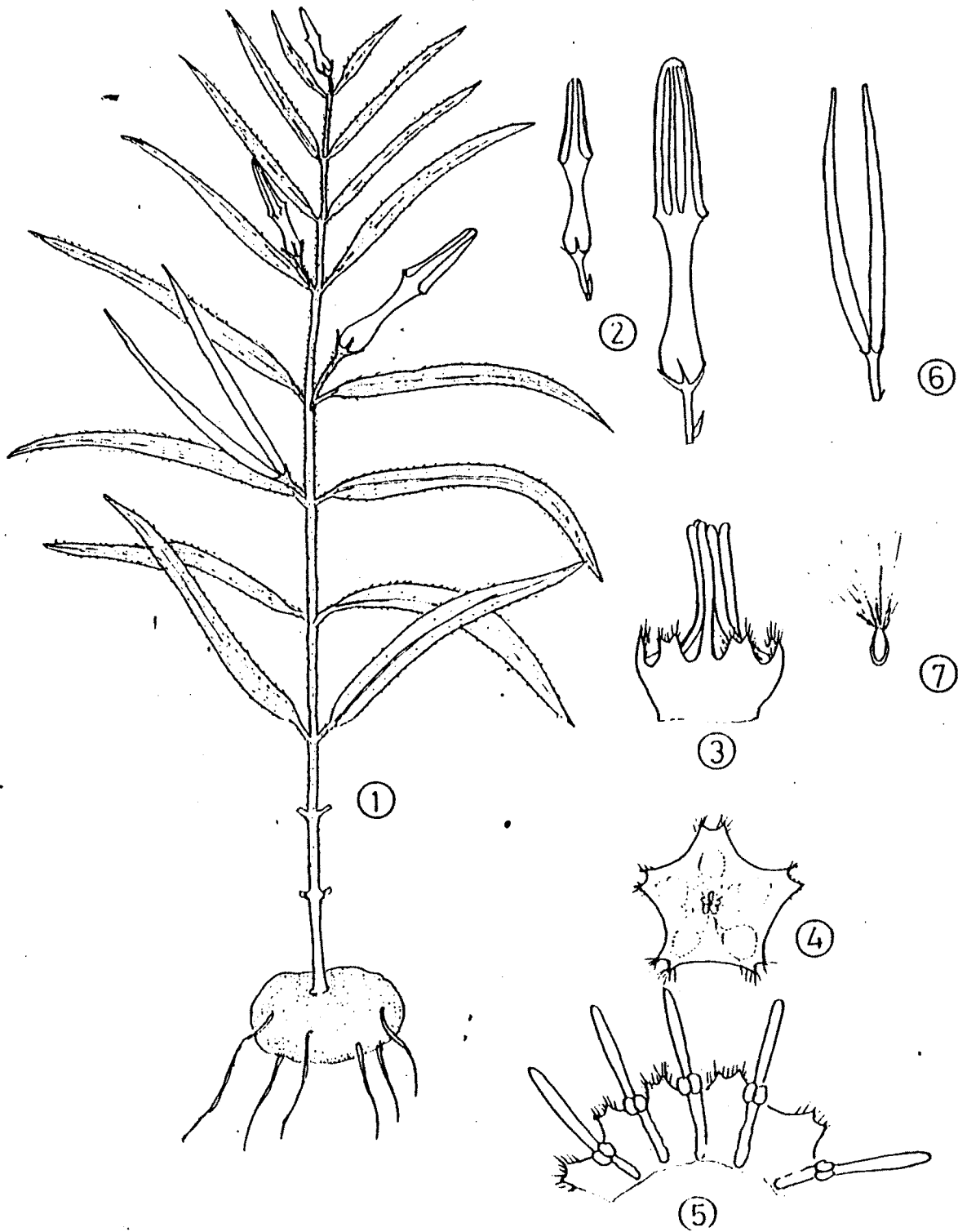


Fig. 1-7: *Ceropegia attenuata* Hook. (1) A Whole plant (2) Flower (3) Corona side view (4) Corona front view (5) Dissected corona (6) Follicle (7) A Seed with coma

Text figure-11



Fig.1-6 *Ceropegia bulbosa* var. *bulbosa* Roxb. (1) Plant with tuber (2) Plant with flowers & follicle (3) Flower (4) Corona (5) Corona (6) Corona front view

Text figure-III



Fig. 1-5: *Ceropogia bulbosa* var. *lushii*(Grqh)Hook (1)A Whole plant (2)Flower (3)Corona side view (4)Corona front view (5)Follicle

Text figure -IV

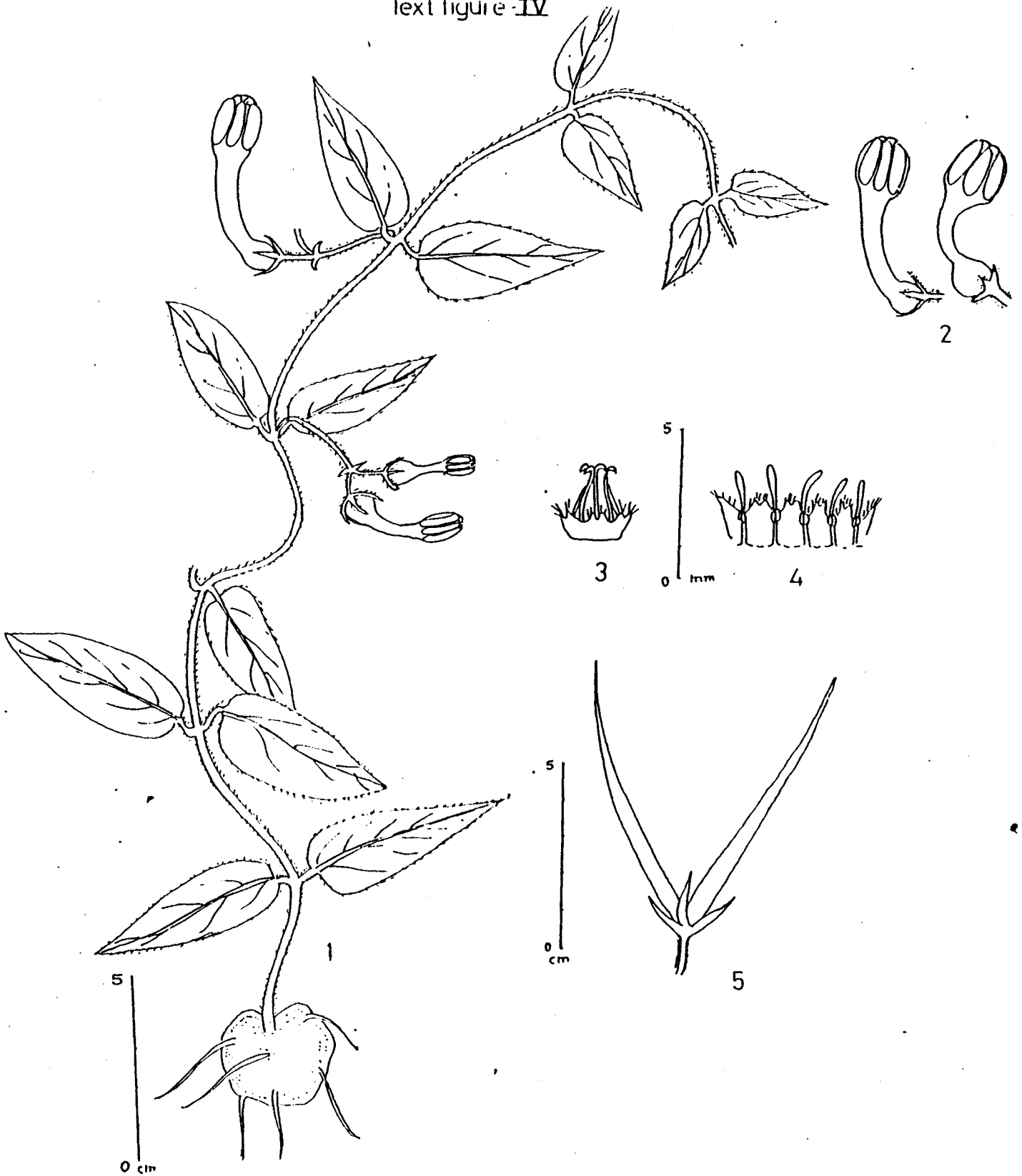


Fig1-5: *Ceropegia hirsuta* Wt. et Arn. (1) A whole plant (2) Flowers
(3) Corona side view (4) A dissected corona (5) Follicle



Fig:1-8: *Ceropogia huberi* Ansari (1) A Whole plant (2) Flower
(3) Corona front view (4) Corona side view (5) A dissected corona (6) Gynostegium (7) Pollinia (8) Follicle (9) Seed

Text figure VI .

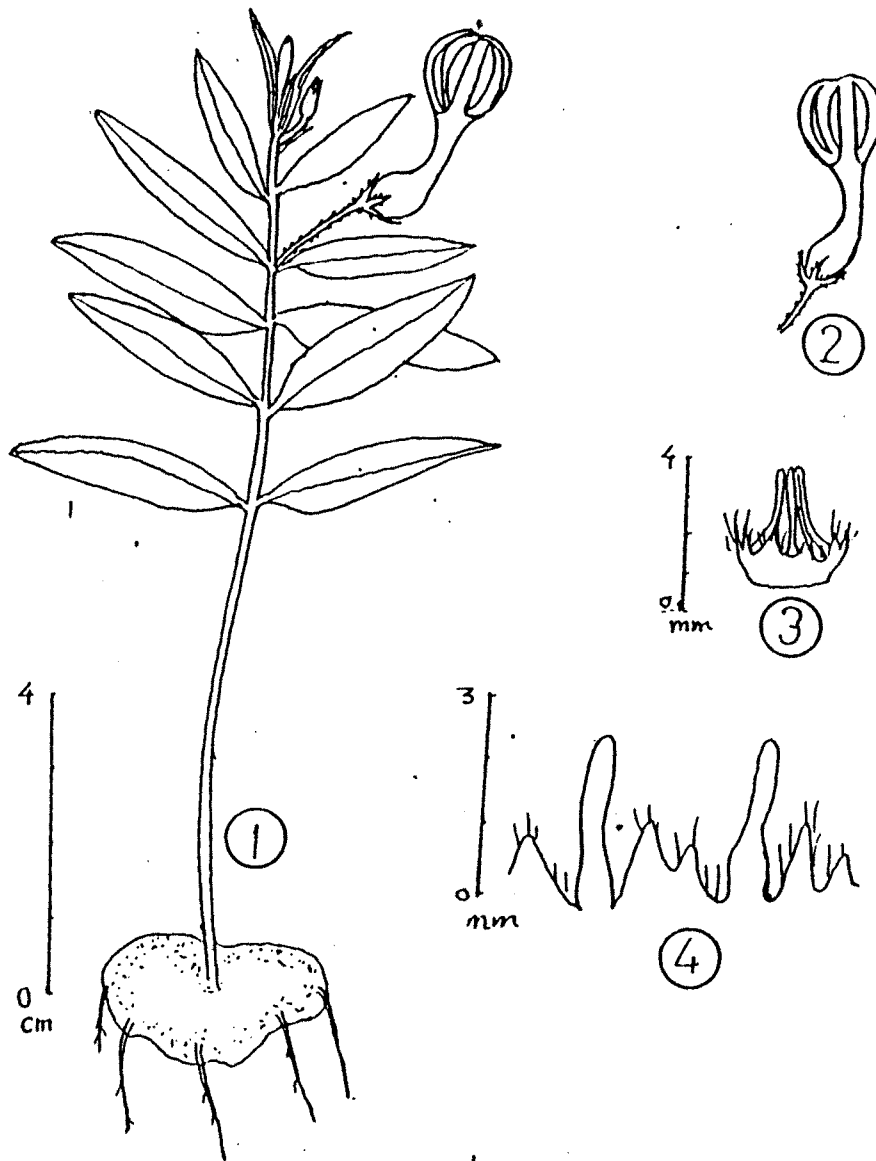


Fig.1-4: Ceropogia jainii Ansari.

(1) A whole plant (2) Flower

(3) Corona side view

(4) A dissected corona

Text figure - VII

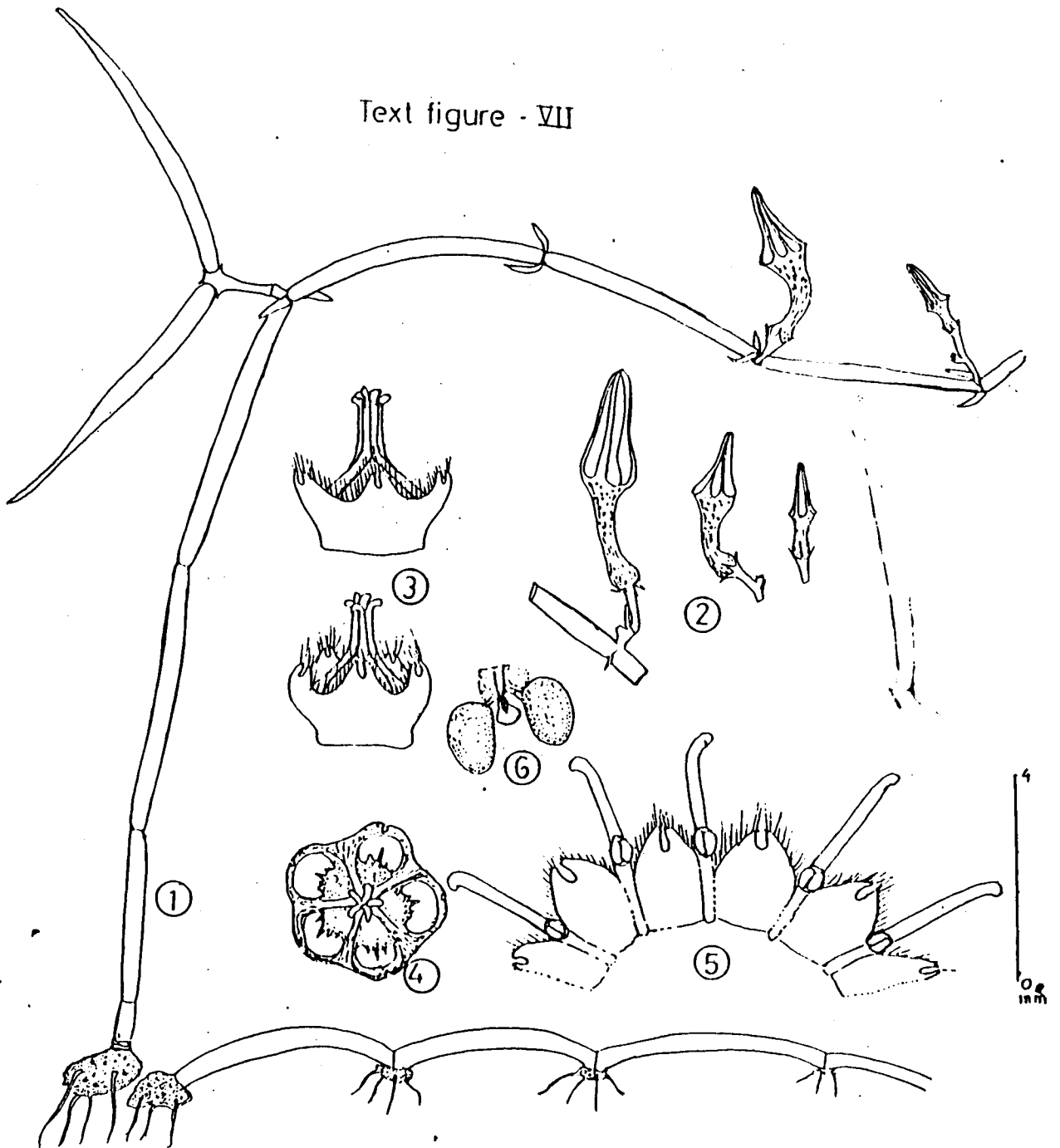


Fig-1-6 : *Ceropogia juncea* Roxb.

- (1) A Whole plant
- (2) Flowers
- (3) Corona side view
- (4) Corona front view
- (5) A Dissected corona
- (6) Pollinia

Text figure VIII

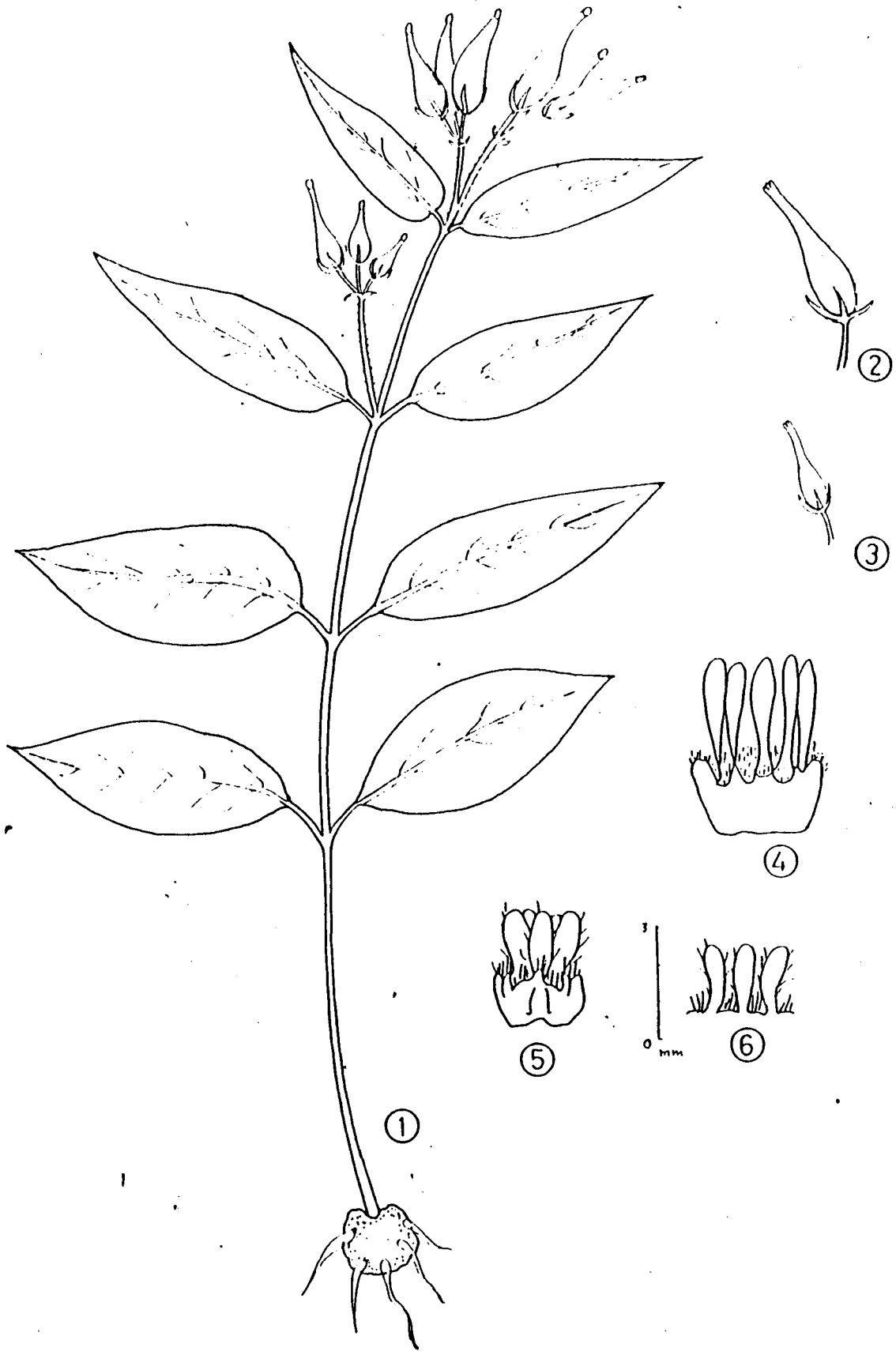


Fig.:1-6: *Ceropogia maccanii*. Ansari.(1)A Whole plate
(2) & (3)Flowers(4)Corona(5)Corona
(6)A Dissected corona.

Text figure IX

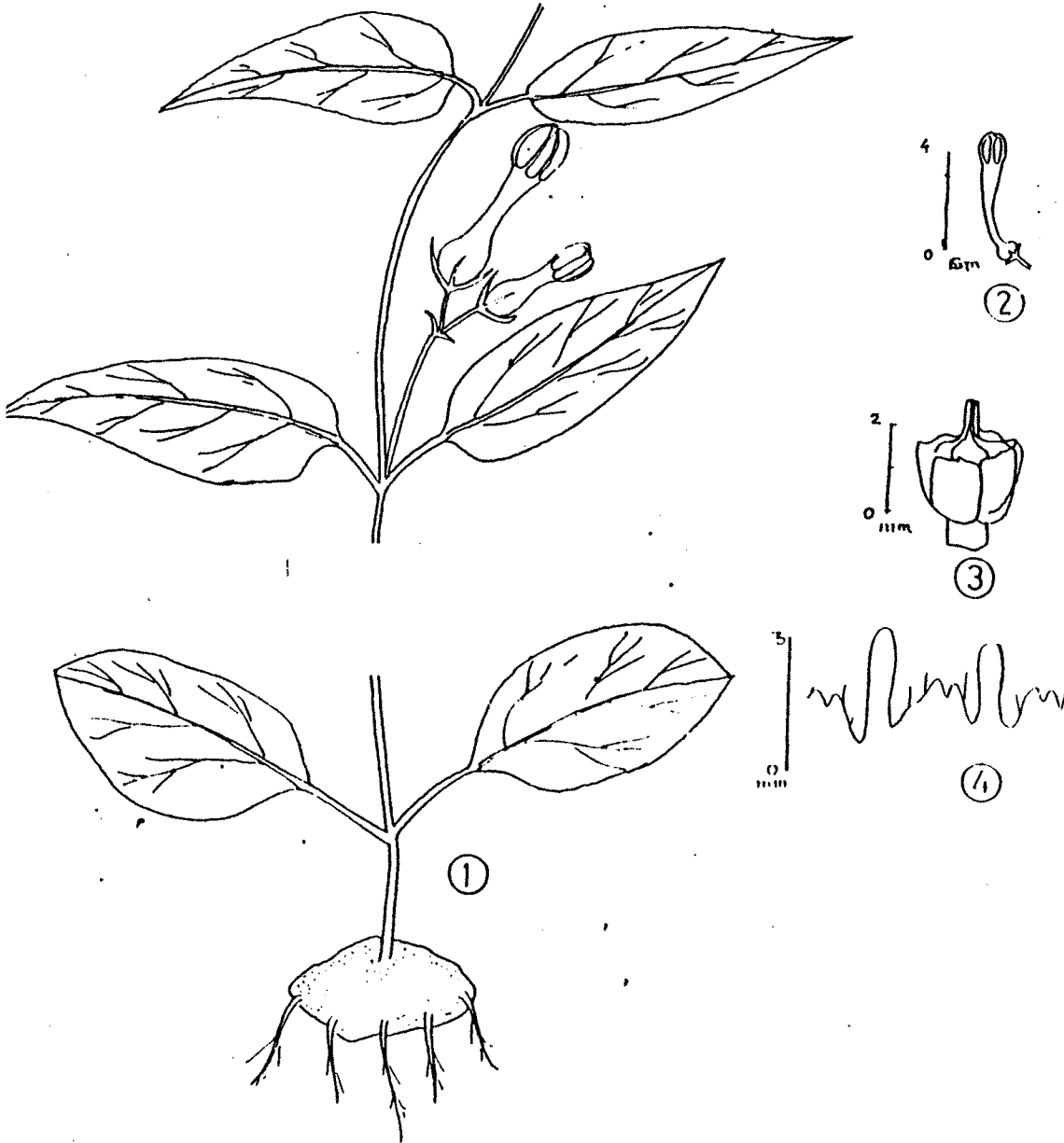
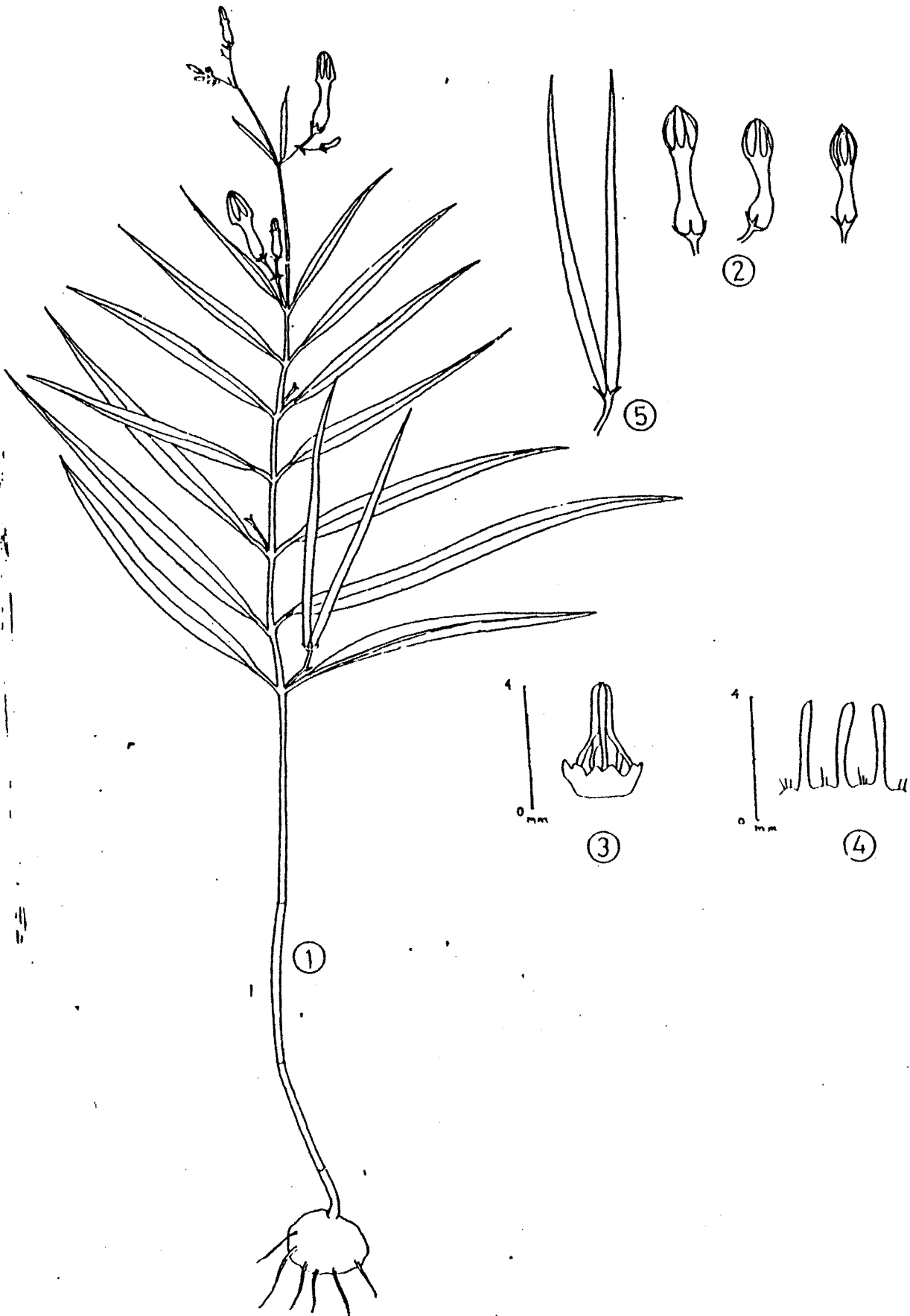


Fig.1-4 : *Ceropegia media* (Huber) Ansari (1) Entire plant
(2) Flower bud (3) Corona side view
(4) A dissected corona

Text figure - X



1 Fig: Ceropogia noorjahaniae Ansari. (1) A Whole plant (2) Flowers
(3) Corona side view (4) A dissected corona (5) Follicle

Text figure XI

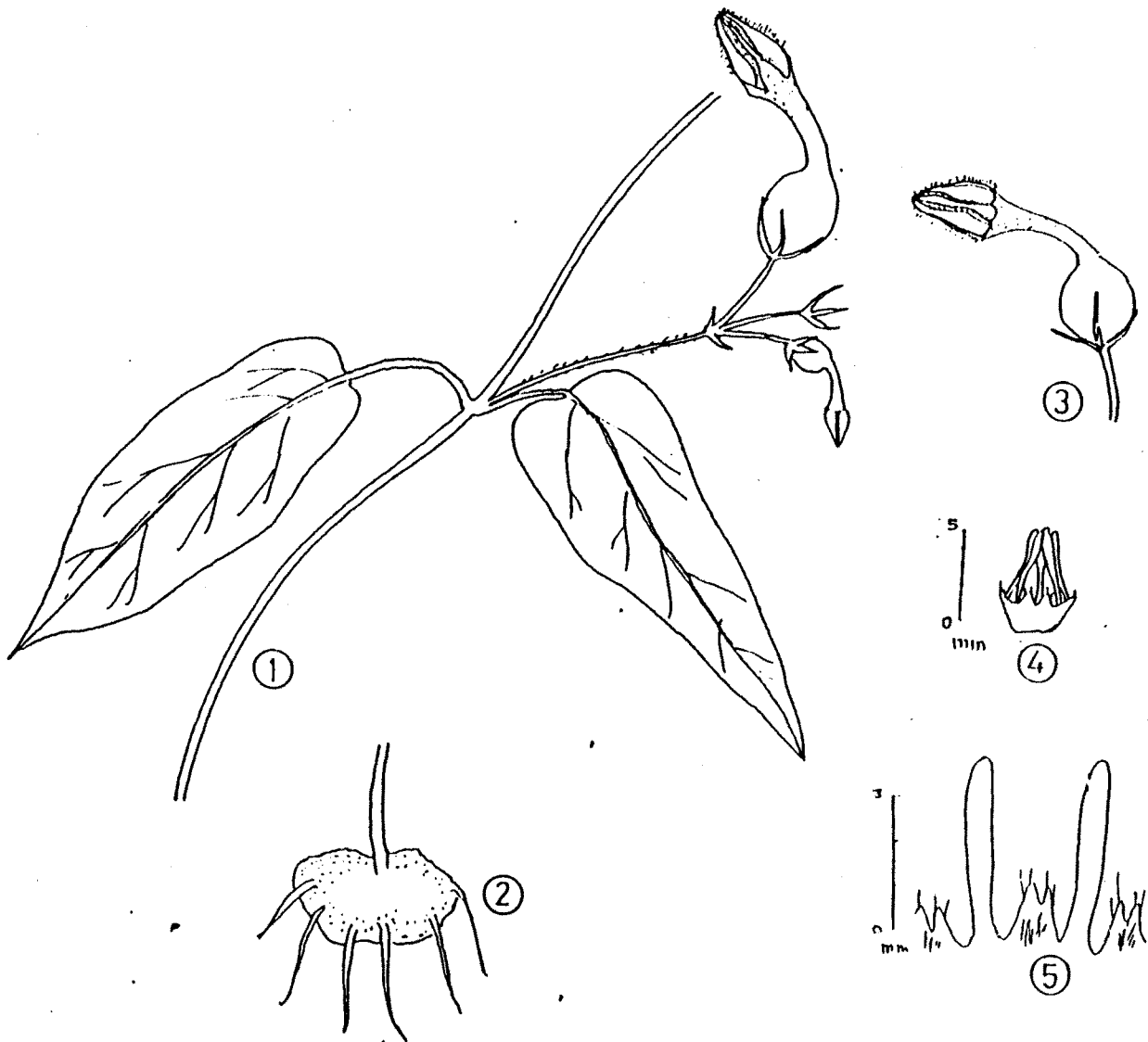


Fig.1-5: Ceropogia oculata Hook (1) Flowering twig
(2) Tuber (3) Flower (4) Corona side view
(5) A dissected corona

Text figure XII

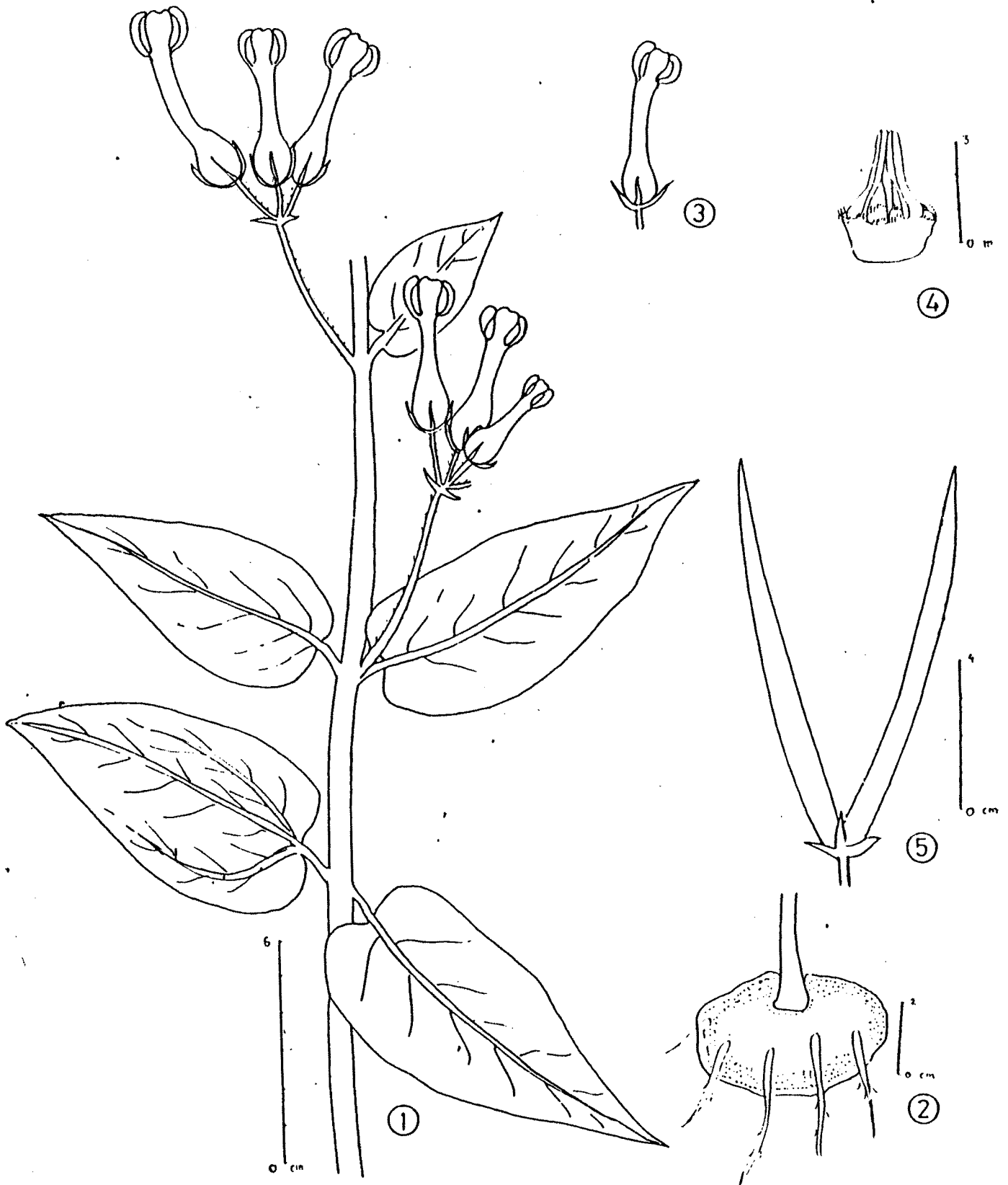


Fig. 1-5: *Ceropogia sahyadrica* Ansari et Kulkarni (1) & (2) A Whole plant with tuber (3) Flower (4) Corona (5) Follicle

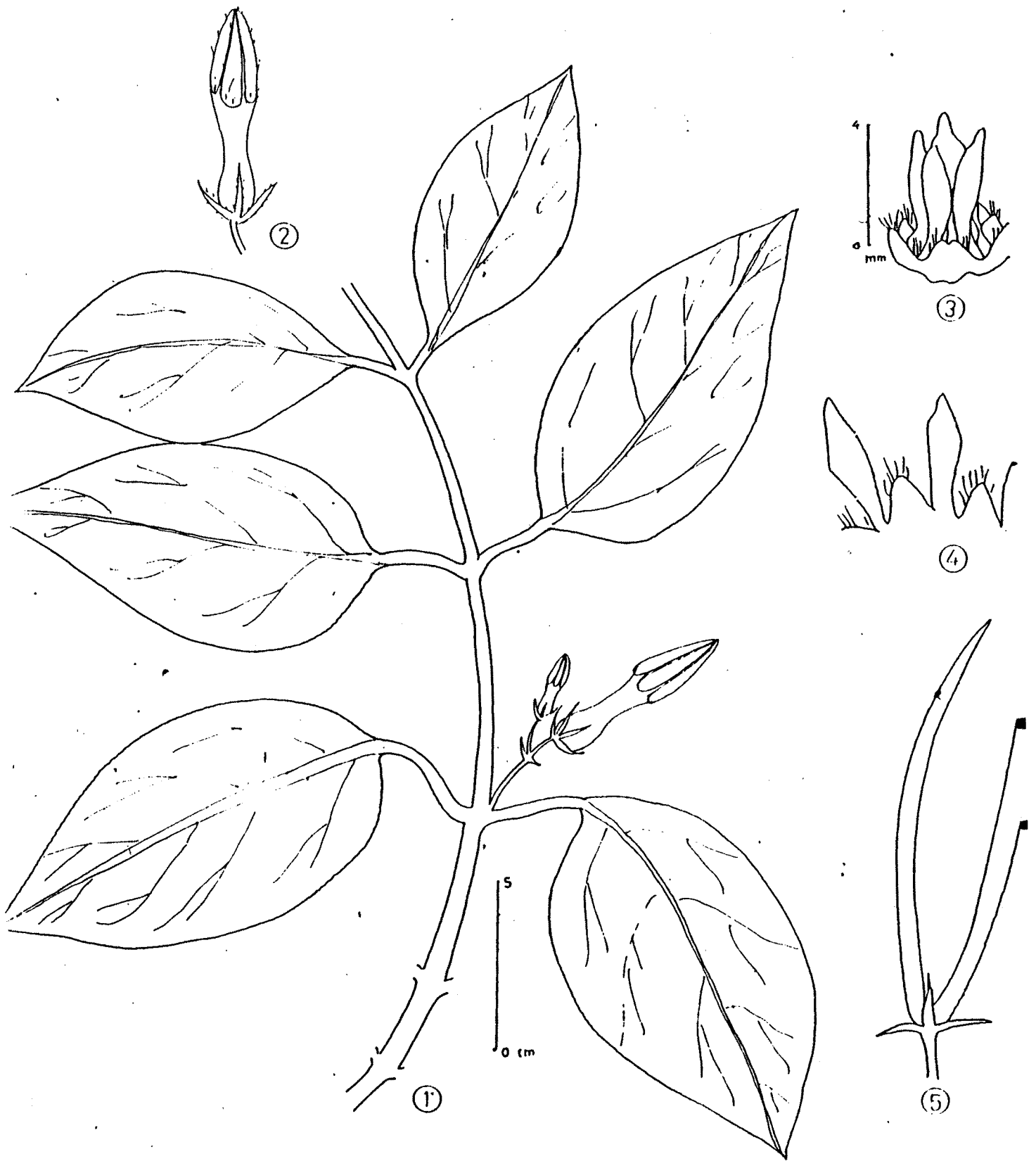


Fig. 1-5: *Cerropegia vincaefolia* Hook (1) A Whole plant (2) Flower (3) Corona side view (4) A dissected corona (5) Follicle

Text figure -XIV

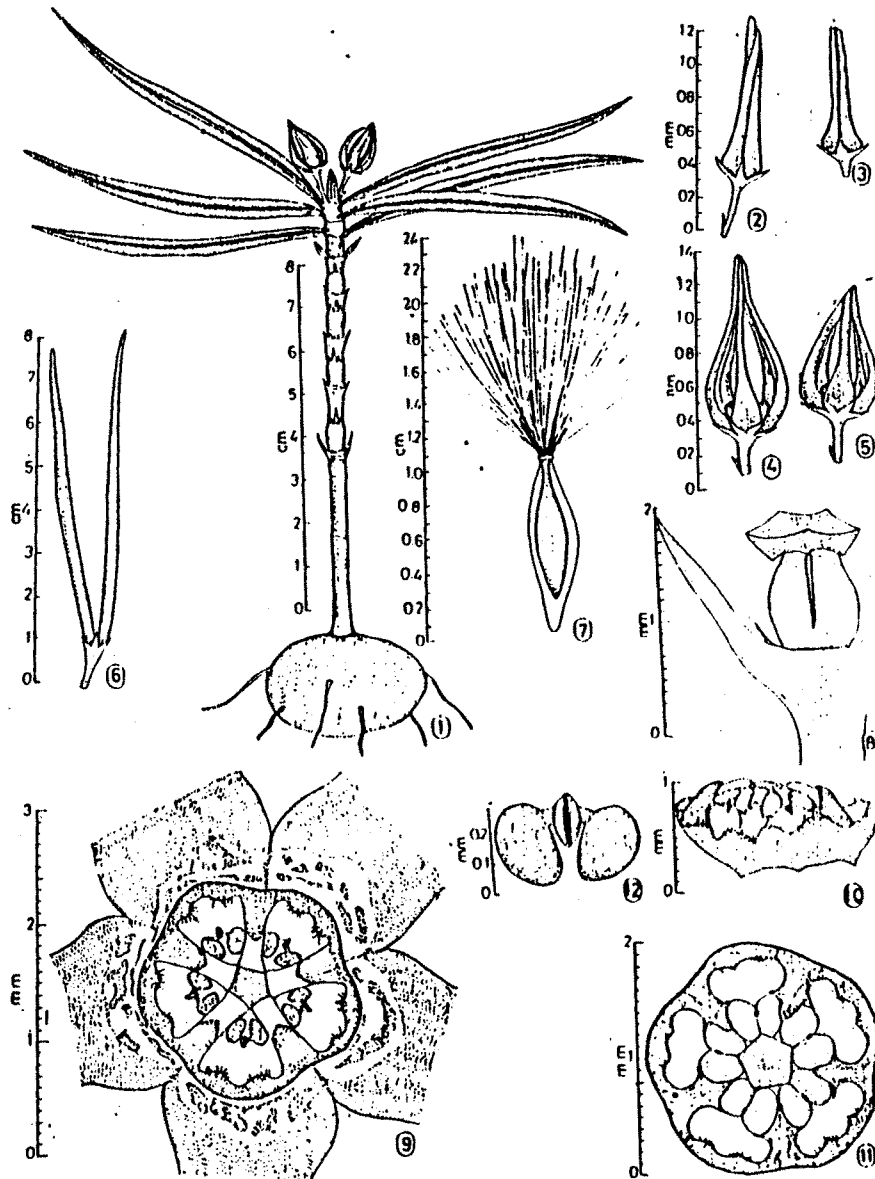


Fig.1-12: Brachystelma edulis Coll. & Helmsl.

- (1) A Whole plant (2) & (3) Flower buds (4) & (5) Flowers (6) Follicle
 (7) Seed with coma (8) Gynostegium (9) Corona front view.
 (10) Corona side view (11) Corona front view (12) Pollinia

Text figure-XV

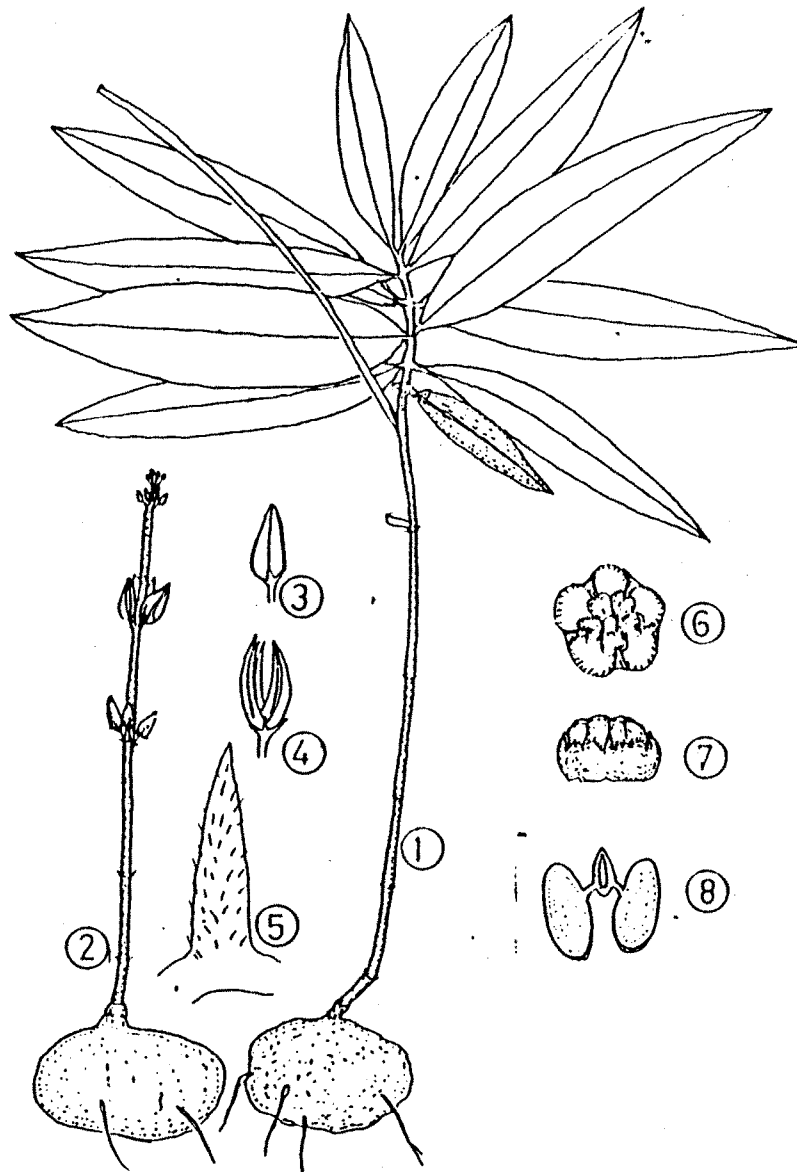


Fig.18: Brachystelma species (1) Plant in vegetative stage
(2) Plant in flowering stage (3) Flower bud (4) Flower
(5) Corolla lobe (6) Corona front view
(7) Corona side view (8) Pollinia

II] Corona

In genus Ceropegia corona is double & staminal. The corona characters of Ceropegia are of diagnostic value & therefore described & shown diagrammatically in Text Fig. XVa.

In C. attenuata (Text Fig. XVa, Fig. 3) outer corona lobes are deltoid-oblong deeply bifid and the segments are acute with very long hairs; inner corona lobes are linear & erect without hairs.

In C. bulbosa var. bulbosa (Text Fig. XVa, Fig. 4) & C. bulbosa var. lushii (Text Fig. XVa, Fig. 5) outer corona lobes are 5, minute, unfid & inner corona lobes are linear & erect.

In C. hirsuta (Text Fig. XVa, Fig. 7) outer corona lobes are subquadrate, deeply bifid & ciliate; inner corona lobes are linear, non hairy & hooked.

In C. huberi (Text Fig. XVa Fig. 8) outer corona is cupular, 5 lobed, entire & glabrous; inner corona is of 5 conical lobes, hairy on outer side & incumbent on anther.

In C. jainii (Text Fig. XVa, Fig. 9) outer corona is cupular, lobes deeply 5-lobed, and hairy along the margins; inner corona consists of 5 linear-subspathulate erect lobes.

In C. juncea (Text Fig. XVa Fig. 10) outer corona is 5-lobed, each lobe bifid with wide sinus & is ciliate on margins; inner corona lobes linear, bend on anther, then erect & hooked.

In C. maccannii (Text Fig XVa, Fig. 11) outer corona is cupular made up of 5 - lobes, each lobe obscurely bifid, hairy along margins & inside; inner corona fleshy, subclavate, hairy, erectodivergent.

In C. media (Text Fig. XVa, Fig 6) outer corona cupular, subquadrate, lobes 5, with few hairs; inner corona is of 5 linear erect-lobes.

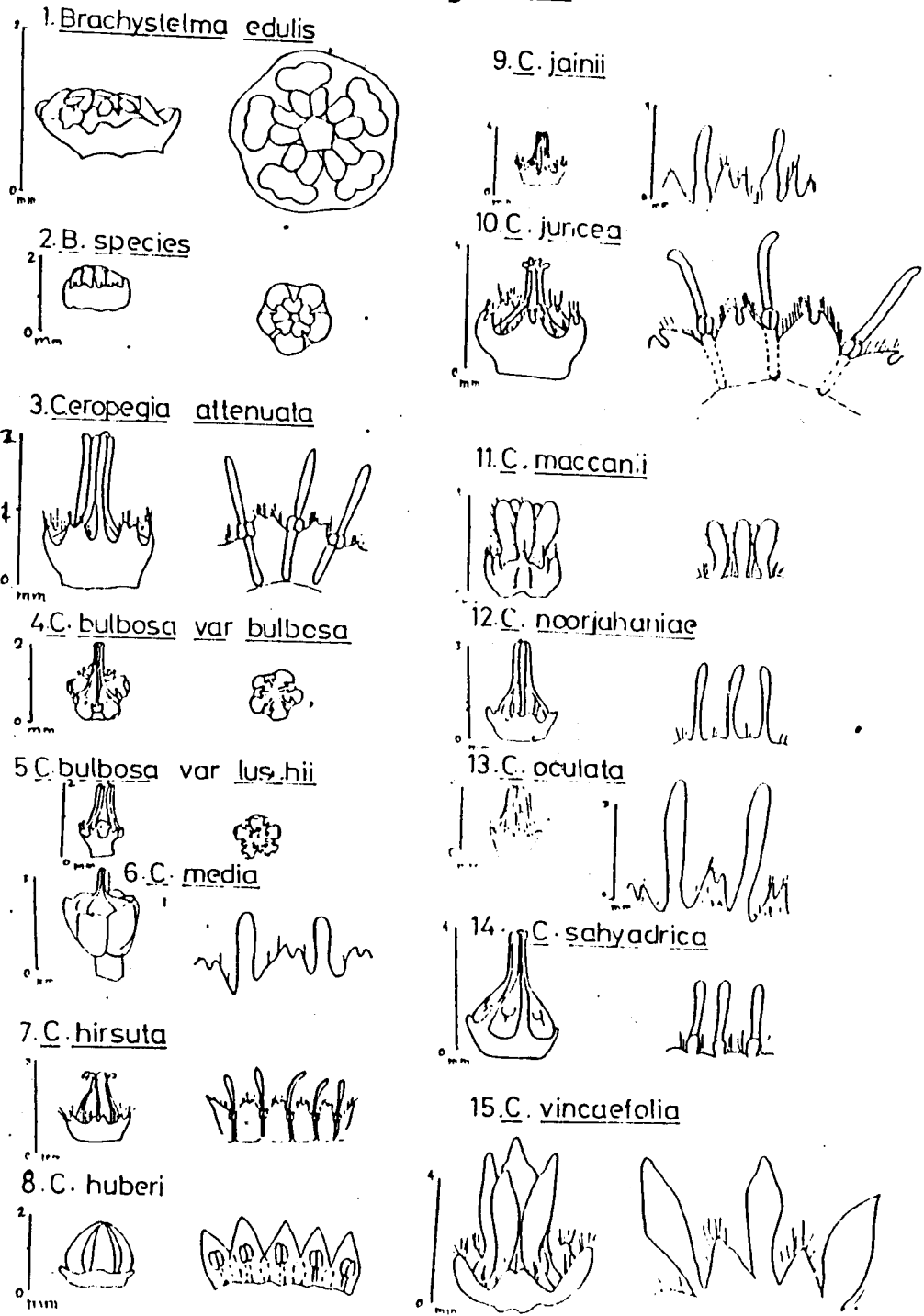
In C. noorjahaniae (Text Fig. XVa, Fig. 12) outer corona cupular of 5 bifid lobes, glabrous outside & sparsely hairy along the margins; inner corona consists of 5 erect, glabrous straight lobes.

In C. sahyadrica (Text Fig. XVa, Fig. 14) outer corona cupular, of 5 deeply emarginate lobes, margins sparsely hairy; inner corona is of 5 -erect slener terete, straight lobes.

In C. vincaefolia (Text Fig. XVa, Fig. 15) outer corona is cupular of 5 broadly emarginate to bifid lobes, hairy inside & along margin; inner corona of 5 compressed, oblanceolate or lanceolate-rhomboidal lobes which are divergent at apex.

In Brachystelma corolla is biseriate & staminal. In B. edulis (Text Fig. XVa, Fig. 1) outer corona cupular of 5 emarginate lobes, lobes glabrous outside but hairy inside & along margins or rarely entirely hairy; inner corona of 5 dark purple procumbent processes which bent upon stigma, usually glabrous.

Text figure XVa



In B. species (Text Fig XVa, Fig. 2) outer corona is cupular of 5 lobes, lobes hairy, inner corona of dark purple procumbent processes which bent upon stigma & are glabrous.

III] Light Windows in flowers of Ceropegia species

In Ceropegia flowers are peculiar and curiously variegated in some of the species (photoplate) I-IV. Corolla is dilated at base, then narrowed into a narrow tube, usually funnel shaped at mouth and corolla lobes are connate at apex. Therefore the interior of the flower there is dark condition and no direct light falls on the reproductive structures (corona). So some of the species of the genus have evolved different types of light windows which illuminate corona. Light windows in some species of Ceropegia are of diagnostic value.

C. vincaefolia shows light window characteristic of the species. In this species there exist a light colored ring around the top of the dilated corolla chamber and light coloured more or less circular areas are found in dark coloured inflated corolla region. (Text Fig. XVb, Fig. 10) These light windows are so arranged that light is focussed on corona.

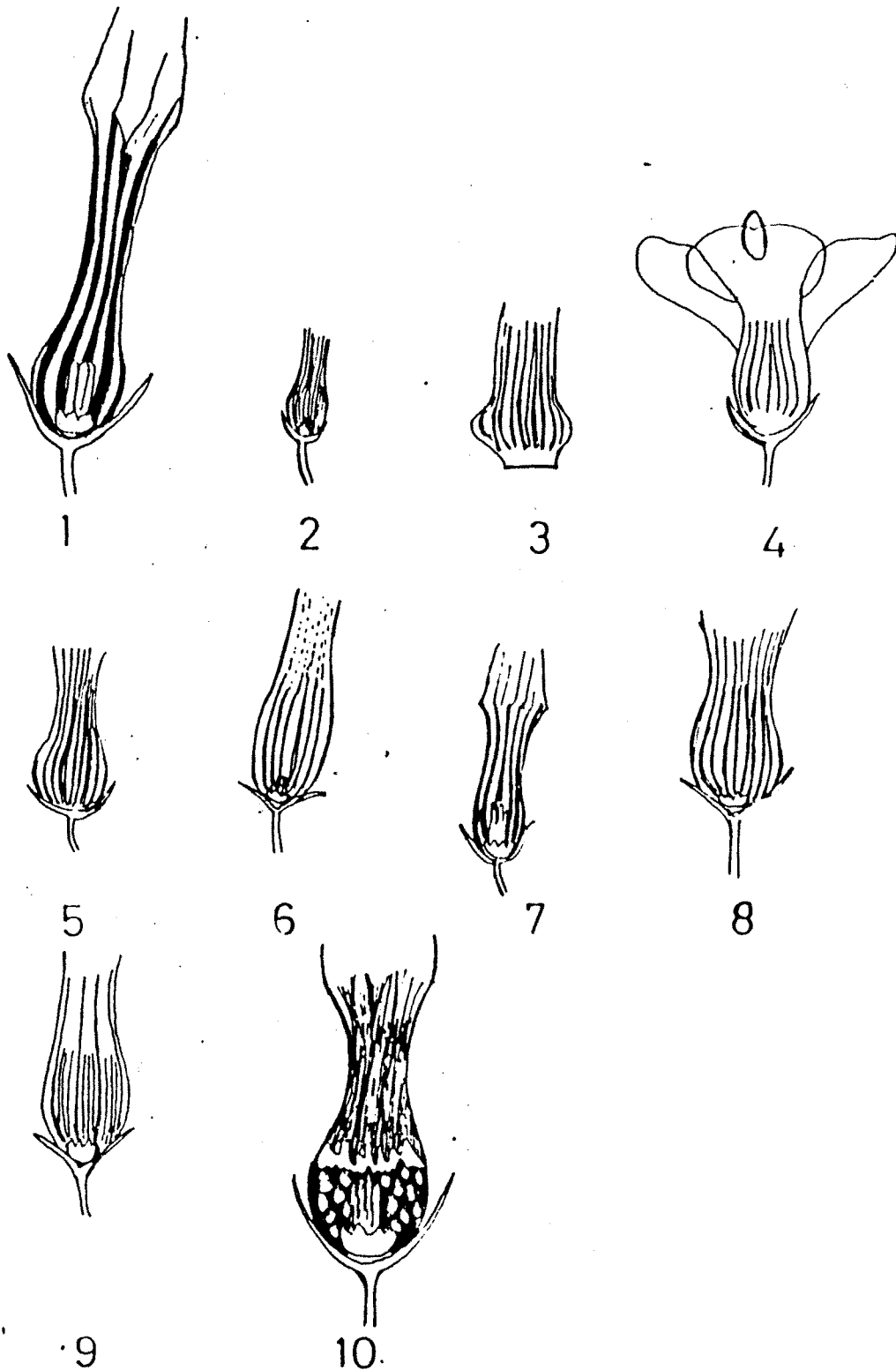
In other species such as C. hirsuta, C. juncea, C. oculata, C. media, C. noorjahaniae, C. bulbosa and C. maccannii there are vertically elongated translucent areas inbetween dark coloured areas (Text Fig XVb). These vertical translucent areas act as slit and admit light illuminating corona

In C. sahyadrica the flowers are almost white, corolla tube is faintly coloured inside and thus sufficient light is available inside inflated corolla tube.

In C. huberi, the flowers are very short, corolla tube is white and faintly purple inside and there are only dark thin lines and sufficient light is available inside inflated corolla tube.

Among the species studied C. vincaefolia shows most-elaborate way of illuminating corona.

Text figure XVb



Figs. 1-10: 1 Ceropegia attenuata 2 C. bulbosa
var. bulbosa 3 C. hirsuta 4 C. huberi 5 C. oculata
6 C. maccannii 7 C. noorjahaniae 8 C. media
9 C. sahyadrica 10 C. vincaefolia

B] ANATOMY

I) Stem Anatomy

Various species of Ceropegia and Brachystelma are perennial herbs with annual aerial parts. Anatomy of mature stem in transverse section is described below. The anatomical characters are summarized in Table VI.

- 1) Ceropegia attenuata Hook (Plate VII, Fig. 29, Plate VIII, Fig. 43; Text Fig. XVI, Fig. 1, Text Fig. XVII, Fig. 1)

It is an erect species. The diameter of stem varies from 0.8-1.7 cm. T.S. of stem is circular in outline. Epidermis is single layered made up of cubical to rectangular cells measuring 9.5-11.4x 9.5-14.31 μm , covered externally with cuticle and some cells produce 2-3 celled trichomes.

There is no distinct hypodermis. Beneath epidermis is a wide cortex consisting of 7-9 layers. The outer cortex is made up of thin walled, isodiametric, elliptic to polyhydral parenchymatous cells. In inner cortex there are patches of cellulosic fibres. Most of the cells of cortex contain starch grains. The cells of outer few layers are comparatively smaller, closely packed and contain chloroplasts. Laticifers are found in inner cortex associated with phloem. Just below cortex, patches of primary phloem are seen followed by secondary phloem. Laticifers are found distributed in phloem region. The activity of cambium is irregular and xylem cylinder is not uniform in thickness. Secondary xylem is more at opposite sides and underdeveloped xylem elements are seen inbetween two well developed

xylem regions. The xylem is composed of few vessels, tracheids, fibres and xylem parenchyma. The xylem elements are arranged in rows. Internal phloem is present inside xylem cylinder. Pith is made up of large parenchymatous cells containing starch-grains and enclosing intercellular spaces.

2) C. bulbosa var. bulbosa (Plate VII, Fig. 30, Plate VIII, Fig. 44; Text Fig. XVI, Fig. 2, Text Fig. XVII, Fig. 2)

It is a climbing succulent species. The diameter of the stem varies from 1.8-2.6 mm. The T.S. of stem is circular in outline with 1.2 grooves in epidermis. Trichomes are absent. The epidermis is single layered made up of barrel-shaped cells. The outer wall of epidermal cells are covered with thick cuticle. The epidermal cells varies in size from 14.3-19 x 14.2-23 μ m. There is no distinct hypodermis. Cortex can be divided into two distinct zones as outer cortex and inner cortex. Outer cortex is about 7 layered in thickness. The cells of outer cortex are polyhedral to circular, variable in size, enclose intercellular spaces and contain chloroplasts. Inner cortex is made up of fibre patches alternating with parenchymatous cells. The wall of fibre cells are made up of cellulose and little lignin. Each fiber patch consists of 7 to 15 fibres. Inside inner cortex there is primary and secondary phloem. In between phloem and inner-cortex laticifer cells are found. In between phloem and secondary xylem there is distinct cambium. The cambium produces secondary xylem which is few layered (3-6 layered). Secondary xylem consists of fibres, vessels, tracheids and xylem parenchyma. The

secondary growth is normal and the cylinder of secondary xylem is more or less uniform in thickness and comparatively narrow. The pith is large made up of parenchymatous cells which enclose intercellular spaces and cells contain chloroplasts.

The stem anatomy reveals that there is little development of mechanical tissue & secondary xylem. All the parenchymatous cells including pith cells contain chloroplast & no starch grains, indicating its photosynthetic nature.

- 3) C. bulbosa var. lushii (Plate VII, Fig. 31, Plate VIII, Fig. 45; Text Fig. XVI, Fig. 3, Text Fig. XVII, Fig. 3)

The stem anatomy of this variety is similar to C. bulbosa var. bulbosa. The diameter of stem varies from 1.5 to 2.5 mm. T.S. of stem is more or less circular in outline with undulating epidermis. Trichomes are absent. The epidermis is single layered made up of rectangular cells. The outer walls of the cells are thickened. The stomata are found in epidermis. The epidermal cells varies from 9.5 x 19 um. The hypodermis is not distinct however the subepidermal cells are small and contain few chloroplasts. The cortex can be divided into outer cortex and inner cortex. The outer cortex is about 10 layered. The cells of outer cortex are large, enclose intercellular spaces and contain chloroplasts. Inner cortex consists of patches of few small fibres alternating with patches of parenchyma. Just below inner cortex there is narrow ring of phloem. There is distinct cambium inbetween xylem & phloem. The sec-xylem consists

of a narrow ring of vascular elements. Secondary xylem is composed of fibres, tracheids, few vessels and xylem parenchyma. Inside secondary xylem there is development of distinct internal phloem. The pith is large and made of cells of varying size, enclosing intercellular spaces and contain chloroplasts.

The stem anatomy reveals that the stem contain little mechanical tissue and secondary xylem and is mainly composed of parenchyma containing chloroplasts indicating its succulent nature and photosynthetic function.

4. C. hirsuta (Plate VII, Fig. 33, Plate VIII, Fig. 46; Text Fig. XVI, Fig. 4, Text Fig. XVII, Fig. 4)

It is a climbing species. The diameter of the stem varies from 2.1-2.3 mm. T.S. of stem is circular in outline with slightly undulating epidermis. Some of the epidermal cells produce trichomes. The trichomes are uniseriate hairs with bulbous base covered with overarched epidermal cells or they are produced by single epidermal cells. The epidermis is single layered made up of oval cells. The outer wall of epidermal cells are covered with cuticle which is papillate. The cells varies in size from 9.5-14.8 x 9.5-19 μ m. Just below epidermis there is indistinct single hypodermal layer consisting of chlorenchymatous rectangular cells. The cortex may be divided into two distinct zones. The outer cortex is about 7 layered made up of oval cells enclosing intercellular spaces and cells contain few chloroplasts and starch grains. Inner cortex is made up of fibre patches forming more or less a continuous cylinder except few

parenchymatous cells separating the fibre patches. The cell-walls of fibre cells are mostly composed of cellulose. Inside cellulosic fibre patches there are 1-2 layers of large parenchymatous cells which are packed with starch grains. Just below inner cortex there is phloem. The laticiferous cells are associated with secondary phloem & inner cortex. There is distinct cambium inbetween secondary xylem & secondary phloem. The sec. xylem consists of fibres, tracheids & few vessel. The fibres and tracheids are arranged in regular rows alternating with each other. Late xylem produces few vessels. Secondary xylem forms a uniform cylinder around pith. The intraxylary phloem patches are observed in pith. The pith is composed of large parenchymatous cells which are packed with starch grains.

5. C. huberi (Plate VII, Fig. 34, Plate VIII, Fig. 47; Text Fig. XVI, Fig. 5, Text Fig. XVIII, Fig. 5)

It is a climbing species. The stem varies in diameter from 1.9 - 2.1 mm. T.S. of stem is circular to oval in outline with slightly undulating epidermis Trichomes are absent on the epidermis. Epidermis is single layered made up of rectangular to oval cells. The outer tangential walls of epidermis show deposition of papillate cuticle. Hypodermis is distinct, single layered made up of rectangular cells. Cortex may be divided into two region. The outer cortex is about 6 layered made up of angular cells enclosing intercellular spaces & contain few chloroplast. Inner cortex consists of 1-3 layers of fibres and form more or less continuous thin cylinder around inner

cortex however this continuity is broken by few parenchymatous cells. Below fibre patches there are 1-2 layers of large parenchymatous cells which contain starch grains. Laticiferous cells are associated with inner cortex & phloem. There is cambium ring inbetween xylem and phloem. Secondary xylem consists of fibres, tracheids & vessels. Tracheids alternate with fibres & they are arranged in rows. There are patches of intraxylary phloem inside the secondary xylem in pith. Pith is made up of large parenchymatous cells which contain starch grains. Laticifers are also observed around internal phloem and outer region of pith.

6. C. jainii (Text Fig. XVI, Fig. 6, Text Fig. XX, Fig. 13)

It is an erect species. The stem varies in diameter from 1-2 mm. T.S. of stem is circular in outline with slightly undulating epidermis. Some of the epidermal cell produce stout uniseriate straight or slightly curved trichomes 2-5 cell in height. Epidermis is single layered made up of oval cells. The outer tangential walls of the epidermal cells are covered with thick cuticle. There is indistinct hypodermis. Cortex can be divided into two regions. Outer cortex is made up of parenchymatous cells containing chloroplasts. In inner cortex there are patches of fibres mixed with large parenchymatous cells which contain starch grains. The cells of fibres are comparatively large. Inside cortex there is phloem which is associated with laticiferous cells. The xylem is differentiated in two groups opposite to each other while in intermediate region between two xylem regions is composed of poorly

differentiated xylem elements. Xylem consists of tracheids, few metaxylem & fibre. Inside xylem cylinder there are patches of internal phloem. The pith is made up of parenchyma containing large number of starch grains.

7. C. juncea (Plate VII, Fig. 35, Plate VIII, Fig. 48; Text Fig. XVI, Fig. 7)

It is a stem succulent climber. The stem varies in diameter from 3.5-4.5 mm. T.S. of stem is circular to oval in outline. The epidermis is single layered. Continuity of epidermis is broken by presence of stomata. The outer tangential walls are thick walled and show papillate cuticle. There is indistinct hypodermis. The cortex is about 11 layered and constitute major bulk of stem tissue. The cortex is made up of large parenchymatous cells enclosing intercellular spaces. The cells contain chloroplast. There are no fibre patches in cortex. The vascular cylinder is highly reduced. Few vascular elements are poorly developed in ring. Pith is made up of large parenchymatous cells enclosing of lot of intercellular spaces and contain chloroplast. Laticiferous cells are distributed in pith & are also associated with secondary phloem. The starch deposition is poor in stem tissue.

The succulent nature of stem is well seen by presence of large cortex and pith, poorly developed vascular tissue & the presence of chloroplasts in all the parenchymatous of stem cells indicate photosynthetic nature of the stem.

8. C. maccannii (Plate VII, Fig. 32, Plate VIII, Fig. 49; Text Fig. XVI Fig. 8, Text Fig. XVIII, Fig. 6)

It is an erect species of Ceropegia. The stem varies in diameter from 3-4 mm. It is circular to quadrangular in shape. T.S. of stem show single layered epidermis made up of barrel shaped cells about 21 x 42 μ m in size. Few scattered hairs 1-3 cell in height are produced by few epidermal cells. The outer tangential walls of epidermis are covered with cuticle. The hypodermis is indistinct. The outer cortex is 7-10 layered in thickness made up of oval elongated cells containing few chloroplasts. Inner cortex consists of patches of fibre alternating with parenchymatous patches. The walls of fibres are of cellulose. Innermost 2-3 layers of cortex are made up of large parenchymatous cells which enclose large intercellular spaces & contain few starch grains. Just inside inner cortex there is phloem. Laticiferous cells are found scattered in phloem & inner cortex. Secondary growth is well marked in the species. The primary xylem elements are larger in size while later vascular elements are smaller in size arranged in radial rows & mostly composed of tracheids & fibres. Few vessel elements are also produced in secondary xylem. Secondary xylem forms a continuous uniform ring. Well marked intra-xylary phloem is developed inside secondary xylem in pith. Some scattered laticiferous cells are observed in the pith. Pith is made up of large parenchymatous cells enclosing large intercellular spaces and containing few starch grains.

9. C. media (Plate VII, Fig. 39, Plate VIII, Fig. 50; Text Fig. XVI, Fig. 9, Text Fig. XVIII, Fig. 7)

It is a climbing species. The stem diameter varies in size from 2-2.5 mm. T.S. of stem is circular to subquadrangular in shape with undulating epidermis. Epidermis is single layered with few small 1-3 celled hairs. The epidermal cells are oval to barrel-shaped ranging in size from 14.3-28.5 μ m. The outer walls of epidermis are thickened. The cortex is 6-7 layered made up of large parenchymatous cells and inner cells of cortex contain starch grains. Middle of cortex consists of fibres alternating with parenchymatous patches. Innermost 2-3 layers of cortex are made up of large parenchymatous cells enclosing intercellular spaces. Inner to cortex there is distinct phloem. The phloem and inner cortex is associated with laticiferous cells. There is distinct secondary growth. The vascular cylinder is comparatively small and little more growth is seen at four opposite regions. The primary xylem consists of large metaxylem which goes on decreasing in size as secondary growth takes place. Few vessel elements are developed at opposite regions. At four opposite regions distinct prominent interxylary phloem development is observed. In remaining portion there is poor development of interxylary phloem. Pith is made up of large parenchymatous cells enclosing large intercellular spaces.

10. C. noorjahaniae (Plate VII, Fig. 36, Plate VIII, Fig. 51; Text Fig. XVI, Fig. 10, Text Fig. XVIII, Fig. 8)

It is an erect species but occasionally shows climbing habit.

The stem varies in diameter from 1.8-2 mm. The epidermis is single layered made up of rectangular cells varying in size from 9.52-11.4x19um. The outer tangential walls show thick cuticle. The outer cortex is 3-5 layered made up of oval parenchymatous cells. The outer cells of outer cortex are smaller and contain chloroplasts while inner cells are larger and contain starch grains. In middle of cortex are seen prominent patches of fibres alternating with parenchymatous patches. The cellwall fibres are thickened and are of cellulose. The inner 3-4 layers of cortex are made up of parenchymatous cells enclosing intercellular spaces and contain abundant starch grains. Just inside the inner cortex are seen phloem patches which are associated with laticiferous cells. There is distinct secondary growth. Primary metaxylems are large in size arranged in radial rows while secondary xylem consists of fibres, tracheids & few vessels mostly developed on two opposite sides. Interaxylary phloem patches are well developed in pith inside xylem cylinder. Pith is made up of parenchymatous cells enclosing inter-cellular spaces & contain abundant starch grains. Laticiferous cells are also observed in pith region.

11. C. oculata (Plate VII, Fig. 38, Plate IX, Fig. 52; Text Fig. XVI, Fig. 11, Text Fig. XIX, Fig. 9)

It is a climbing species. The diameter of stem varies from 3-3.2 mm. T.S. of stem is circular in outline with slightly undulating epidermis. Epidermis produces uniseriate trichomes 3-7 cell in length. The base of trichome is covered with surrounding epidermal cells. The epidermal cells are barrel shaped. The outer wall of epidermis is cutinized and cuticle show slight papillation.

Hypodermis is single layered made up of thick walled barrel shaped cells. The outer cells of outer cortex are thick-walled collenchymatous and smaller in size containing few chloroplasts. The inner cells of outer cortex are larger and are packed with starch grains. Middle cortex consists of patches of fibres alternating with parenchymatous cells. The inner 2-3 layers of cortex are made up of larger parenchymatous cells with intercellular spaces. Inside cortex there is phloem. The phloem and inner cortex is associated with many laticiferous cells. Inside phloem there is distinct cambium and secondary growth. Vascular cylinder is narrow. Vascular elements are more developed in four opposite decussate leaves. Primary xylem is made up of small protoxylem and large metaxylem. The latter elements are smaller in size and consists of mainly tracheids, fibres and few vessels. Vessels are usually developed at 4 opposite corners. Similarly there are 4 prominent patches of interxylary phloem inside each prominent patch of xylem. The pith is made up of large parenchymatous cells enclosing air spaces and containing few starch grains. Laticiferous cells are also observed in pith.

12. C. sahyadrica (Plate VII, Fig. 41, Plte IX, Fig. 53; Text Fig. XVI, Fig. 12, Text Fig. XIX, Fig. 10)

It is an erect and most robust species among the species studied. The diameter of the stem varies from 0.8 to 1.2 cm. T.S. of stem is circular to bluntly quadrangular. The epidermis is single layered with slightly thickened outer walls. The epidermal cells are 21-42 x 21 um without any epidermal outgrowth. The cortex is

massive about 11 layered made up of large parenchymatous cells with large intercellular spaces. The cells are rounded to oval in shape. In the middle of cortex there are several patches of fibres interrupted by parenchymatous cells. Comparatively fibre development is poor. Below fibre patches there are 4 layers of parenchyma with intercellular spaces without starch grains. Laticifers are more numerous between fibre patches & phloem. Below cortex are seen intact patches of primary phloem followed by secondary phloem. Laticiferous cells are found associated with phloem. There is distinct secondary growth in this species. Vascular cylinder consists of protoxylem, metaxylem and the secondary xylem consists of small sized fibres, tracheids and few vessel elements. Fibres and tracheids are found in radial rows. Inside protoxylem are seen well developed patches of interxylary phloem. The pith is large made up of parenchymatous cells enclosing intercellular spaces and contain no starch grains.

13. C. vincaefolia (Plate VII, Fig. 37, Plate IX, Fig. 54; Text Fig. XVI, Fig. 13, Text Fig. XIX, Fig. 11)

It is a climbing species. The diameter of stem varies from 3-6 mm. T.S. of stem is circular in outline with slightly undulating epidermis. Epidermis is single layered made up of barrel shaped cells. The outer tangential walls of the epidermis are cutinized and show single raised papillae per cell. Outer cortex is 7-8 layered made up of parenchymatous cells enclosing small intercellular spaces and contain starch grains. Middle of cortex consists of patches of

fibres alternating with parenchymatous cells. Innermost cortex is 1-2 layered made up of parenchymatous cells similar to outer cortex and are packed with starch grains. Few laticiferous cells are found associated with inner cortex and phloem. There is little secondary growth. Below cortex there is phloem. There is distinct cambium. The xylem cylinder is composed of protoxylem, metaxylem and little amount of secondary xylem consisting of fibres, tracheids and no vessels. Inside the protoxylem, patches of interxylary phloem are well developed. Pith is comparatively smaller in size made up of parenchymatous cells containing starch grains. There are few scattered laticifers in outer region of pith.

14. Brachystelma edulis (Plate VII, Fig. 40, Plate, IX, Fig. 55; Text Fig. XVI, Fig. 14, Text Fig. XIX, Fig. 112)

It is an erect species. The diameter of stem varies from 1.6 to 2 mm. T.S. of stem is circular to elliptic in outline. The epidermis is single layered made up of oval to rectangular cells ranging in size from 9.5-14.3 x 14.2-19 μ m. Some epidermal cells produce trichomes 1-3 cell in height. The outer tangential walls of epidermis are covered with cuticle which is smooth. There is no distinct hypodermis. The cortex is 10-12 layered made up of parenchymatous cells which enclose intercellular spaces and contain chloroplasts. In inner cortex there are either isolated fibres or patches of fibres separated from each other by parenchymatous cells. Distinct patches of primary phloem are seen just below the cortex. Few laticiferous cells are seen associated with phloem. Just below the primary phloem is seen secondary phloem. Xylem cylinder

consists of fibres, tracheids and few vessels. Inside vascular cylinder there are patches of secondary phloem in the pith region. Pith is made up of large parenchymatous cells enclosing intercellular spaces. Many laticiferous cells are also observed in pith. The cells of cortex or pith do not contain starch grains.

15. B. species (Plate VII, Fig. 42, Plate IX, Fig. 56; Text Fig. XVI, Fig. 15, Text Fig. XX, Fig. 14)

It is an erect species. The stem diameter varies from 1.8 to 2.1 mm. T.S. of stem is circular in outline with undulating epidermis. The epidermis produces 1-2 celled trichomes. The epidermal cells are radially elongated. Outer tangential walls are covered with cuticle. The epidermal cell varies from 14.31-19 x 9.5-19 μm in size. The outer cortex is 6-7 layered made up of parenchymatous cells enclosing intercellular spaces and contain chloroplasts. Middle of cortex consists of almost continuous layer of fibre cells mixed with parenchymatous cells. The inner cortex is 1-3 layered made up of parenchymatous cells enclosing intercellular spaces. Few laticiferous cells are found scattered in inner cortex. Just below inner-cortex, distinct patches of primary phloem are observed. The secondary growth is observed. Differentiation of tissue is irregular i.e. in some regions xylem is well developed while at other places phloem is developed well. Secondary xylem consists of a narrow ring of vascular elements such as protoxylem, metaxylem, fibres, tracheids and few vessels. Just below protoxylem there is development of distinct patches of interxylary phloem in pith. Pith is made up of parenchymatous cells which enclose intercellular spaces and few laticiferous cells.

From comparative account of stem anatomy, it is clear that the gross anatomy of stem remain same in all the species of Ceropegia. Variations in cortex, fibre patches and secondary growth is observed. Similarly some species show uneven secondary growth. In some species the parenchyma contains starch grains while other lack starch grains. Similarly gross anatomy of stem of Ceropegia and Brachystelma is similar and indicate their closeness.

PLATE - VII : Figs. 29-42 : Showing stem anatomy of Ceropegia
Brachystelma species

T. S. of stem :

- Fig. 29 : C. attenuata x 33
- Fig. 30 : C. bulbosa var. bulbosa x 33
- Fig. 31 : C. bulbosa var. lushii x 28
- Fig. 32 : C. maccannii x 10
- Fig. 33 : C. hirsuta x 29
- Fig. 34 : C. huberi x 28
- Fig. 35 : C. juncea x 28
- Fig. 36 : C. noorjahaniae x 28
- Fig. 37 : C. vincaefolia x 28
- Fig. 38 : C. oculata x 28
- Fig. 39 : C. media x 28
- Fig. 40 : Brachystelma edulis x 28
- Fig. 41 : Ceropegia sahyadrica x 10
- Fig. 42 : Brachystelma species x 28

PLATE - VIII : Figs. 43-51 : Showing stem anatomy of Ceropegia species.

T. S. of stem :

Fig. 43 : C. attenuata x 113

Fig. 44 : C. bulbosa var. bulbosa x 113

Fig. 45 : C. bulbosa var. lushii x 113

Fig. 46 : C. hirsuta x 113

Fig. 47 : C. huberi x 113

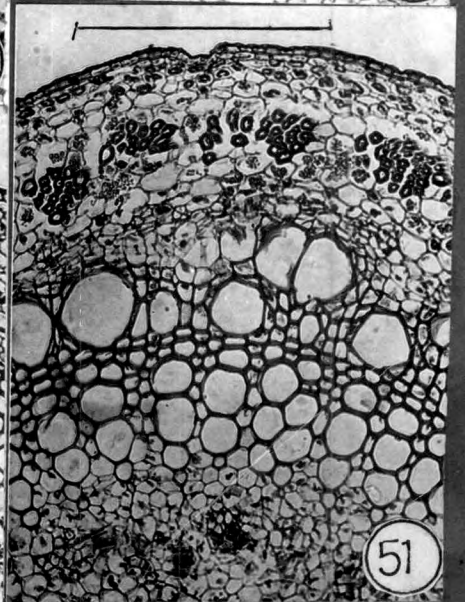
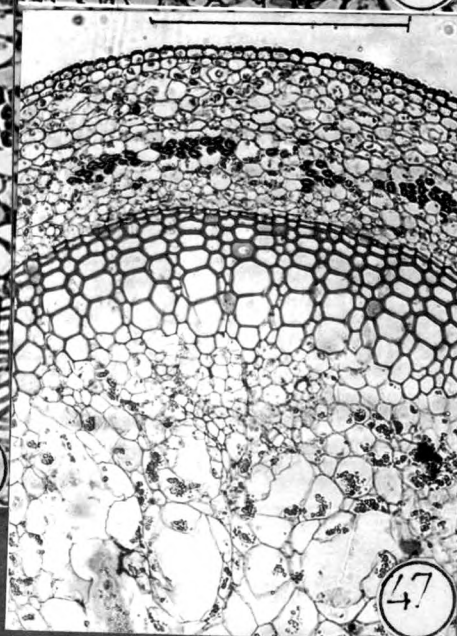
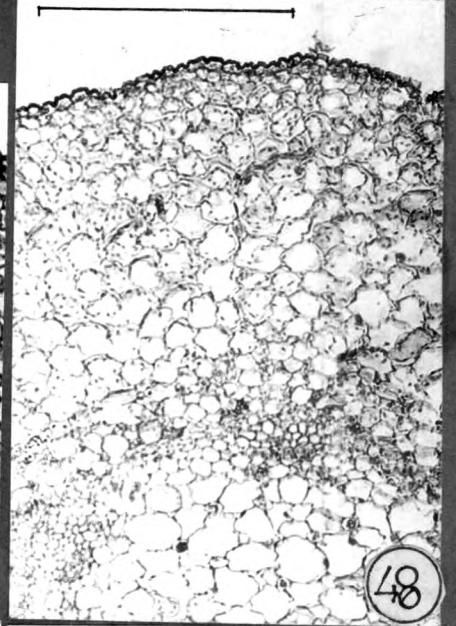
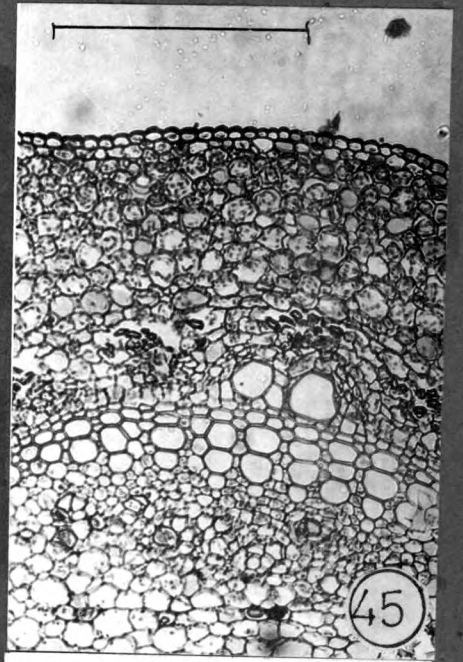
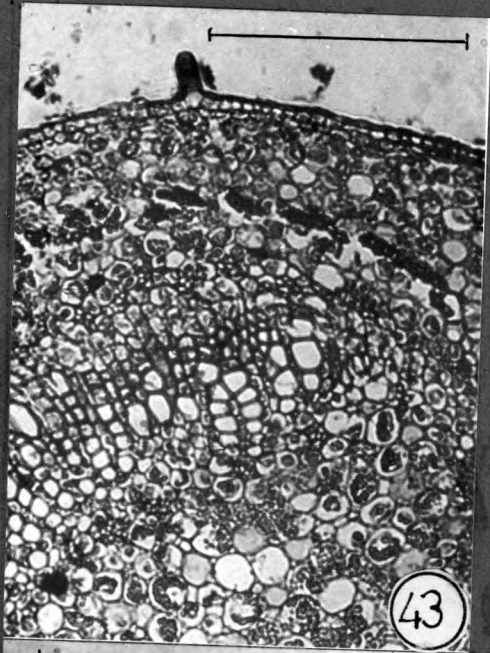
Fig. 48 : C. juncea x 113

Fig. 49 : C. maccannii x 113

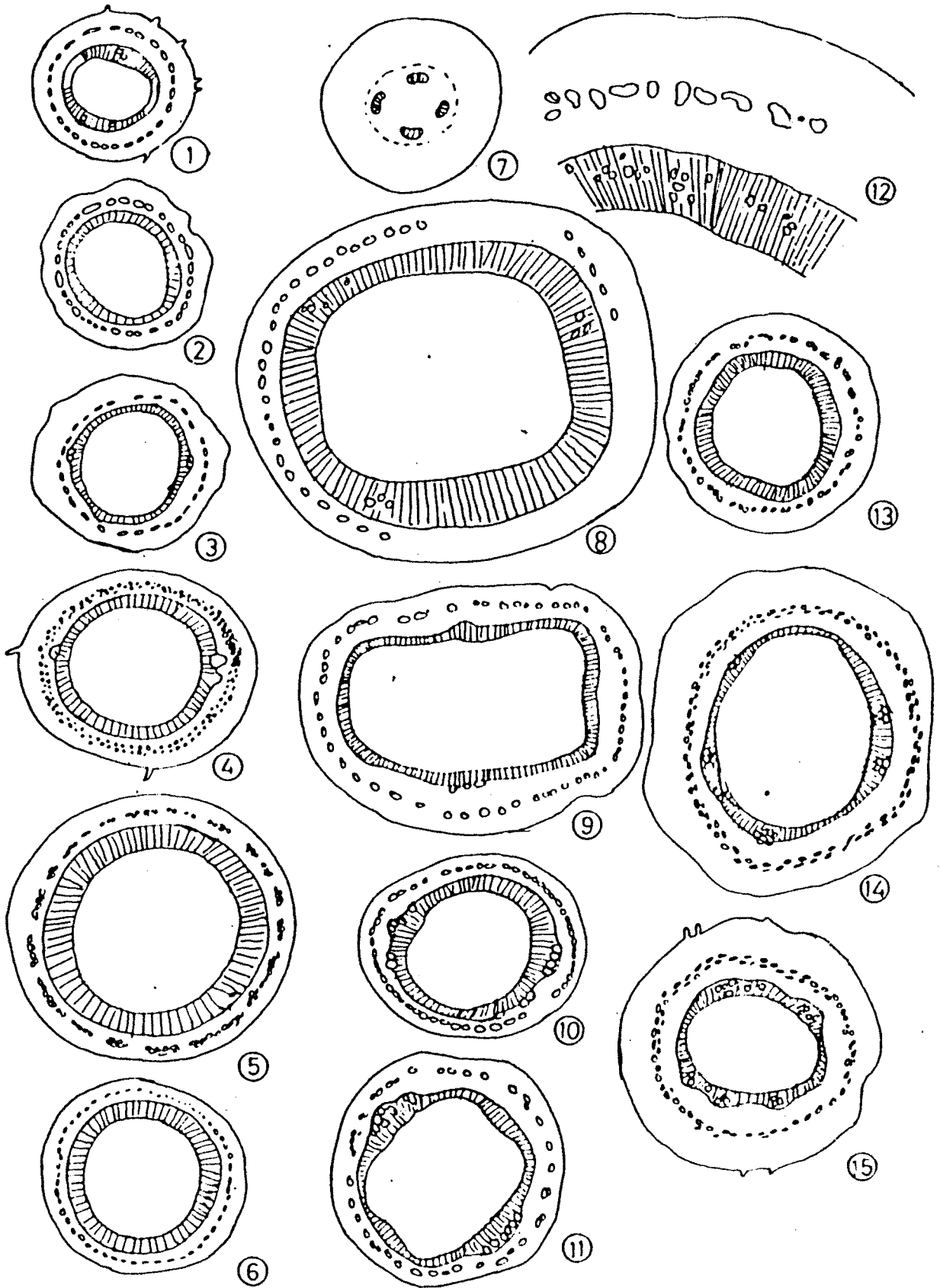
Fig. 50 : C. media x 113

Fig. 51 : C. noorjahaniae x 113

PLATE VIII.



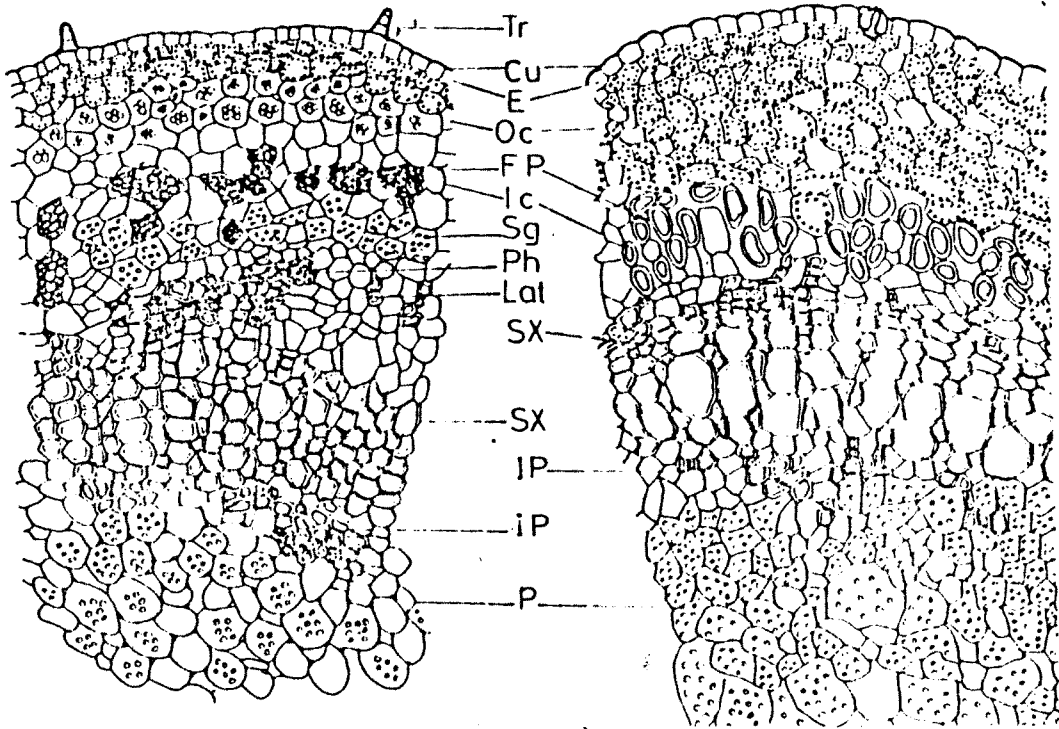
Text figure XVI



Figs 1-15: *Ceropogia attenuata* 2 *C. bulbosa* var. *bulbosa* 3 *C. b* var. *lus hii* 4 *C. hirsuta* 5 *C. huberi*
 6 *C. jaini* 7 *C. juncea* 8 *C. maccanni* 9 *C. media* 10 *C. nairjhanvii* 11 *C. oculata*
 12 *C. sahyadrica* 13 *C. vinayakia* 14 *Brachystelma edulis* 15 *B. sp.*

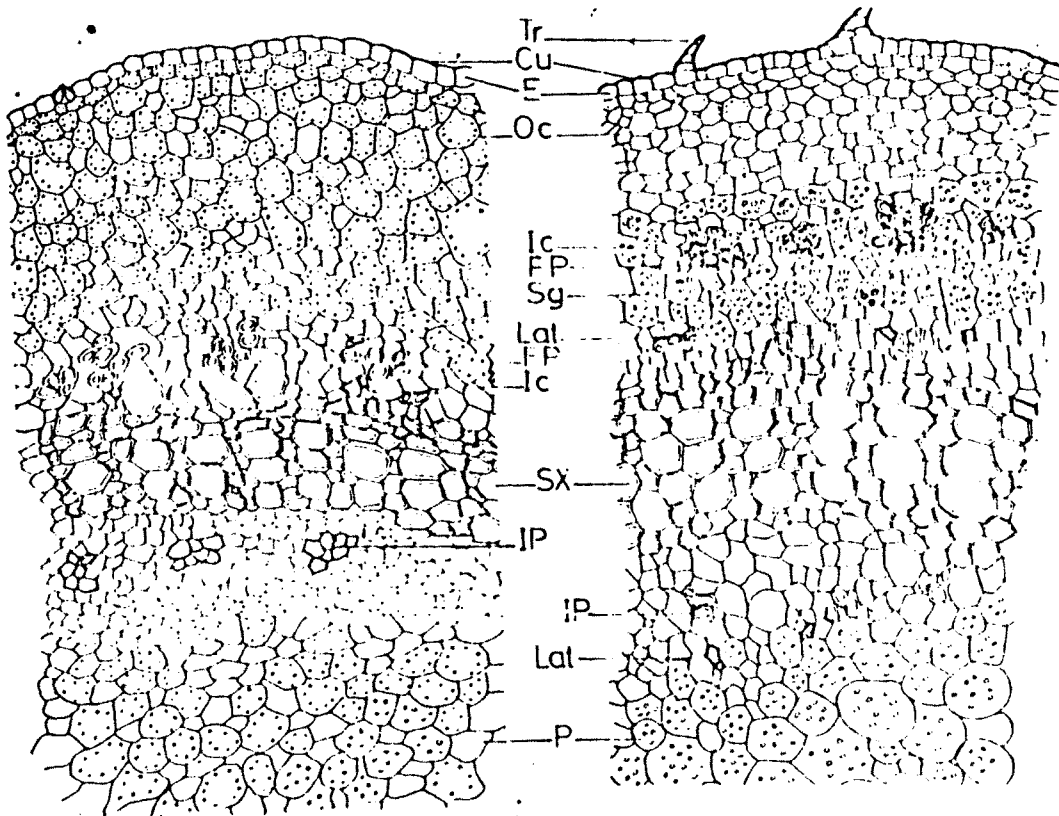
T. S. of stem Fig. 8 X 5 & Figs. 1-15 X 25

Text figure XVII



1 *C. attenuata*

2 *C. bulbosa* var. *bulbosa*



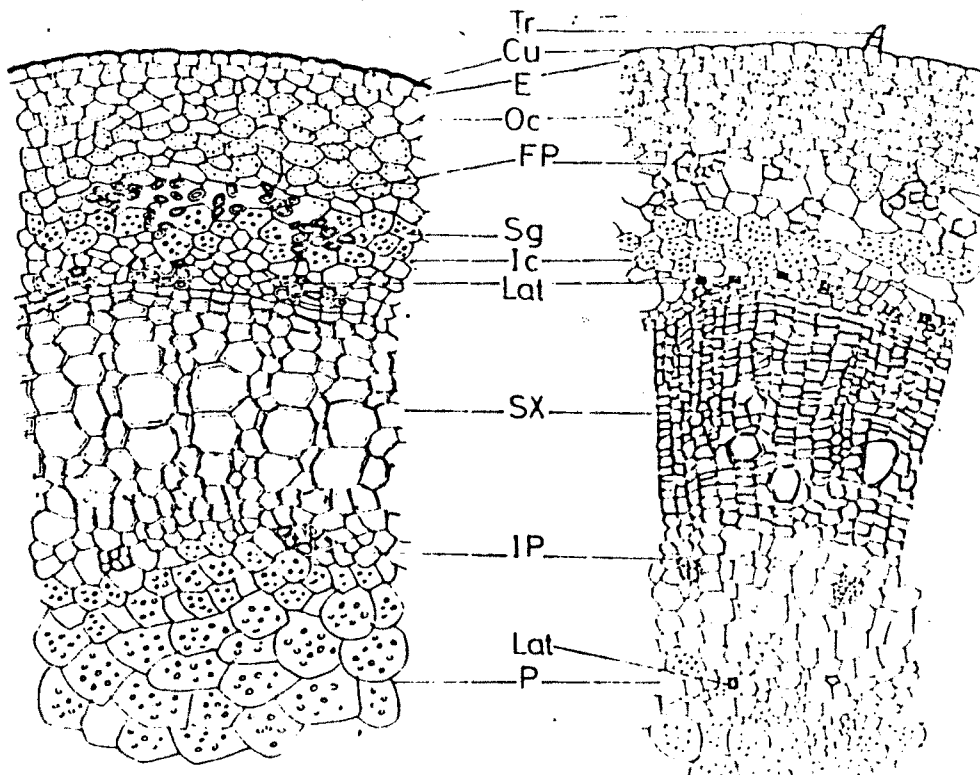
3 *C. bulbosa* var. *lus. hii*

4 *C. hirsuta*

T. S. of stem Figs. 1-4 X 150

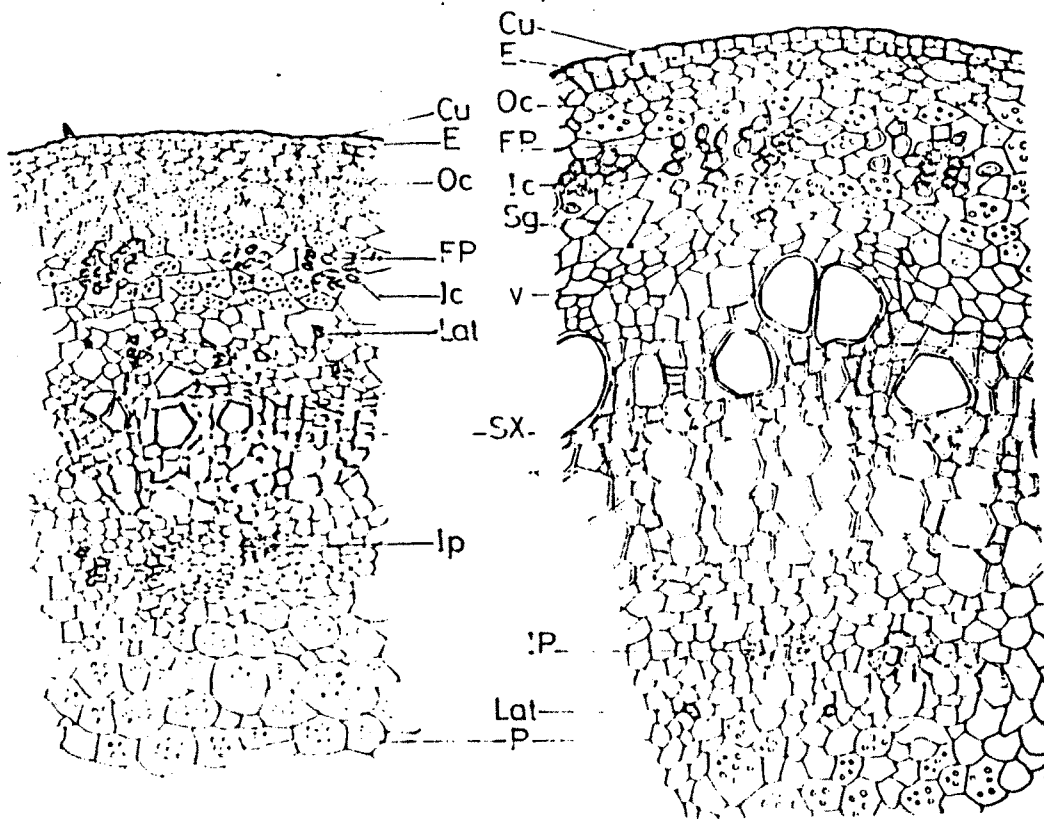
(Tr-Trichome, Cu-Cuticle, E-Epidermis, Oc-Outer cortex, FP-Phloem fibres, Ic-Inner cortex, Sg-Starch grains, Ph-Phloem, Lat-Laticifers, SX-Secondary xylem, IP-Internal phloem, P-Pith.)

Text figure XVIII



5 *C. huberi*

6 *C. maccunnii*

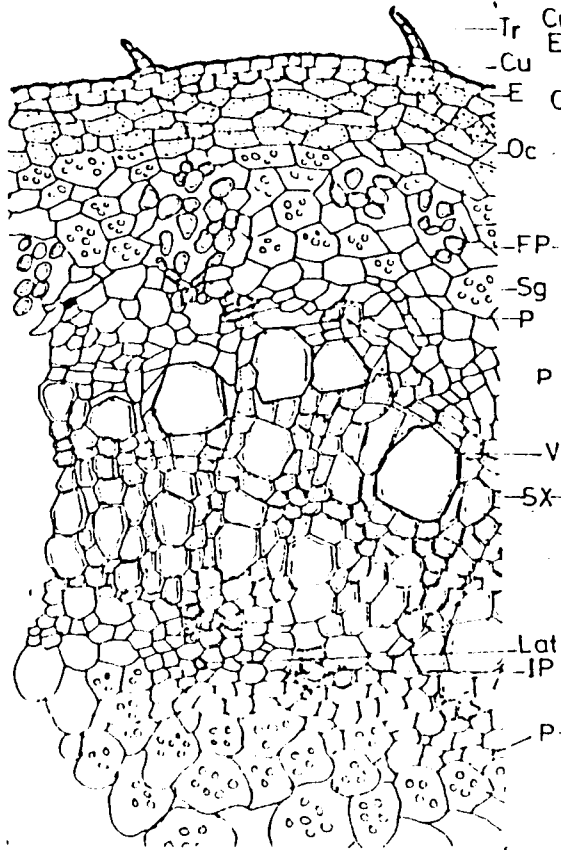


7 *C. media*

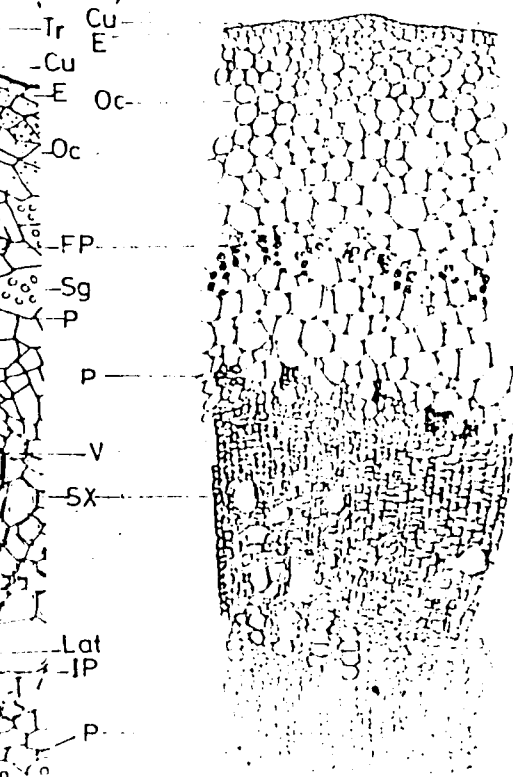
8 *C. noorjahnicae*

T. S. of stem Figs 5-8 X 150

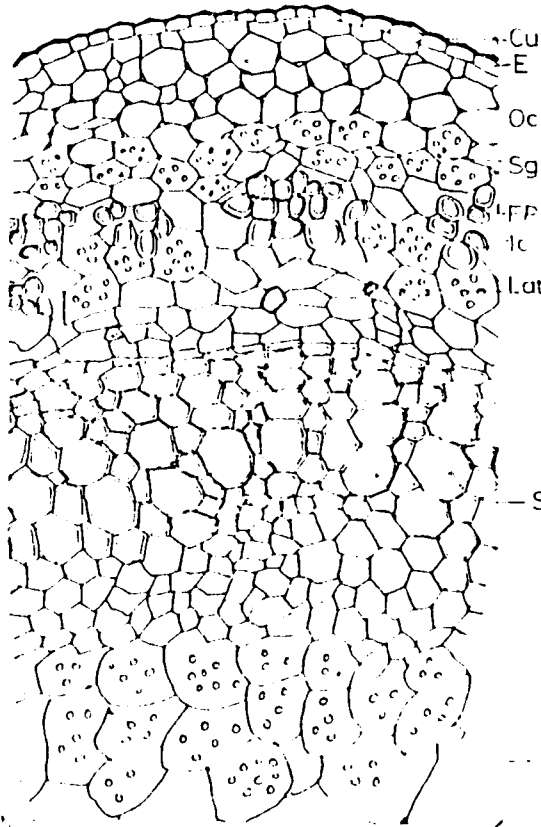
Text figure XIX



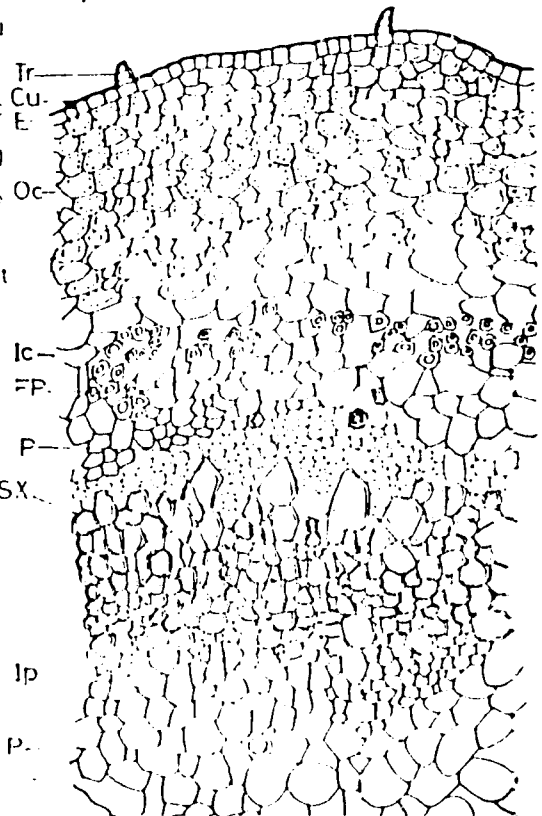
9 *C. oculata*



10 *C. sahyadrica*



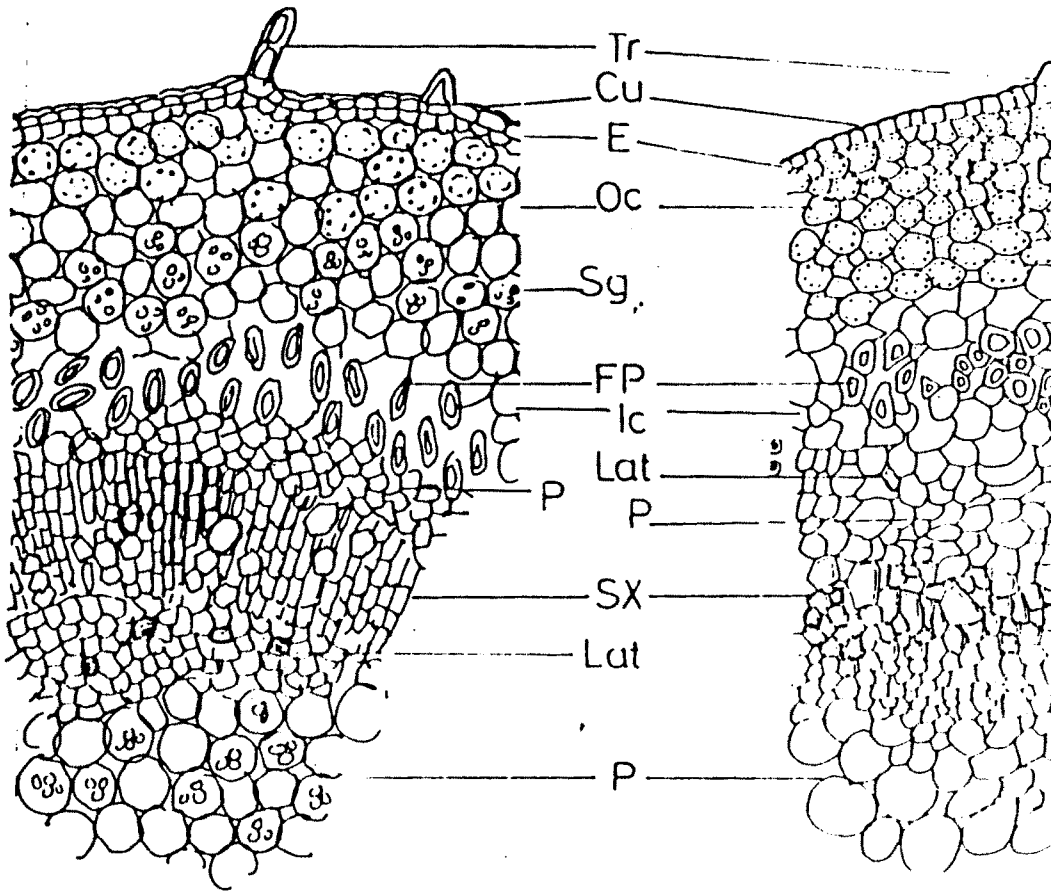
11 *C. vincaefolia*



12 *Brachystelma edulis*

T. S. of stem Figs. 9-12 X 150

Text figure XX



13 C. jainii

14 Brachystelea

T. S. of stem Figs. 13-14 X 150

6 Comparative account of anatomical characters of stem of various species of *Ceropegia* and *Brachystelma*

	<i>Ceropegia</i> <i>attenuata</i>	<i>C. bulbosa</i> var. <i>bulbosa</i>	<i>C. b. var.</i> <i>lushii</i>	<i>C. hirsuta</i>	<i>C. huberi</i>	<i>C. juncea</i>	<i>C. maccaniffi</i>	<i>C. media</i>	<i>C. noorjahaniae</i> <i>oculata</i>	<i>C. sahyadrica</i>	<i>C. vincaefolia</i>	<i>Brachystelma edulis</i>	<i>Brachystelma</i> <i>species</i>
1. Diameter of stem (mm)	0.8-1.7	1.5-2.6	2.2-5	2.1-2.3	1.9-2.1	3-5	3-4	2-2.5	1.8-2	8-12	3-6	1.6-2	1.8-2.1
2. Size of epidermis (um)	9.51-11.4 9.51-14.31	14.31-19 14.2-21.85	9.51-19.04	9.52-14.3 9.51-19.04	9.51x14.31	14.3-19.4 9.51-19.4	21x42	14.31x28.5	9.51-11.4 x 19	21.42x21	9.51-14.31 x 23.81	9.51-14.31 x14.31-19	14.3-19 x 9.51-19
3. Thickness of (um) outer cortex	144-171	144-161	124-138	162-181	86.1-105	219-409	210-336	152-171	48-67	210.336	171-190	333.1-371	171-190
4. Thickness of fibrous patches	38-48.1	36-67.1	38-48.1	67-86.1	19-48.1	19.4-38	84-168	38-76	57-67.1	840-882	67-86	48.1-67.1	48.1-86.1
5. Phloem thickness (um)	76-86.1	29.1-48.1	29.1-38	48.1-67.1	38-48.1	67.1-86.1	63-84	67.1-76	48.1-57	168-210	38-87.1	67.1-76	67.1-86.1
6. Thickness of cortex	247-268	209-256.5	190-285	218.5-313.5	142.5-181.1	380-456	462-504	342-380	171-219.1	1680-1764	323-361	333.1-380	352.1-399
7. Thickness of vascular cylinder (um)	143.1-162.1	86.1-124.1	29.1-144	105.1-144	152-181.1	29.1-38	294-420	38-200	133-333.1	840-1050	165.1-177	38-133	48.1-143.1
8. Thickness of internal phloem (um)	29.1-48.1	162.1-171	76-144	67-133	105.1-152	19-29.1	210-294	124.1-152	105.1-133	210-294	105.1-124.1	67.1-86.1	29.1-67.1
9. Diameter of pith (um)	238.1-257.1	285-475	523.1-808.1	874-903.1	713.1-855	428.1-475	1848-2436	874-912	684-713.1	4200-4536	760-836	570-627	590-618
10. Epidermal outgrowth present or absent	+	-	-	+	-	-	+	-	+	+	-	+	+
11. Vessels present or absent	+	-	+	+	-	-	+	+	+	+	-	+	+
12. Diameter of um vessel	29.1-38	-	48.1-76	58	-	-	84-168	38-48.1	38-76	42-105	-	19.33	24.38

Present +
Absent -

II) Petiole

1) Ceropegia attenuata (Plate X Fig. 57; Text Fig. XXI Fig. 1)

Transverse section of the petiole shows concavoconvex outline. Diameter of the petiole varies from 0.4 - 0.5 mm. The epidermal cells are thick walled & barrel shaped. The epidermal cells in ventral furrow are comparatively larger than the cells of other region. The cells are covered with cuticle. Some of the epidermal cell elongate to form uniseriate, multicellular trichomes 2-4 cell long. The epidermis is followed by 2-4 layers of collenchyma and rest of the layers are parenchymatous. The stele consists of 3 vascular bundles. The central bundle is the largest and crescent shaped while other two are much smaller. The starch is present below phloem and around lateral vascular bundles. The xylem occupies the central position of the bundle, consisting of vessels, tracheids & parenchyma. Phloem patches surround the xylem. Laticifers are found associated with phloem and also distributed in parenchyma.

2) C. bublosa var. bulbosa (Text Fig. XXI. Fig. 3)

Transverse section of the petiole shows concave convex outline. Diameter of petiole varies from 1.30 - 1.40 mm. Single layered epidermis is made up of cubical cells covered with cuticle on outer surface, cell walls are thick. Trichomes are absent on epidermis. The epidermis is followed by 2-3 layered collenchyma and rest of the layers are parenchymatous. Most of the tissue of petiole is parenchyma and this parenchyma contain chloroplasts. The stele

consists of three vascular traces. The central bundle is the largest and crescent shaped while two lateral bundles are small. The xylem occupies the central position of the bundle which is surrounded by phloem patches. The laticifers are found distributed in parenchyma, however many of them are found associated with ventral phloem below groove region. Major tissue of petiole is chlorenchyma.

3) C. bulbosa var. lushii (Plate X, Fig. 61;

Text Fig. XXI, Fig. 6)

Transverse section of petiole is 'V' shaped. The epidermis is single layered made up of cubical thick walled cells. The epidermal cells in furrow region are larger than on convex side of petiole and are covered with cuticle. There are three vascular bundles. The central is large and crescent shaped while lateral are small, rounded. Xylem of central bundle consists of 8-12 rows of tracheids. Xylem is surrounded by patches of phloem. Laticifers are found associated with phloem however few are found in parenchyma. Major tissue of petiole is chlorenchyma.

4) C. hirsuta (Plate X, Fig. 62; Text Fig. XXI, Fig. 7)

Tranverse section of the petiole shows concaveconvex outline. The diameter of the petiole varies from 1.5 - 1.6 mm. The epidermis is uniseriate and cells are rectangular in outline with thin radial and thick tangential walls. Some of the epidermal cells produce 5-15 celled, uniseriate, nonglandular trichomes. Outer walls of epidermis are covered with cuticle. Epidermis is followed by 2-4 layered

collenchymatous cells in ventral corners of petiole and 2-3 layered in other parts. There are three vascular traces. The lateral one are small and rounded. Medium bundle is large crescent-shaped. Xylem occupies the central position of the bundle and consists of 14-17 rows of tracheids, phloem patches surround the xylem. Very few laticifers are observed around phloem. Other layers consists of parenchyma.

5) Ceropegia huberi (Plate X Fig. 60; Text Fig. XXI, Fig. 2)

Transection of the petiole shows 'V' shaped outline. The diameter of petiole varies from 1.5 - 2 mm. The epidermis is single layered, the epidermal cells along concave side are larger as compared to other epidermal cells. Epidermal cells are covered with cuticle on outer surface. Hypodermis is 3-4 layered in ventral corners, while 2-3 layered in other regions composed of collenchymatous cells. Vascular traces - 3, the central large crescent shaped. Xylem occupies the central position, which is surrounded by phloem patches. On dorsal side and outside phloem the row of parenchymatous cells contain starch grains and form sheath. On lateral side there are two small rounded vascular bundles which are also surrounded by Starch Sheath. Sometimes two additional vascular bundles are found. The other part of petiole is made up of parenchyma and the cells in ventral region of petiole contain starch grains. Laticifers are more common below groove associated with phloem.

6) C. jainii

Transverse section of petiole shows concavoconvex outline. Epidermis is single layered made up of cubical cells whose outer walls are thickened. Some of epidermal cells form uniseriate 2-3 called

trichomes. Epidermis is followed by 2-3 layered collenchymatous-cells and rest of the layers are parenchymatous. The stele consists of crescent shaped median vascular bundle and small round lateral bundles. The xylem of median bundle occupies the central position and is surrounded by phloem. The lateral bundles are small and contain few tracheids. Laticifers in single are present in the cortex and associated with phloem region. The parenchyma containing starch grains completely encircle lateral bundles while it is found only below lower phloem in central bundle.

7) C. juncea

It is stem succulent plant and leaves are very much reduced and sessile. T.S. of basal portion of leaf is concaveconvex in shape. Epidermis is single layered with cuticle on their outer walls. There is no distinct hypodermal collenchyma. The stele consists of single crescent shaped vascular bundle. The xylem lies in the centre which is surrounded by phloem. There are no lateral bundles and also starch is lacking. Most of the tissue of petiole is chlorenchyma. Laticifers are more numerous lying outside phloem and in region.

8) C. maccannii (Plate X, Fig. 63, Text Fig. XXI, Fig. 4)

Trans-section of the petiole shows concavoconvex outline. Single layered epidermis is made up of thick walled cubical cells covered with cuticle on outer walls. Some of the epidermal cells produce uniseriate multicellular trichomes 2-3 cell long. Epidermis

is followed 2-4 layers of collenchyma and rest of the layers are parenchymatous. The stele consist of crescent shaped central vascular bundle consisting of 8-10 rows of tracheids; the two lateral are small and round. Xylem at the centre of vascular bundles are surrounded by starch sheath while in central bundle the parenchymatous cells containing starch are found below dorsal phloem. Few laticifers are found associated with phloem.

9) C. media (Plate X, Fig. 64, Text Fig. XXI, Fig. 9)

T.S. of petiole is 'V' shaped and diameter of petiole varies from 1.5 - 2.5 mm. Single layered epidermis is made up of cubical cells covered with cuticle on outer face. Some of the epidermal cells produce uniseriate hairs. Epidermis is followed by 2-4 layers of collenchymatous layers. The stele consists of three vascular traces. The median bundle is crescent shaped consisting of central xylem surrounded by phloem patches. Xylem of central bundle consists of 13-15 rows of tracheids. The lateral vascular bundles are round and are encircled by a sheath of parenchyma containing starch grains. Below crescent shaped central bundle there is a row of parenchyma cells containing starch grains. Rest of the tissue of petiole is parenchymatous. Laticifers are found associated with phloem. Some are found in cortex.

10) C. noorjahaniae Plate X, Fig. 58, Text Fig. XXI, Fig. 12)

T. S. of petiole is concave-convex. The diameter of petiole

varies from 0.90 - 1 mm. Single layered epidermis is made up of cubical cells covered with papillate cuticle on its outer walls. Some of the epidermal cells produce uniseriate 2-3 celled trichomes especially on margin of groove. Epidermis is followed by 1-3 layers of collenchyma and rest of the layers are parenchymatous. The stele consists of central crescent shaped vascular bundle. Xylem of central bundle is made up of 10-14 row of tracheids. Xylem is surrounded by patches of phloem. Lateral bundles are surrounded by single layered parenchymatous cells containing starch grains while in central bundle the starch sheath is present on lower portion only. Laticifers are found associated with phloem and cortex. They are more numerous in between dorsal phloem and groove.

11. C. sahyadrica (Plate X, Fig. 65; Text Fig. XXI, Fig. 13)

It is robust species and has stout petiole ranging in size 3.5 - 4.5 mm. Transection of petiole is concave-convex in outline. The single layered epidermis is composed of small cubical to barrel shaped cells. The cell possess cuticle on their outer walls. Hypodermis is composed of 2-4 layers of collenchyma and rest of the tissue is parenchyma. There are three vascular traces. The median bundle is crescent shaped and larger in size. The xylem occupies the central position composed of 12-16 rows of tracheids and is surrounded by phloem. The lateral bundles are rounded & surrounded

by sheath of parenchymatous cells containing starch grains. Similarly there is 2-3 layers of parenchyma below dorsal phloem which contain starch grains. Laticifers are found in cortex and associated with phloem.

12. C. oculata (Plate X, Fig. 59; Text Fig. XXI, Fig. 11)

The diameter of petiole varies from 1.5 - 2 mm. Transection of petiole is concavo-convex in outline. Epidermis is single layered made up of cubical cells. The cuticle is present on outer wall of epidermis. Hypodermis is collenchymatous and is 3-4 layered. There are three vascular traces. The median is large and crescent shaped. Xylem occupies the central position and consists of 16-18 rows of tracheids. Xylem is surrounded by phloem. The lateral bundles are small and rounded. Starch sheath was observed around lateral bundles & below central bundle. Laticifers are found associated with ventral phloem. Few are observed in cortex. Outer part of petiole is made up of parenchyma.

13) C. vincaefolia (Plate X, Fig. 66; Text Fig. XXI, Fig. 10).

The petiole diameter varies from 1.5 - 3 mm. Transection of petiole is concavo-convex in out line. Epidermis is single layered made up of small cubical cells covered with cuticle on outer walls. Epidermis is followed by 3-5 layered collenchyma and the rest of the tissue is parenchyma. There are three vascular bundles. The central one is larger and crescent shaped. The xylem

occupies the central position and is composed of 14-16 rows of tracheids. Xylem is surrounded by phloem. The lateral bundles are small rounded and contain few tracheids. Lateral bundles are surrounded by starch sheath. Starch is also found below dorsal phloem. Laticifers are found in cortex and associated with phloem. They are more numerous between groove and ventral phloem.

14. Brachystelma edulis (Plate X, Fig. 67; Text Fig. XXI Fig. 5)

T. S. of petiole is concave-convex in outline. The diameter of petiole varies from 0.3-4 mm. Epidermis is single layered made up of cubical cells. The epidermal cells are covered with cuticle on outer walls. Some of the epidermal cells produce uniseriate 2-3 celled trichomes. Collenchymatous hypodermis is indistinct except below groove. The stele consists of central crescent shaped vascular bundle. The xylem occupies the central position and is surrounded by phloem. Lateral bundles are small 2-6 in number and surrounded by starch sheath. There is starch sheath below ventral phloem. Laticifers are found distributed in cortex and associated with phloem.

15) Brachystelma species (Plate X, Fig. 68; Text Fig. XXI, Fig. 8)

Transection of petiole is 'V' shaped in outline. It varies in diameter from 0.4 - 0.5 mm. The single layered epidermis is made up of cubical cells which are covered with thick cuticle on

**PLATE - X : Figs. 57-68 : Showing petiole anatomy of Ceropegia &
Brachystelma species.**

T. S. of petiole :

Fig. 57 : C. attenuata x 35

Fig. 58 : C. noorjahaniae x 35

Fig. 59 : C. oculata x 35

Fig. 60 : C. huberi x 35

Fig. 61 : C. bulbosa var. lushii x 35

Fig. 62 : C. hirsuta x 29

Fig. 63 : C. maccannii x 35

Fig. 64 : C. media x 29

Fig. 65 : C. sahyadrica x 35

Fig. 66 : C. vincaefolia x 29

Fig. 67 : Brachystelma edulis x 29

Fig. 68 : B. species x 35

Text figure-XXI



Figs.1-13 : T.S. of petiole. Fig.1 X 50, Fig.2 X 26, Fig.3 X 29, Fig.5 X 31, Figs.6 & 7 X 32, Fig.8 X 41, Fig.9 X 30, Fig.10 X 22, Fig.11 X 58, Fig.12 X 47, Fig.13 X 23

their outer walls. Some of the epidermal cells produce 2-5 celled uniseriate trichomes. Collenchymatous hypodermis is indistinct but below groove a group of collenchymatous cells is present. The rest of the layers are parenchymatous. The stele consists of central large crescent shaped vascular bundle. Xylem lies in the centre and made up of 8-10 rows of tracheids. It is surrounded by phloem. Below dorsal phloem there is sheath of parenchyma containing starch grains, 2-4 lateral bundles are small rounded and are surrounded by starch sheath. Laticifers are found associated with phloem and cortex.

III) Leaf

1. Ceropegia attenuata (Plate XI, Fig. 69, Text Fig. XXIIa Fig. 1)

The leaves are dorsiventral & hypostomatic. Midrib represents a concavo-convex structure. The epidermis is externally covered by thick ridged cuticle. Below ventral groove there is group of few collenchymatous cells which is followed by the parenchyma. On dorsal side of collenchyma, palisade layer is observed. An arc of vascular tissue is present in upper region of midrib. It consists of bicollateral bundle. Laticifers are distributed in the phloem region. Vascular arc is surrounded by parenchyma which do not contain chloroplast. Just above dorsal epidermis there are 2-3 layers of collenchymatous cells. In lamina region the cells of upper epidermis are larger and rectangular covered with striated cuticle. Just below upper epidermis there

is single layered palisade. The rest of the tissue consists of spongy tissue & vascular traces. Lower epidermis is made up of small cubical cells and are covered with cuticle. The continuity of epidermis is broken by stomata.

2. C. bulbosa var. bulbosa (Plate XI, Fig 70; Text Fig. XXIIa Fig. 2)

The leaves are thick & fleshy. The leaves are isobilateral and amphistomatic. T. S. of leaf does not show concavo-convex structure in midrib region except slight depression on ventral side & insignificant elevation at dorsal side. Both lower and upper epidermises are made up of similar cubical to rectangular cells, which are covered externally by striated cuticle & posses stomata. Collenchyma found in other nonsucculent species of Ceropegia is not observed either below upper epidermis or lower epidermis in midrib region. An arc of vascular tissue is present in the centre of midrib. It consists of bicollateral bundle which is surrounded by parenchymatous cells containing chloroplasts. In lamina region there is very weak differentiation of mesophyll. Just below upper epidermis there are 3-5 layers of vertically elongated oval parenchymatous cells containing numerous chloroplasts. Below this are found weakly differentiated vascular traces. Inbetween vascular traces & lower epidermis there are parenchymatous oval cells which contain chloroplasts. Leaf anatomy viz. no differentiation into palisade & spongy tissue stomata on both surfaces, chloroplasts in all cells, reduced vascular traces & mechanical tissue indicate its succulent nature.

3. C. bulbosa var. luschii (Plate XI, Fig. 72; Text Fig. XXIIa Fig. 3)

The leaves are thick and fleshy. They are amphistomatic & isobilateral, however the mesophyll is weakly differentiated into upper vertically elongated cells & lower somewhat rounded cells. T.S. of leaf is 'V' shaped structure. Both the epidermises are made up of cubical to rectangular cells & possess stomata. Outer surfaces of the epidermal cells are covered with striated cuticle. In midrib region there are no collenchyma layers below lower and upper epidermises. Small arc of vascular bundle is found in the centre of mid-rib region. It consists of bicollateral bundle which is surrounded by parenchymatous cells. Laticifers are found around vascular tissue, associated with phloem. In lamina region, mesophyll consists of 3-5 layers of vertically elongated parenchymatous cells which contain chloroplasts. Below these layers are found lateral traces which are followed by parenchyma. In lower portion, the parenchyma cells are rounded & contain fewer chloroplasts. Trichomes are absent on both epidermises.

4. C. hirsuta (Plate XI, Fig. 75, Text Fig. XXIIa, Fig. 4)

The leaves are dorsiventral & hypostomatic. The upper epidermis is made up of large rectangular cells. Their outer walls are covered with cuticle. In midrib region few epidermal cells are small in size below which 1-2 layers of collenchyma are present followed by parenchyma. An arc of isobilateral vascular bundle is present in upper region. The lower epidermis in midrib region is

made up of cubical cells covered with ridged cuticle. Inside lower epidermis there are 2-3 layers of collenchyma. Rest of the tissue of midrib is parenchymatous & contain no chloroplasts. In lamina region, mesophyll is differentiated into single layered palisade 2-4 layered spongy tissue. Inbetween palisade & spongy tissue are found lateral vascular traces. Both epidermis possess trichomes. The continuity of lower epidermis is broken by presence of stomata.

5. C. huberi (Plate XI, Fig. 71; Text Fig XXIIb, Fig. 5)

The leaves are dorsiventral and hypostomatic. Midrib represents concavoconvex structure. The cells of upper epidermis are longer than lower epidermis. Both epidermises are covered with cuticle. In midrib region just below upper epidermis there are 2 layers of collenchyma followed by parenchyma. An arc of bicollateral vascular bundle is present in upper portion of mid-rib region. Laticifers are associated with phloem. There are 1-2 layers of collenchyma inside lower epidermis in midrib region. Upper epidermis possesses few scattered hairs. Mesophyll is distinguished into layer of palisade & 8-4 layers of spongy tissue. Inbetween palisade & spongy tissue are found lateral vascular traces. Continuity of lower epidermis is broken by stomata.

6. C. jainii (Text Fig XXII b, Fig 6)

The leaves are dorsiventral & hypostomatic. Midrib represents concave-convex structure. The cells of upper epidermis are larger than lower epidermis. The cells of both epidermis are covered with

striated cuticle. 2-3 celled trichomes are present on both epidermises but they are more common on upper epidermis. In midrib region the cells of upper epidermis are smaller. Inside epidermis there is a group of collenchymatous cells. In the centre of midrib there is an arc of isobilateral vascular bundle. Inside lower epidermis there are 2-3 layers of collenchyma. Rest of the tissue is parenchyma. In the lamina region the mesophyll is distinguished into single layered palisade & 3-4 layered spongy tissue. Inbetween these tissues are found lateral traces. In midrib region the laticifers are associated with phloem. Continuity of lower epidermis is broken by stomata.

7. C. juncea (Plate XI, Fig. 80, Text Fig. XXII, Fig. 7)

It is stem succulent species. Leaves are reduced to scales or absent. T. S. of leaf is planoconvex structure. Leaves are isobilateral and amphistomatic. Both epidermises are made up of similar cells and are covered externally by striated cuticle. There is no collenchyma beneath upper or lower epidermis in midrib region. A small arc of bicolateral vascular bundle is present in the centre of midrib region. Laticifers are found associated with phloem of central trace. Mesophyll consists of polygonal parenchymatous cells which contain chloroplast. Small lateral traces are found in middle of mesophyll in lamina region. There is no mechanical tissue and vascular tissue is poorly developed which indicate its succulent nature.

8. C. maccanii (Plate XI, Fig. 78, Text Fig. XXII, Fig. 8)

Leaves are dorsiventral and hypostomatic. Midrib represents concave-convex structure. The cells of upper epidermis are large, barrel shaped while that of lower epidermis are small, cubical & rectangular. In midrib region, the cells of upper epidermis are small below which there is single layer of collenchyma consisting 4-5 cells. Collenchyma is followed by parenchyma. Below parenchyma there is an arc of bicollateral vascular bundle which is surrounded by parenchyma. Few laticifers are found associated with phloem. Inside lower epidermis there are 2-3 layers of collenchyma. In lamina region the mesophyll consists of single layer of palisade & 2-3 layers of spongy tissue. Inbetween these two tissues there are traces of vascular bundles. Continuity of lower epidermis is broken by stomata.

9. C. media (Plate XI, Fig. 73, Text Fig. XXIIIa Fig. 9)

The leaves are dorsiventral & hypostomatic. Midrib represent concavo-convex structure. The epidermal cells of upper epidermis are barrel shaped and larger than the lower epidermis. The cells of lower epidermis are cubical to rectangular in shape. Trichomes are absent on both the epidermis. In midrib region the cells of upper as well as lower epidermis are smaller & just below upper epidermis, there are 1-2 layers of collenchyma while inside lower epidermis there are 2-3 layers of collenchyma. Collenchyma is followed by parenchyma. An arch of bicollateral vascular bundle is situated in the centre of midrib. Few laticifers are associated

with phloem. In lamina region, mesophyll is differentiated into single layered palisade & 3-6 layers of spongy tissue. Inbetween spongy parenchyma & palisade there are traces of lateral bundles. Continuity of epidermis is broken by stomata.

10. C. noorjahaniae (Plate XI, Fig. 74, Text Fig. XXIIIa, Fig. 10)

The leaves are dorsiventral & hypostomatic. Midrib represents concavo-convex structure. The epidermal cells of upper epidermis are larger, barrel shaped while that of lower epidermis are smaller, cubical to rectangular. Some of the epidermal cells produce 2-3 celled trichomes. In midrib region the epidermal cells are smaller in size. The epidermal cells are covered with striated cutical on its outer surface. Just below upper epidermis there are 1-2 layers of collenchyma followed by parenchyma. Inside lower epidermis there are 2-3 layers of collenchyma. An arch of bicollateral vascular bundle is present in the centre of midrib region. Laticifers are found associated with phloem. They are more numerous on ventral side of vascular trace. In lamina region the mesophyll is distinguished into single layered palisade & 4-6 layers of spongy tissue. Lateral vascular traces are found inbetween these two tissues. Continuity of lower epidermis is broken by stomata.

11. C. oculata (Plate XI, Fig. 76; Text Fig XXIIIa, Fig. 11)

The leaves are dorsiventral & hypostomatic. Midrib represents concavo-convex structure. The cells of upper epidermis are larger than lower epidermis. They are barrel shaped. The cells

of lower epidermis are cubical to rectangular. In midrib region the cells of upper epidermis are small followed by single layer of collenchyma. Below collenchyma there is parenchyma. An arc of bicollateral vascular bundle is present in the centre of the midrib. Inside lower epidermis there are 2-3 layers of collenchyma. Rest of the tissue is parenchyma. Laticifers are found associated with phloem. In lamina region mesophyll is distinguished into single layered palisade followed by 2-3 layers of parenchyma. In between spongy tissue & palisade are found lateral vascular traces. The continuity of epidermis is broken by stomata.

12. C. sahyadrica (Plate XI, Fig. 79; Text Fig. XXIIIa, Fig. 12)

The leaves are dorsiventral and hypostomatic. Midrib is very prominent & represents concavo-convex structure. The cells of upper epidermis are larger, barrel shaped while that of lower epidermis are small cubical to rectangular in shape. Both are covered with cuticle on outer surface. In midrib region the cells of upper epidermis are small followed by 1-2 layers of collenchyma followed by 3-4 layers of parenchyma. An arc of bicollateral vascular bundle is present in the centre of midrib. Phloem is associated with laticifers. Inside lower epidermis there are 2-4 layers of collenchyma. Rest of the tissue in midrib is made up of parenchyma. In lamina region the mesophyll is distinguished into single layered palisade & 3-4 layers of spongy tissue.

Inbetween spongy tissue and palisade are found lateral vascular traces. The continuity of lower epidermis is broken by stomata.

13. C. vincaefolia (Plate XI, Fig. 77; Text Fig. XXIIIb, Fig. 13)

The leaves are dorsiventral & hypostomatic. Midrib represent concavo-convex structure. The cells of upper epidermis are larger, barrel shaped while that of lower epidermis are small, cubical to rectangular in shape. Epidermal cells are covered with cuticle. In midrib region the cells of upper epidermis are small below which there is a group of 4-6 cells of collenchyma. Below collenchyma there is parenchyma. In the centre of midrib there is an arc of bicollateral vascular bundle. Inside lower epidermis there are 2-3 layers of collenchyma. Rest of the tissue of midrib is made up of polygonal parenchymatous cells. In lamina region the epidermis is differentiated into single layered palisade and 2-4 layers of spongy tissue. Inbetween these tissues lie lateral vascular traces. The continuity of lower epidermis is broken by stomata.

14. C. woodii (Text Fig. XXIII b, Fig. 14)

Leaves are thick & fleshy. They are isobilateral and amphistomatic. Both epidermises are made up of more or less cubical to rectangular cells. The epidermal cells are covered with striated cuticle. Midrib region is somewhat planoconvex structure. No collenchyma is observed either below lower or upper epidermis.

A small arc of vascular bundle is present in the centre of midrib surrounded by parenchyma which contain chloroplasts. In lamina region the cells below upper epidermis are somewhat vertically elongated while in lower region they are round. All the cells of leaf contain chloroplasts. In lamina region the cell below upper epidermis are somewhat vertically elongated while in lower region they are round. All the cells of leaf contain chloroplasts. Most of this tissue is water storage tissue containing chloroplasts.

15. Brachystelma edulis (Plate XI, Fig. 81, Text Fig. XXIII Fig. 15)

The leaves are dorsiventral and amphistomatic. The cells of upper epidermis are larger and barrel shaped while that of lower epidermis are smaller, cubical to rectangular in shape. Cells of both epidermis are covered externally by striated cuticle. Continuity of both the epidermises is broken by presence of stomata. In midrib region the cells of both epidermis are smaller in size & the upper epidermis is followed by palisade layer. Inside lower epidermis there are 2-3 layers of collenchyma. In the centre of midrib there is an arc of bicollateral vascular strand. Rest of the tissue is made up of polygonal parenchyma. Laticifers are found associated with phloem. In lamina region the mesophyll is distinguished into 3-4 layered palisade and 3-4 layered spongy tissue. Inbetween these two tissues lie traces of vascular bundles. Trichomes are found on both epidermis but they are more common on upper epidermis.

PLATE - XI : Figs. 69-82 : Showing leaf anatomy of Ceropegia &
Brachystelma species.

T. S. of leaf :

Fig. 69 : C. attenuata x 35

Fig. 70 : C. bulbosa var. bulbosa x 35

Fig. 71 : C. huberi x 35

Fig. 72 : C. bulbosa var. lushii x 35

Fig. 73 : C. media x 35

Fig. 74 : C. noorjahaniae x 35

Fig. 75 : C. hirsuta x 35

Fig. 76 : C. oculata x 35

Fig. 77 : C. vincaefolia x 35

Fig. 78 : C. maccannii x 35

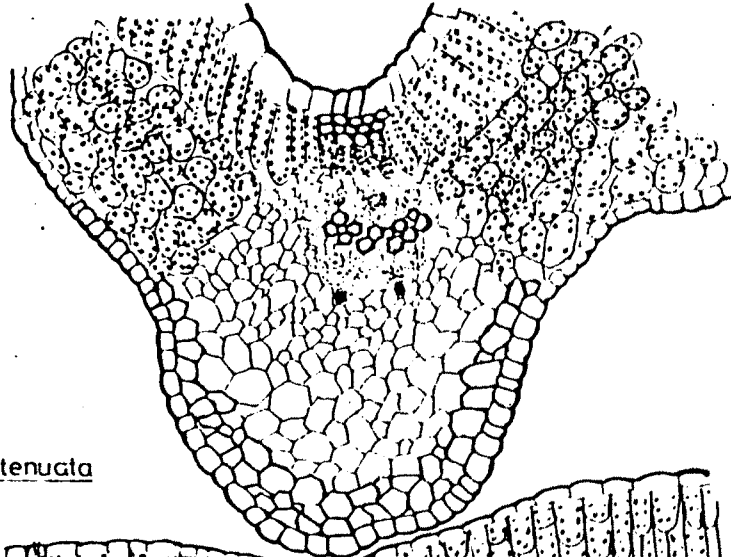
Fig. 79 : C. sahyadrica x 29

Fig. 80 : C. juncea x 35

Fig. 81 : Brachystelma edulis x 35

Fig. 82 : B. species x 35

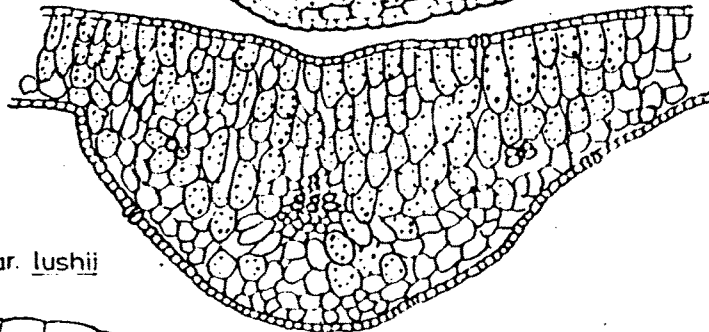
Text figure XXIIa



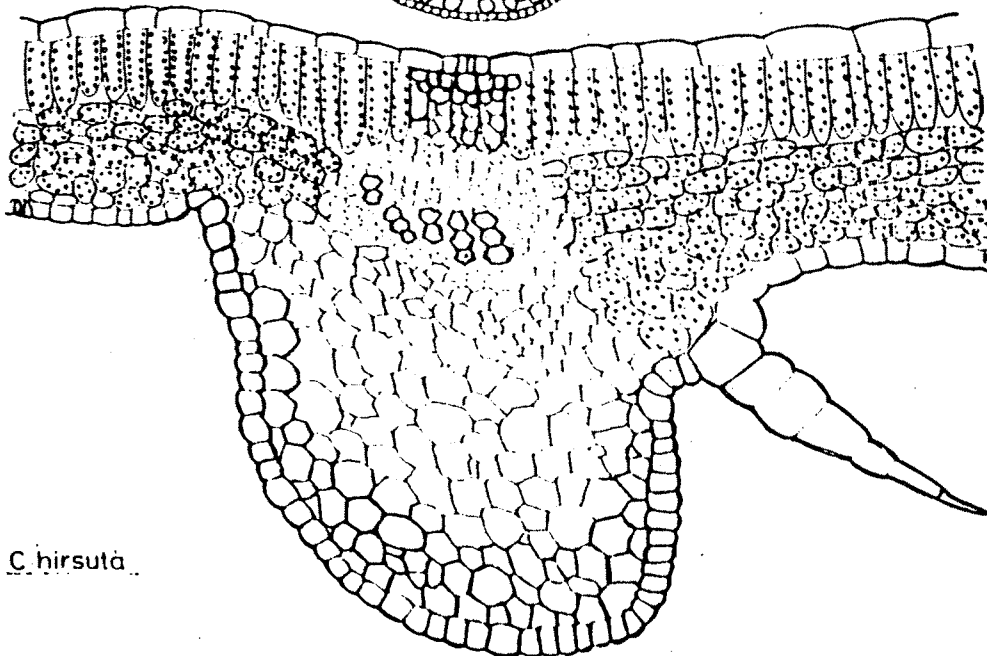
1 Ceropogia attenuata



2 C. bulbosa var. bulbosa



3 C. bulbosa var. lushii



4 C. hirsuta

Figs.1-4 : I. S. of leaf Fig.1 X 109, Fig.2 X 70, Fig.3 X 53, Fig.4 X 147.

Text figure XXII b

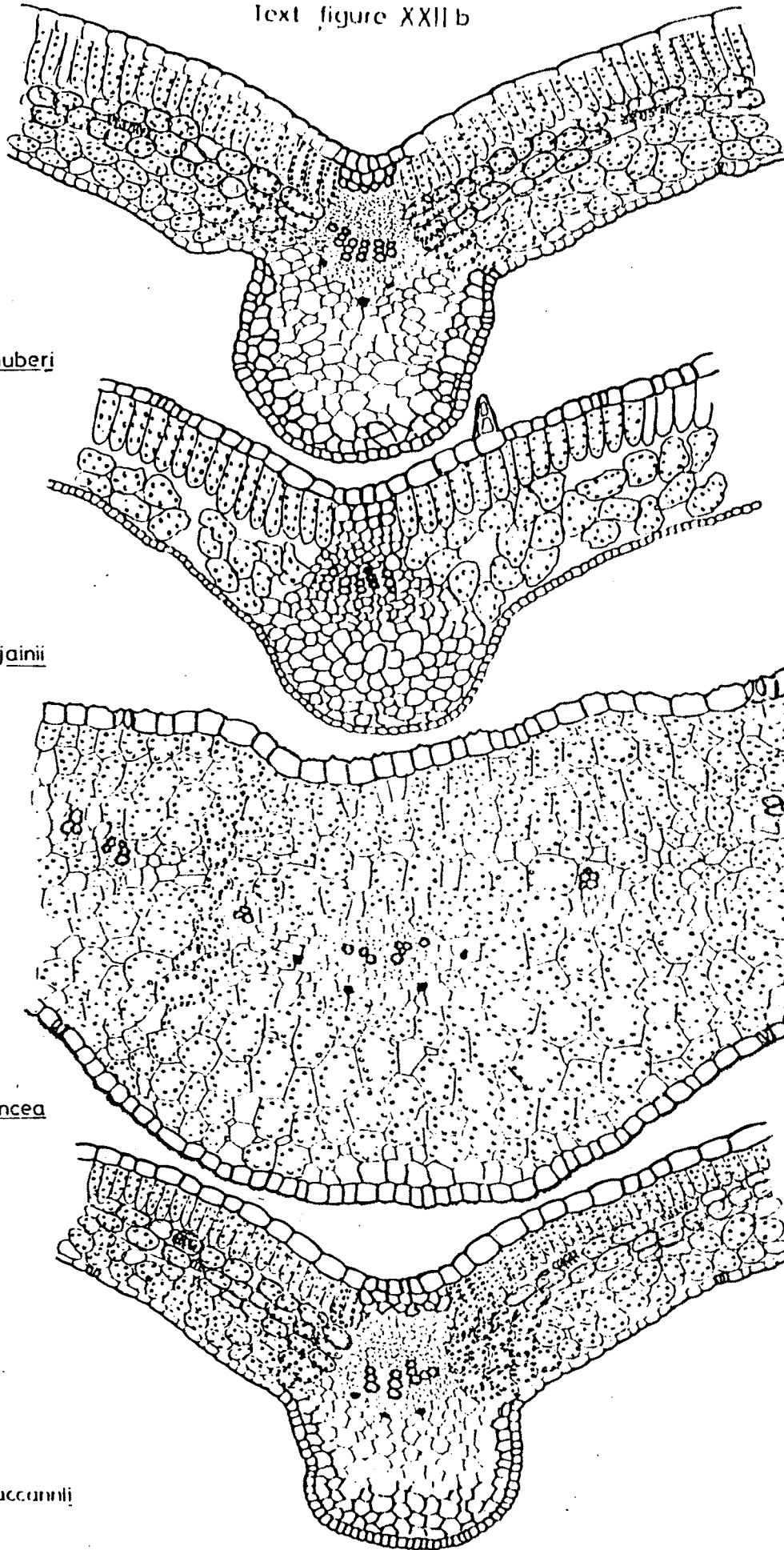
5 *C. huberi*

6 *C. jainii*

7 *C. juncea*

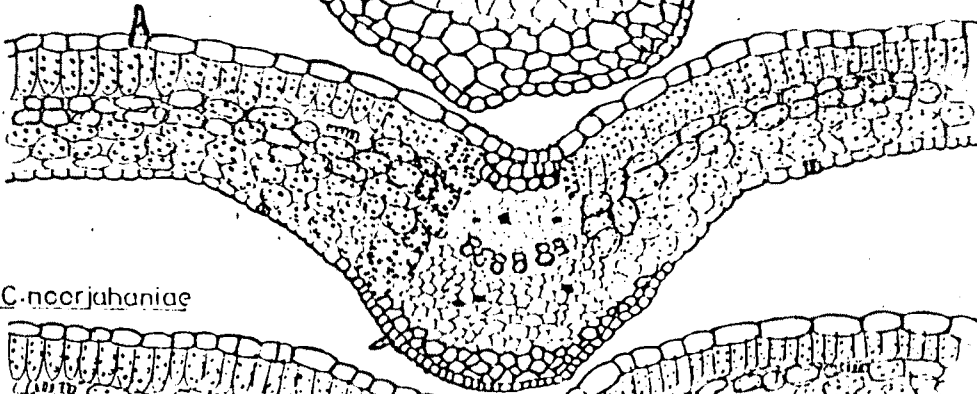
8 *C. maccanli*

Figs. 5-8: T.S. of leaf Fig. 5 X 71, Fig. 7 X 1/7, Fig. 8 X 80.

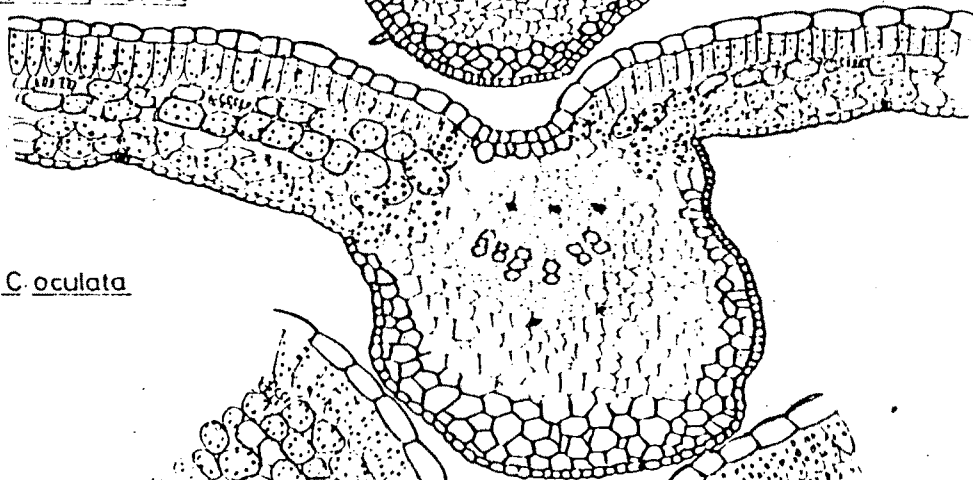


Text figure XXIIIa

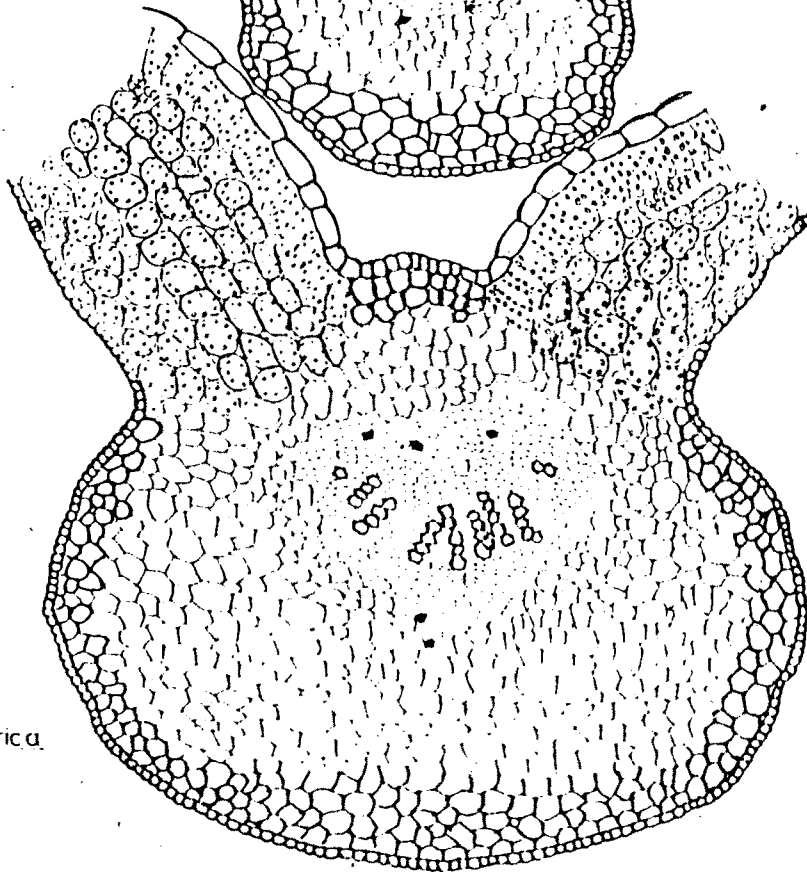
9 *C. media*



10 *C. neorjahaniae*



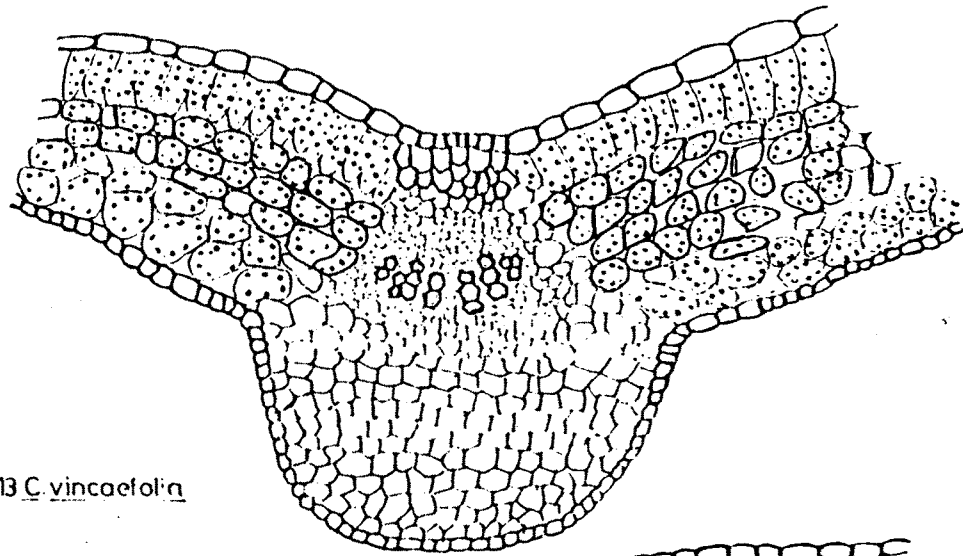
11 *C. oculata*



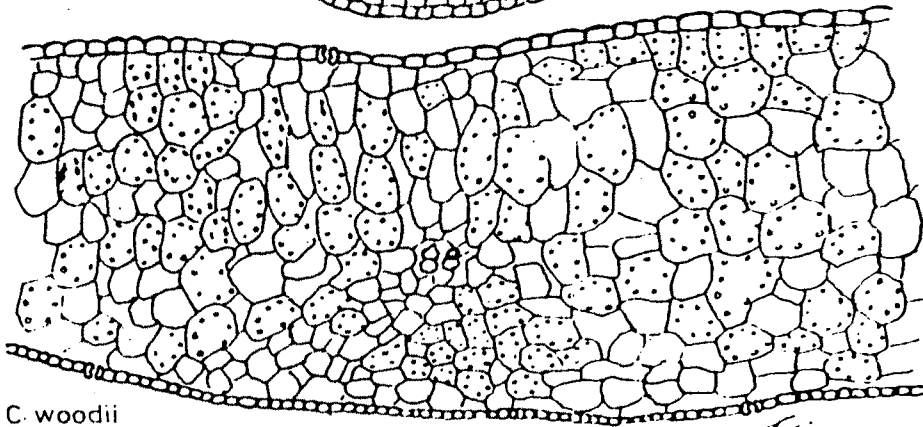
12 *C. sahyadrica*

Figs. 9-12: T. S. of leaf. Fig. 9 X 74, Figs 10-11 X 71, Fig. 12 X 49.

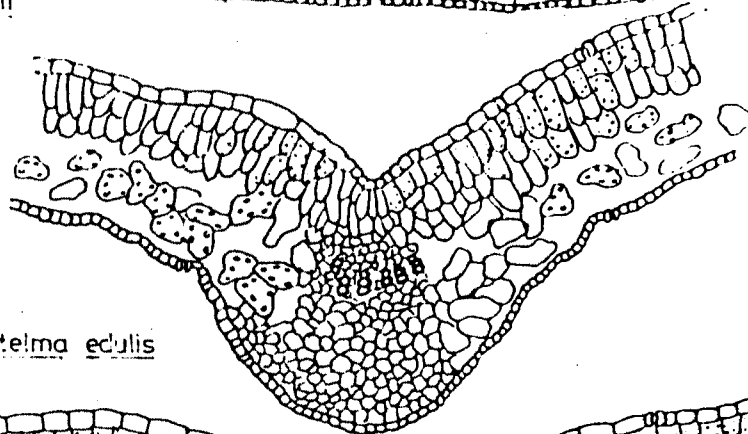
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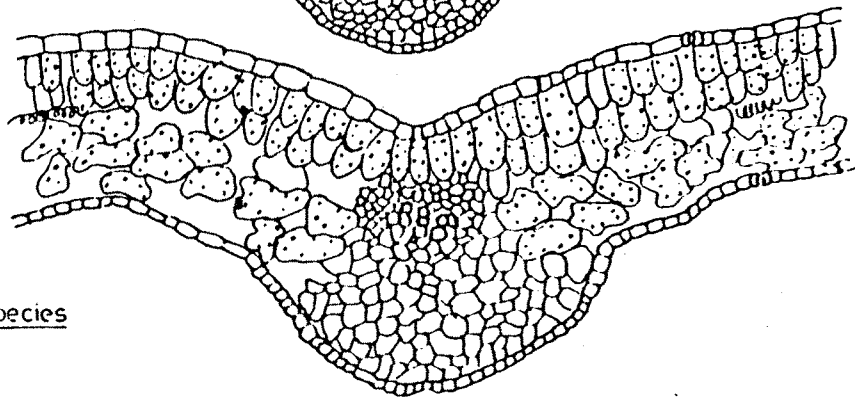
13 *C. vincaefolia*



14 *C. woodii*



15 *Brachystelma edulis*



16 *P. species*

Figs.13-16:T. S. of leaf,Figs.13 & 15 X 66, Fig.16 X 71.

16. B. species (Plate XI, Fig. 82; Text Fig. XXIIIb, Fig 16)

The leaves are dorsiventral & amphistomatic. The cells of upper epidermis are larger and barrel shaped while that of lower epidermis are smaller, cubical to rectangular in shape. Epidermal cells of both surfaces are covered with striated cuticle. Continuity of both epidermises is broken by presence of stomata. In midrib region the cells of upper epidermis are smaller followed by palisade. In the centre of midrib there is an arc of bicollateral vascular bundle. The laticifers are found associated with phloem. Inside lower epidermis there are 2-3 layers of collenchyma. Rest of the tissue is made up of parenchyma. In lamina region the mesophyll is distinguished into 2-3 layered palisade and 2-3 layered spongy tissue. Inbetween these two tissues are found lateral traces of vascular bundles. Trichomes are present on both the epidermis.

IV) Cuticle

Comparative account of cuticular characters is given in table VIII and shown in photoplate XII to XVI & Text Fig.- XXVII.

1. Ceropegia attenuata : Leaves hypostomatic. Epidermis distinguished into costal and intercostal areas on lower surface only.

Upper epidermis (Plate XII, Fig. 83; Plate XVII. Fig. 115, Fig. XXIV, Fig. 1). Both the intercostal and the costal cells are more or less of the same size & appearance. Cells, polygonal,

almost isodiametric, 5-6 sided, walls straight. Hairs simple, unbranched, bent forward, 2-4 celled, arising from a single basal more or less rounded cell surrounded by a ring of 7-8 polygonal clear cell usually similar in appearance and size to the inner costal cells. Striations less prominent in costal region becoming more prominent towards margin of leaf. Striations more prominent around hair bases transversing many cells and adjoining with striations of other hairs. Other cells with usually 3 striations while few cells are centre of striations & striations of them remain confined to cells.

Lower epidermis (Plate XVI, Fig. 95, Text Fig. XXVI Fig.1)

The cells in midvein region elongated, rectangular with few simple unbranched hairs. Intercostal cells are uniformly amoeboid or rather irregularly outlined. Individual cells are of different shapes. Most of the cells have one long axis but the long axis of these cells are disposed in all direction. With this result the cells show a characteristic mosaic alignment. Stomata are enriched by 4-6 subsidiary cells. Stomata close (1-4 cells apart) paracytic, smaller than the other intercostal cells; guard cells with faint outline and lodged in the curves of the intercostals, their long axis disposed in all directions. Occasionally stomata with single guard cells are observed. Striations not much prominent, arising from guard cells into 2-6 bundles depending upon number of subsidiary cells either remaining confined to subsidiary cells or extending for 2-3 cells.

2. C. bulbosa var. bulbosa : Leaves amphistomatic. Epidermis poorly distinguished into costal and intercostal areas.

Upper epidermis (Plate XII, Fig. 85, Text Fig. XXIV, Fig. 2) Cells of intercostal and costal region are more or less similar in size and appearance. Cells are polygonal, isodiametric, 5-6 sided, walls straight. No epidermal outgrowths were observed. Stomata distant, (3-8 cell apart), guard cells obscure, surrounded by 3-5 subsidiary cells, subsidiary cells smaller than other epidermal cells. Stomata oriented in all directions. Frequency of stomata less than on the lower surface, usually stomata are paracytic. Striations prominent, arising from guard cells into bundles as many as subsidiary cells. Striations usually confined to subsidiary cells or extending 2 - 3 cells.

Lower epidermis (Plate XIV, Fig. 97, Text Fig. XXVI, Fig. 2) The cells in midvein region elongated, rectangular, with very few stomata. The epidermal cells amoeboid, isodiametric, 5-6 sided, walls wavy. Stomatal structure and striation character are similar to upper epidermis. Stomata frequency is more on lower epidermis.

3. C. bulbosa var. lushii (Plate XII, Fig. 87, Plate XIV Fig. 99; Plate XVII, Fig. 116; Text Fig. XXVI, Fig. 3, Text Fig. XXVI, Fig. 3) The upper and lower epidermis shows similar characters with that of C. bulbosa var. bulbosa, however in C. bulbosa var. lushii the striations run from stomata to stomata and all the cells of epidermis shows striations.

4. C. hirsuta : Leaves hypostomatic. Epidermis distinguished into costal and intercostal areas.

Upper epidermis (Plate XII, Fig. 84, Plate XVII, Fig. 117; Text Fig. XXVI, Fig. 4) The epidermal cells are polygonal, isodiametric 5-6 sided, walls straight, thick with which many crystals are associated. Hairs simple, unbranched, 5-15 celled, pointed, arising from 1-3 basal cells surrounded by 7-10 cells. Striations prominent on hairs and extending to many cells around hair base. Some epidermal cells form centre of striations & striations remain confined to cell while other are with obscure striations.

Lower epidermis (Plate XIV, Fig. 96; Text XXVI, Fig. 4) Intercostal cells are uniformly amoeboid or irregularly shaped. Most of the cells are with one axis but the long axis of these cells are disposed in all directions with the result the cells show a characteristic mosaic alignment. Stomata usually paracytic, surrounded by 3-5 subsidiary cells, guard cells with very faint outline striations faint. Crystals found associated with upper epidermal cells, are not found on lower epidermis.

5. C. huberi : Leaves hypostomatic, undistinguishable into costal and intercostal areas.

Upper epidermis (Plate XII, Fig. 86, Plate XVII, Fig. 118, Text Fig. XXIV, Fig. 5) Epidermal cells polygonal, isodiametric, 5-6 sided, walls straight. Hairs simple, unbranched, 2-6 celled, arising from a single more or less rounded cells surrounded by a ring of 9-12

polygonal clear cells similar to intercostal cells. Epidermal cells without content. Striations in cells around hair base radiating from hair base and extending for 2-3 cells, other cells without striations.

Lower epidermis (Plate XIV, Fig. 98, Text Fig. XXVIj, Fig. 5) Intercostal cells are uniformly amoeboid in shape, cell walls wavy, cells clear, without cell content, stomata close (1 - 2 cells apart) surrounded by 3 - 5 subsidiary cells, subsidiary cells undistinguishable from other epidermal cells and therefore stomata anomocytic, guard cells with clear outline, stomata oriented in all directions. Striations absent, hairs absent.

6. C. jainii : Leaves hypostomatic. Epidermis undistinguishable into costal & intercostal regions.

Upper epidermis (Plate XVI, Fig. 109, Plate XVII, Fig. 121, Text Fig. XXV, Fig. 12) Epidermal cells are polygonal, straight walled, almost isodiametric bearing few scattered hairs. The cells are clear without any content. Hairs 1 - 3 cell in height, simple, unbranched arising from one or two large rounded cells which is surrounded by 7 - 13 cells. Striations radiating from hair base and extending to several cells. All epidermal cells show striations & some cells from centre of striations & striations in these cells usually remain confined to these cells. The striations are prominent and similar to C. noorjahaniae.

Lower epidermis (Plate XV, Fig. 108, Text Fig. XXVII, Fig. 13) Intercostal cells are usually straight walled or with slightly

wavy walls, clear without any content. Stomata usually paracytic, large, guard cells distinct surrounded by 3 - 5 subsidiary cells, close, separated by only 1 - 3 epidermal cells. Striations absent. Few hairs are present on lower epidermis.

7. C. juncea (Plate XVI, Fig. 113 & 114) : Leaves are amphistomatic. Epidermis distinguishable into costal and intercostal regions. The epidermal characters on upper and lower surface remain same. In costal region the cells are rectangular & devoid of stomata. The costal rectangular cells merge into polygonal, more or less isodiametric intercostal cells. The stomata are of paracytic type. Striations are very prominent in costal region and run from base of leaf to apex. Striations are less prominent in intercostal epidermal cells. Some small crystals are seen in epidermal cell usually one or two per cell. It is a stem succulent species. Paracytic stomata are found in rows on stem.

8. C. maccannii : Leaf hypostomatic, epidermis undistinguishable into costal and intercostal region.

Upper epidermis (Plate XII, Fig. 88, Plate XVII, Fig. ,Text Fig. XXIV, Fig. 6) Epidermis cells are polygonal, almost isodiametric, straight walled with few scattered hairs and isolated patches of 5-8 brown walled cells. Hairs simple, unbranched, 3-5 celled, arising from single basal cell which is surrounded by many cells. Striations obscure seen only on the cells around hair base, others are devoid of striations.

Upper epidermis (Plate XIV, Fig. 100, Text Fig. XXVI, Fig. 6) Epidermal cells amoeboid in shape, clear without any content. Stomata anomocytic, surrounded by 3-5 subsidiary cells, close, 1-4 cell apart, subsidiary cells undistinguishable from other epidermal cells, guard cell with faint margin, striations absent. Hairs absent on lower epidermis.

9. C. media : Leaf hypostomatic. Epidermis clearly distinguished into costal & intercostal regions.

Upper epidermis (Plate XIII, Fig. 89, Plate XVII, Fig. 120, Text Fig. XXVI, Fig. 7) Intercostal epidermal cells somewhat amoeboid, almost isodiametric, without any trichomes. Epidermal cells are clear without any cell content. Striations absent.

Lower epidermis (Plate XV, Fig. 101, Text, Fig. XXVI, Fig. 7) The epidermal cells are amoeboid in outline with wavy walls. Subsidiary cells are smaller than other epidermal cells & usually lie parallel to long axis of stomata & thus stomata are paracytic, some times anomocytic, striations absent.

10. C. noorjahaniae : Leaves hypostomatic. Epidermis distinguishable into costal & intercostal regions. Costal cell rectangular elongated lying parallel to the leaf axis. Intercostal cells polygonal.

Upper epidermis (Plate XIII, Fig. 91, Plate XVII, Fig. 123) Text Fig. XXIV, Fig. 8) Intercostal epidermal cells polygonal, almost isodiametric, straight walled, bearing simple, unbranched 2-4 celled

hairs arising from rounded basal cell which is surrounded by 5-8 cells. Surrounding cells are similar to other epidermal cells. Striations radiate from hair bases & extend to many cells. Other epidermal cells from a centre of striations & striations usually remain confined to individual cells. All the cells show striations & it is prominent diagnostic character of the species.

Lower epidermis (Plate XV, Fig. 103, Text Fig. XXVI, Fig. 8)

It can be distinguished into intercostal & costal regions. The cells of costal region are barrel shaped elongated lying parallel with long axis of leaf. It is devoid of stomata. Intercostal cells are polygonal, 5-6 sided, straight-walled clear without any cell content. Stomata close (separated by 3-5 cells), guard cells surrounded by 4-5 subsidiary cells, subsidiary cells smaller than other epidermal cells, stomata paracytic or anomocytic. Striations arising from guard cells in bundles as many as guard cells and extending to neighbouring stomata. Some stomata without striations. The hairs present only in costal region.

11. C. oculata : Leaf hypostomatic, Epidermis distinguishable into costal and intercostal regions.

Upper epidermis (Plate XIII, Fig. 93, Plate XVII, Fig. 125, Text Fig. XXIV, Fig. 9) The costal epidermis is made up of elongated, barrel shaped cells, their long axis parallel to midrib. The intercostal cells are polygonal, almost isodiametric, clear without any cell content, however there are small patches of small rounded

or polygonal cells usually with brown cell walls. The hairs are simple, unbranched, 4-5 celled, arising from single rounded basal cell which is surrounded by 8-13 cells which are smaller than other epidermal cells. Striations absent.

Lower epidermis (Plate XV, Fig. 105, Text Fig. XXVI, Fig. 9) Cells of costal region are elongated, rectangular to polygonal thickwalled, becoming wavy in outline towards margins & merging into epidermal cells. The intercostal cells amoeboid in shape with wavy cell walls. Hairs very few, just like on upper epidermis. Stomata surrounded by 3-4 subsidiary cells which are undistinguishable from other epidermal cells, stomata anomocytic or paracytic. Striations absent.

12. C. sahyadrica : Leaf hypostomatic. Epidermis distinguishable into costal & intercostal regions.

Upper epidermis (Plate XIII, Fig. 90, Plate XVII, Fig. 124, Text Fig. XXV, Fig. 10) General appearance of the epidermis is typical that of squamous epithelium of frog. The costal region is made up of long elongated rectangular cells. The intercostal cells are polygonal, more or less isodiametric, clear without any cell content, straight walled. Hairs many, unbranched, simple, 4-7 celled, arising from single or few basal cells which are surrounded by numerous rounded cells which are distinct from other epidermal cells. Faint striations radiating only from hair base & extending to several cells while other epidermal cells are without striations.

Lower epidermis (Plate XV, Fig. 107, Text Fig. XXVII, Fig.10) Without hairs except on costal region. The cells of costal region elongated barrel shaped, rectangular with few scattered hairs. Cells of innermost region polygonal, walls undulating but not amoeboid type, clear, of various shapes & size. Stomata usually surrounded by 4 subsidiary cells out of which two elongated cells lie parallel to the long axis of guard cells, thus stomata paracytic, striations usually absent, if present vary faint extending to few surrounding cells.

13.C. vincaefolia : Leaf hypostomatic. Epidermis distinguishable into costal & intercostal regions. Hairs are almost from both epidermises.

Upper epidermis (Plate XVI, Fig. 110, Plate XVII, Fig. 126, Text Fig. XXV, Fig. 11) It is exactly similar to C. sahyadrica. Intercostal cells are narrow, elongated, rectangular, barrel shaped, merging into intercostals. The epidermal cells are polygonal, almost isodiametric, straight walled, clear without any cell content, hairs are absent. Striations are absent. There are no islands of small rounded cell. The general appearance look like honey-comb.

Lower epidermis (Plate XV, Fig. 102, Text Fig. XXVII, Fig. 11) The cells of costal region elongated, rectangular, straight walled, 4-5 sided, clear, merging into epidermal cells characteristic of intercostal region. The intercostals wavy in outline, more or less amoeboid, clear. Stomata usually surrounded by 4 subsidiary cells, out of which 2 lie parallel to long axis of guard cells, thus stomata paracytic or rarely anomocytic because of subsidiary cells are similar

to other epidermal cells. Stomata close separated by 1-3 cells. Hairs absent. Striations absent.

14. C. woodii : Leaves amphistomatic. Epidermis not distinguishable into costal & intercostal regions.

Upper epidermis (Plate XVI, Fig. 111, Plate XVII, Fig. 127, Text Fig. XXV, Fig. 14) Epidermal cells are polygonal, straight walled, subsidiary cell smaller than other epidermal cells, stomata usually paracytic, stomata is surrounded by 2 circles of subsidiary cells. Striations prominent in all epidermal cells and around stomata.

Lower epidermis (Plate XVI, Fig. 112, Text Fig. XXVII, Fig. 12) It is like to upper epidermis. Some of the epidermal cells posses 1 or small crystals.

15. Brachystelma edulis : Leaf amphistomatic. Epidermis distinguishable into costal & intercostal regions on lower surface.

Upper epidermis (Plate XIII, Fig. 92, Plate XVII, Fig. 128, Text Fi. XXV, Fig. 15) The cells of costal and intercostal regions are more or less similar in shape but differ in orientation, the former oriented in rows while latter are irregularly placed. The epidermal cells are polygonal, isodiametric, 4-7 sided, straight walled. Stomata sparse separated by 4-7 cell apart, surrounded by 4-5 subsidiary cells, usually paracytic, subsidiary cells smaller than other epidermal cell, striations found in all the cells running from cell to cell. Hairs simple, unbranched, 2-3 celled from marginal epidermis.

Lower epidermis (Plate XV, Fig. 104, Text Fig. XXVII, Fig. 14) Coastal cells rectangular, elongated, smaller than other epidermal cells running parallel, producing 2-3 celled hairs pointed forward, arising from single basal cell surrounded by 4-5 polygonal cells. Cells of costal region show prominent striations. Intercostal cells polygonal with slightly undulating wall cells of different size, stomata surrounded by 4 subsidiary cells, usually paracytic, sometimes surrounded by a ring of 4-6 other epidermal cells. All the cells of epidermis & subsidiary cells show striations running over many cells.

16. Brachystelma species (Plate XIII, Fig. 94, Plate XV, Fig. 106, Plate XVII, Fig. 129, Text Fig. XXV, Fig. 16, Text Fig. XXVII, Fig. 15) Cuticular characters are similar to B. edulis but striations are less prominent in this species.

From table VIII it is clear that in stem and leaf succulent species of Ceropegia viz. C. bulbosa, C. nuncea & C. woodii leaves are amphistomatic, isobilateral & shows prominent striations on epidermal cells of both surfaces. In rest of the species with membranous leaves are hypostomatic & dorsiventral. Similarly in Brachystelma, the leaves are amphistomatic and dorsiventral.

Stomatal size in different species of Ceropegia range from 21-26 x 11-27 μ m. Largest stomata were observed in C. juncea while smallest stomata were found in C. juncea while smallest stomata were found in C. jainii & C. woodii. Abnormal stomata with single guard cells observed in almost all the species but the frequency of such

abnormal stomata were more in succulent species. Stomata in Brachystelma range in size from 22-30 x 15-27 μm .

Stomatal frequency ranged from 48-762 per mm^2 in various species of Ceropegia. Highest stomatal frequency (761/ mm^2) was observed in C. jainii followed by C. attenuata (332/ mm^2). The stomatal frequency above 200 per mm^2 was observed in C. hirsuta, C. huberi, C. juncea, C. maccannii & C. sahyadrica. Rest of the species showed less than 200 stomata per mm^2 . Lowest stomatal frequency was observed in C. woodii which is a cultivated species. In Brachystelma species stomata ranged in number from 81-259 per mm^2 .

From table 8 it is clear that in all the species with amphistomatic leaves have less stomata on upper surface as compared to lower surface.

Epidermal cell size in various species is Ceropegia varied from 37-67 x 12-43 μm . Longest epidermal cells were observed in C. bulbosa, C. media, C. oculata, C. vincaefolia. Smallest epidermal cells were found in C. jainii. In Brachystelma epidermal cells ranged in size from 32-45 x 20 μm .

Stomatal index varies from 4-46 in Ceropegia species. It was minimum(s) in C. woodii & maximum (47) in C. jainii. From table VIII it is clear that species with amphistomatic leaves have less stomatal index on lower surface except C. woodii. Stomatal index on upper surface of leaf in Brachystelma species varies from 15-18

while on lower surface it ranged from 9-13.

Very prominent striations on both the surfaces of leaf were observed in Ceropegia attenuata, C. bulbosa, C. jairii, C. noorjahaniae, C. woodii & Brachystelma species. Striations were found to be absent on both the surfaces in C. media, C. oculata & C. vincaeflia. Striations in some species are of diagnostic value.

Artificial key to the species studied based on cuticular characters given below :

1. Leaves amphistomatic.

2. Leaves membranous, not fleshy, trichomes present

1. Brachystelma edulis

2. B. species

2. Leaves fleshy, trichomes absent

3. Stomatal frequency 146-195/mm², stomatal index 14-23 on lower surface.

3. C. bulbosa

3. Stomatal frequency ca 50/mm², stomatal index ca 5 on lower surface

4. C. woodii

2. Leaves fleshy, reduced to scales or absent, trichomes absent.

5. C. juncea

1. Leaves hypostomatic

4. Striations present on both surfaces of leaf.

5. Stomatal frequency very high ca $761/\text{mm}^2$

6. C. jainii

5. Stomatal frequency high ca $332/\text{mm}^2$

7. C. attenuata

5. Stomatal frequency between $150\text{--}250/\text{mm}^2$

6. Striations very prominent, most of the upper epidermis form centres of striations & striations remain usually confined to cells, crystal absent.

8. C. noorjahaniae

6. Striations on upper epidermis not prominent, cells do not form centres of striations. Crystal present with epidermal cells

9. C. hirsuta

4. Striations present only on upper epidermis, usually on cells around hair bases & around stomata. Stomatal frequency ca 200 or more than $200/\text{mm}^2$

10. C. maccannii

11. C. huberi

12. C. sahyadrica

4. Striations absent on both the epidermis. Stomatal frequency less than $200/\text{mm}^2$

13. C. vincaefolia

14. C. media

15. C. oculata

PLATE - XII : Figs. 83-88 : Showing cuticular characters of Ceropegia species.

Upper epidermis :

Fig. 83 : C. attenuata x 113

Fig. 84 : C. hirsuta x 113

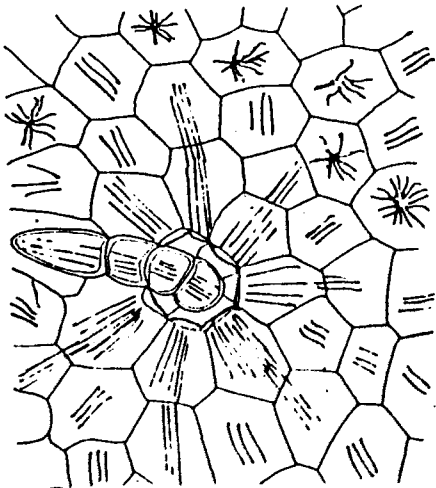
Fig. 85 : C. bulbosa var. bulbosa x 113

Fig. 86 : C. huberi x 113

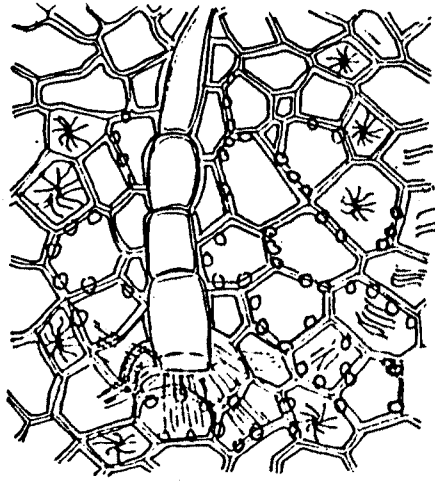
Fig. 87 : C. bulbosa var. lushii x 225

Fig. 88 : C. maccannii x 113

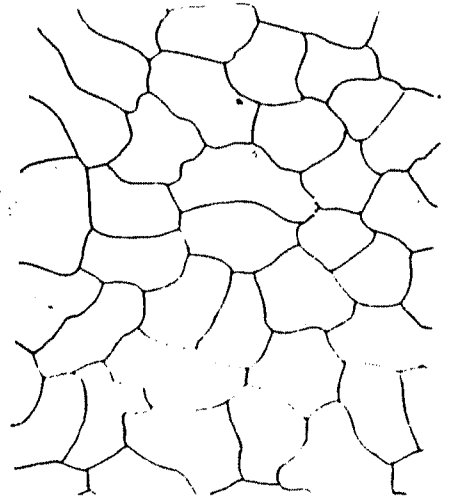
Text figure XXIV



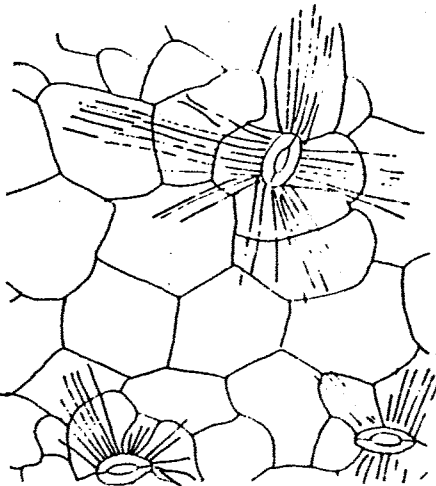
① *Ceropegia attenuata*



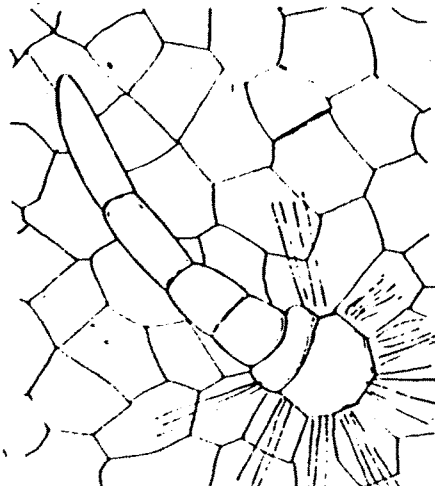
④ *C. hirsuta*



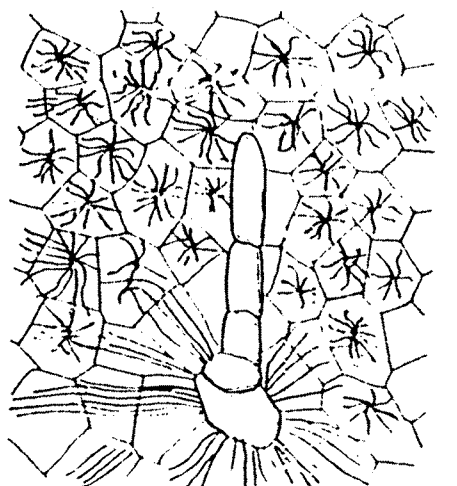
⑦ *C. media*



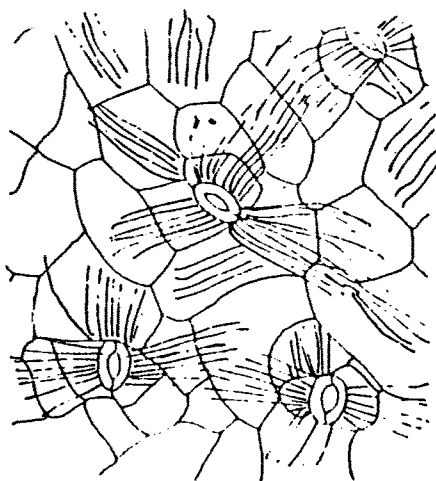
② *C. bulbosa* var. *bulbosa*



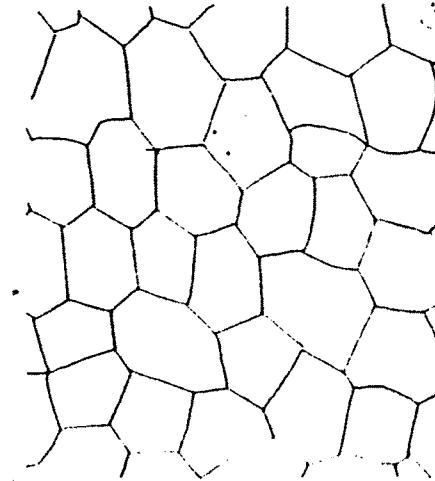
⑤ *C. huberi*



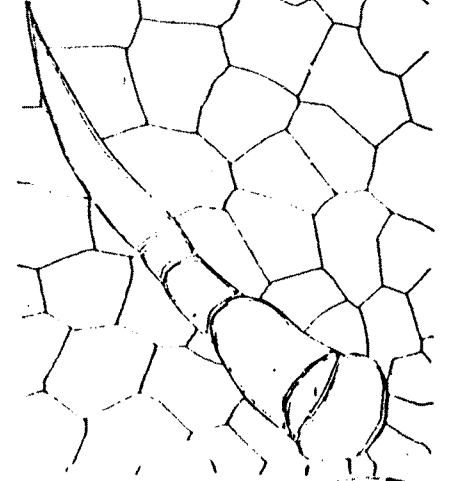
⑧ *C. noorjahaniae*



③ *C. bulbosa* var. *lus_hii*

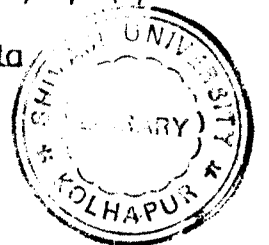


⑥ *C. maccannii*

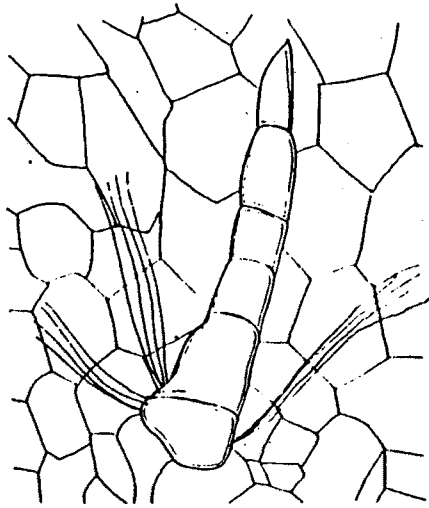


⑨ *C. oculata*

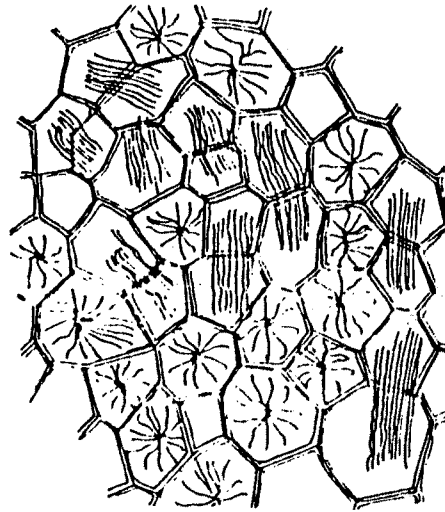
Upper epidermis Figs. 1-9 X 195



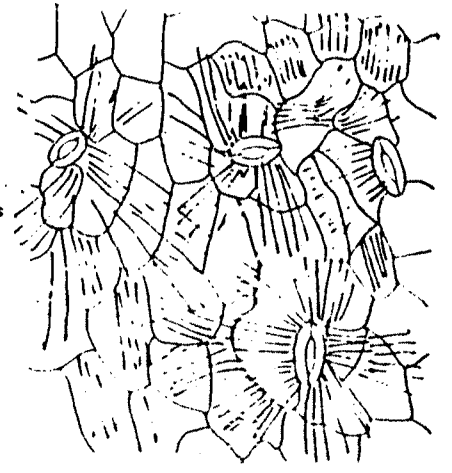
Text figure-XXV



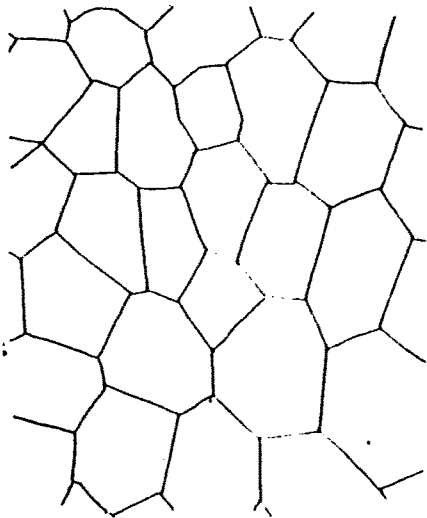
10 C. sahyadrica



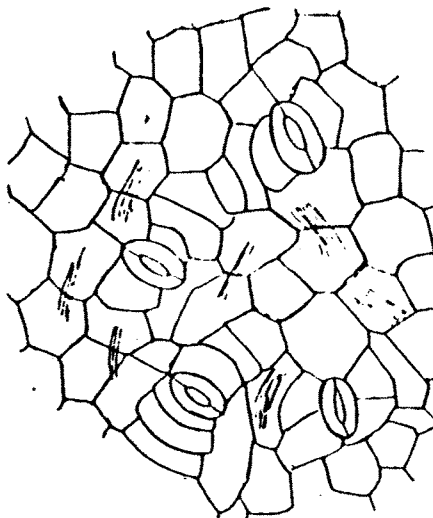
12 C. jainii



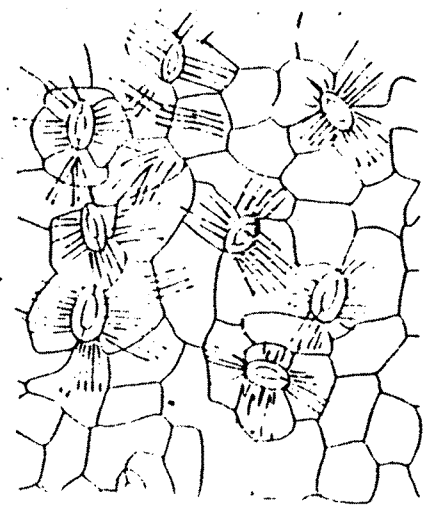
15 Brachystelma edulis



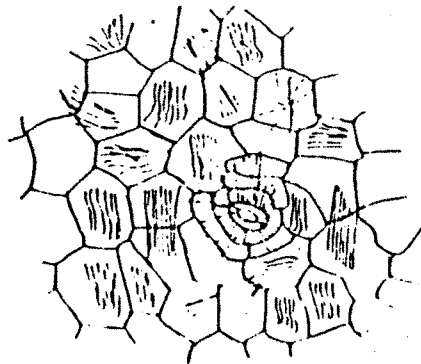
11 C. vincaefolia



13 C. juncea



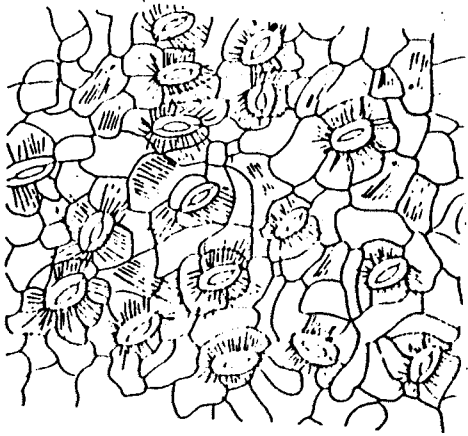
16 B. species



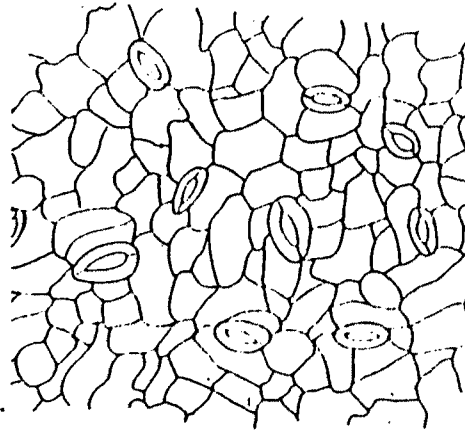
14 C. woodii

Upper epidermis Figs.10-16 X 195

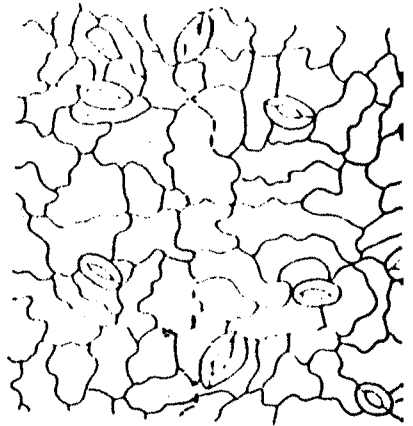
Text figure XXVI



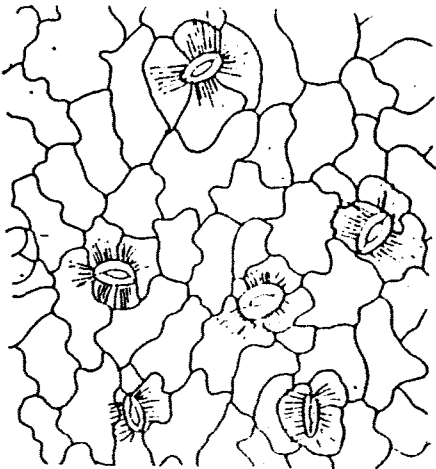
① Ceropogia attenuata



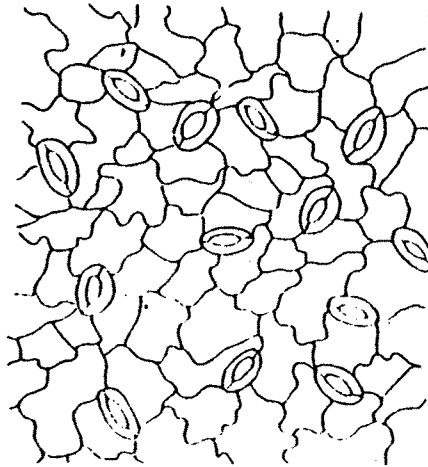
④ C. hirsuta



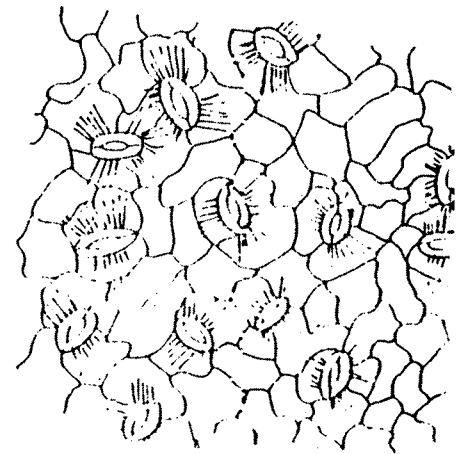
⑦ C. media



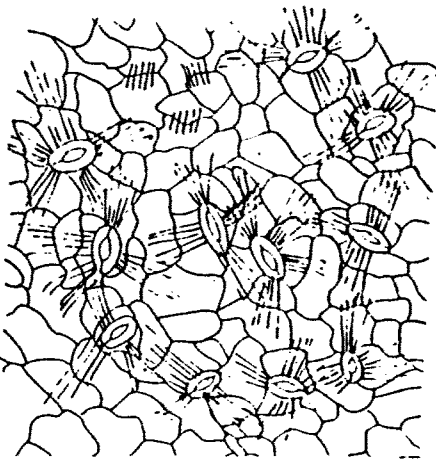
② C. bulbosa var. bulbosa



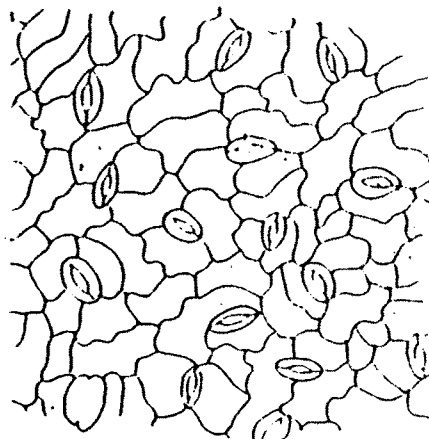
⑤ C. huberi



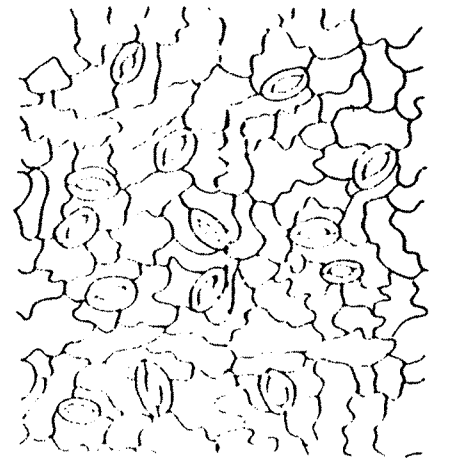
⑧ C. noorjariae



③ C. b var. lus hii



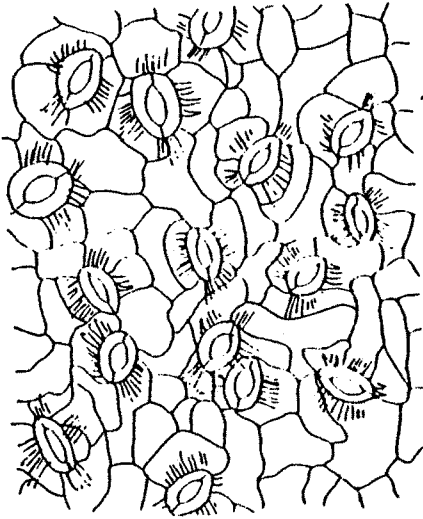
⑥ C. maccannii



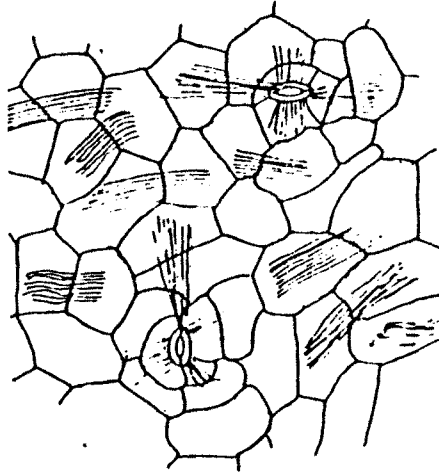
⑨ C. oculata

Lower epidermis Figs. 1-9 X 195

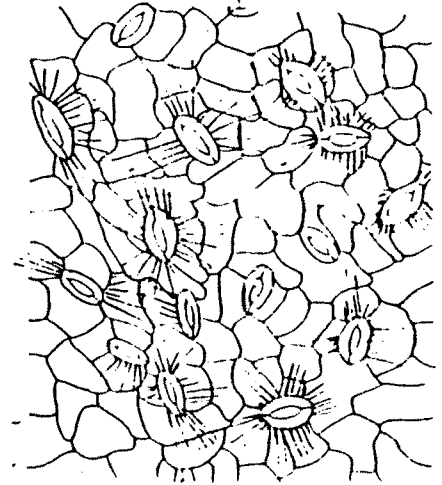
Text figure-XXVII



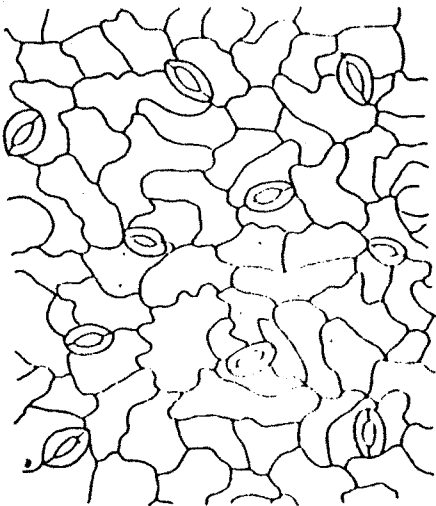
10 C. sahyadrica



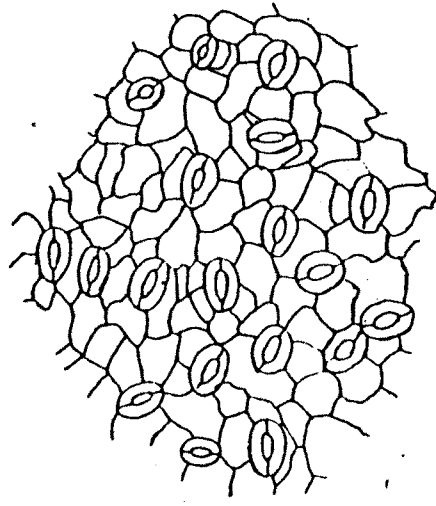
12 C. woodii



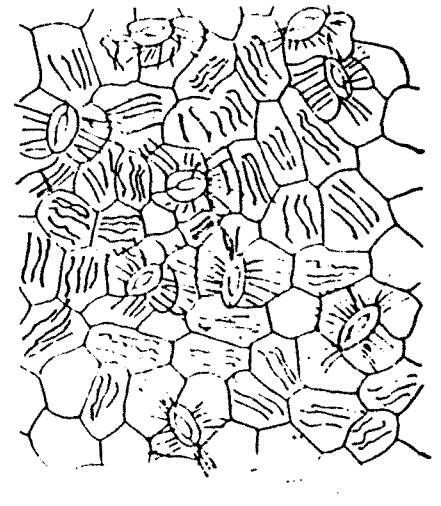
14 Brachystelma edulis



11 C. vincaefolia



13 C. jainii



15 B. species

Lower epidermis Figs.10-15 X 195

V) Trichomes

Trichome characters along with their distribution on aerial parts of Cerpegia and Brachystelma species are given in table 8 and text figure XXVIII figures 1-7 & text fig. XXIX Figs. 8-12.

1. C. attenuata - Trichomes are multicellular, uniseriate, 1-8 celled. Trichomes are present on all the aerial parts. The trichomes on stem are short, hooked and one-celled. Trichomes on leaf margins are short, 3-4 celled, pointed forward. Trichomes on sepals are 3-5 celled and are pointed forward.

2. C. bulbosa var. bulbosa - Trichomes absent.

3. C. bulbosa var. lushii - Trichomes absent.

4. C. hirsuta - Trichomes are long, elongated, uniseriate, multicellular, 5-21 celled. Trichomes are present on all aerial parts. Longest trichomes are found on peduncle. Basal cell of trichome is surrounded by many cells.

5. C. huberi - Trichomes are multicellular, uniseriate, 3-8 celled. Trichomes are absent on the stem, petiole, bract and calyx. They are found on leaf, peduncle and pedicel. They are either hooked or straight.

6. C. jainii - Trichomes are multicellular, uniseriate, short, 1-6 celled. Trichomes are found on almost all aerial parts. Trichomes are present on upper surface of leaf while lower surface is almost glabrous except nerves.

7. C. juncea - Trichomes absent.

8. C. maccannii - Trichomes are multicellular, uniseriate, 4-8 celled. Trichomes are present on stem, petiole, leaf, peduncle and pedicel while bract and calyx is glabrous. Trichomes on stem, petiole, pedicel and leaf are short, 4-7 celled, peduncle posses stout, larger, 5-10 celled hairs.

9. C. media - Trichomes are uniseriate, multicellular 2-19 celled. Trichomes are found only on stem, petole and peduncle. They are absent on pedicel, bract and calyx. Stem is sparsely hairly & hairs are short, bent and 2-8 celled. Petiole is also sparsely hairyly. The upper surface is almost glabrous. Longest hairs, upto 19-celled in height are found on pedicel.

10. C. noorjahaniae - Trichomes are multicellular uniseriate, 2-10 celled. They are present on all the aerial parts. Stem is sparsely hairy. There are many hairs on the margins of groove of petiole. Leaves are sparsely hairy on upper surface while lower surface is almost glabrous except nerves. Peducles are sparsely hairy.

11. C. oculata - Trichomes are multicellular, uniseriate, 3-15 celled. Trichomes are present on stem, petiole, leaf and peduncle. Trichomes on stem are short, 3-4 celled, straight or bent. Stem is sparsely hairy. Longest hairs upto 15-celled in height are found on pedicel & peduncle.

12. C. sahyadrica - Trichomes are multicellular, uniseriate, 3-11 celled present on all the aerial parts except calyx. Stem, peduncle and

Table : 7 Comparative account of cuticular characters of various species of *Ceropegia* & *Brachystelma*

Name of the species	Stomata		Stomatal size μm		Stomatal frequency/mm ²		Stomatal index		Epidermal cell size μm		Striations			
	Lower	Upper	Length	Breadth	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper		
													Length	Breadth
1. <i>Ceropegia attenuata</i> Hook	+	-	27.5	15	-	-	332.79	-	17.90	-	32.5	17.5	++	+++
2. <i>C. bulbosa</i> Roxb. var. <i>bulbosa</i>	+	+	27.5	12.5	25	15	194.80	48.6	22.64	9.37	60	37.5	++	++
3. <i>C. bulbosa</i> var. <i>jushii</i> (Grah) Hook	+	+	27.5	10	35	22.5	146.10	64.6	14.06	12.12	47.5	27.5	++	++
4. <i>C. hirsuta</i> Wt. et. Ara.	+	-	27.5	12.5	-	-	211.03	-	16.04	-	37.5	40	+	+
5. <i>C. huberi</i> Ans.	+	-	30	12.5	-	-	211.03	-	24.52	-	50	82.5	-	+
6. <i>C. jainii</i> Ans.	+	-	21.25	11.25	-	-	761.4	-	46.5	-	18.75	12.5	+	+++
7. <i>C. juncea</i> Roxb.	+	+	31.25	26.25	36.25	27.5	217.08	129.6	10.89	7.78	43	5.5	++	++
8. <i>C. maccannii</i> Ans.	+	-	30	15	-	-	227.27	-	17.07	-	32.7	17	-	+
9. <i>C. media</i> (Hober) Ansari	+	-	35	17.5	-	-	129.87	-	15.38	-	67.5	27.5	-	-
10. <i>C. noorjahaniae</i> Ans.	+	-	30	17.5	-	-	178.57	-	11.70	-	37	25	+	+++
11. <i>C. oculata</i> Hook	+	-	35	15	-	-	113.63	-	11.11	-	57.5	35	-	-
12. <i>C. sahyadrica</i> Ans. et. Kul.	+	-	30	15	-	-	211.03	-	16.66	-	50	17.5	-	+
13. <i>C. vincaefolia</i> Hook	+	-	30	20	-	-	146.10	-	14.05	-	55	32.5	-	-
14. <i>C. woodii</i>	+	+	23.75	15	31.25	20	48.6	32.4	4.91	6.06	59.5	43.75	++	+++
15. <i>Brachystelma edulis</i> Coll. & Helmsl	+	+	22.5	17.5	27.5	15	243.50	113.4	18.29	12.5	32.5	20	++	+++
16. <i>Brachystelma</i> species	+	+	30	17.5	27.5	17.5	259.74	81.0	15.38	9.43	45	27.5	++	++

+ - Stimulation faint & only found in cells around hair base & stomata
 ++ - Striations found in most of the epidermal cells
 +++ - Striations very prominent, present on all the cells.
 - - Present
 - - Absent

and leaves are sparsely hairy. Leaves are hairy on upper surface while lower surface is almost glabrous. Leaf margins are hairy. Short trichomes are found on stem, peduncle and petiole. Bracts and leaf margins possess longer trichomes.

13. C. vincaefolia - Trichomes are stout, multicellular, uniseriate, 2-16 celled. Trichomes are present on leaf, peduncle, bract and calyx while they are absent on stem, petiole and pedicel. Longest hairs upto 16 cell in height are found on peduncle.

14. C. woodii - Trichomes absent.

15. Brachystelma edulis - Trichomes are short, erect and hooked, 1-5 celled. They are present on all the aerial parts. Trichomes on stem are hooked and pointed downward. Bracts sparsely hairy only at apex. Leaf margins possess 1-3 celled hairs pointed forward. Leaf hairy on both surfaces. The hairs on leaf 1-5 celled, pointed forward

16. B. species - Trichomes are short, erect or hooked, 1-5 celled. They are present on all the aerial parts. They are similar to B. edulis.

Key to the species of Ceropegia and Brachystelma based on trichome character.

1. Trichomes absent on aerial parts of plants.

1. C. bulbosa var bulbosa

2. C. bulbosa var. lushii

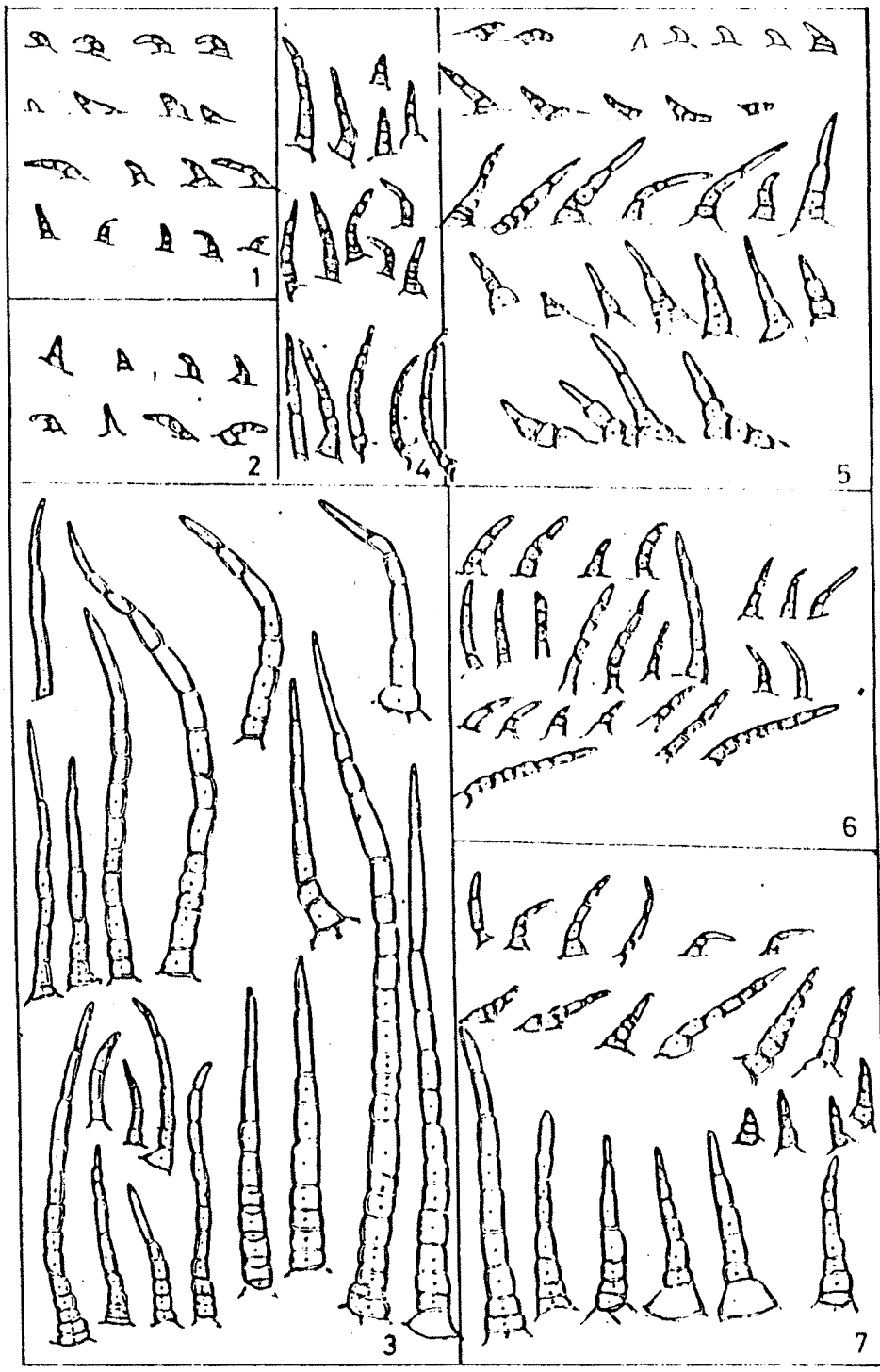
3. C. juncea

4. C. woodii

1. Trichomes present on aerial parts of plants.
 2. Trichomes of peduncle and pedicel large, 10-20 cell in height.
 3. Trichomes present on all aerial parts.
 5. C. hirsuta
 3. Trichomes not present on all aerial parts.
 4. Trichomes present on pedicel.
 6. C. media.
 7. C. oculata
 4. Trichomes absent on pedicel
 8. C. vincaefolia
2. Trichomes of peduncle and pedicel short, less than or upto 10 cell in height.
 5. Trichomes more or less straight, not hooked, trichomes usually more than 5 - cell in height.
 6. Trichomes present on all aerial parts.
 9. C. attenuata
 10. C. jainii
 6. Trichomes absent on ~~some~~ aerial parts.
 7. Trichomes absent on petiole & stem.
 11. C. huberi
 7. Trichomes present on petiole & stem.

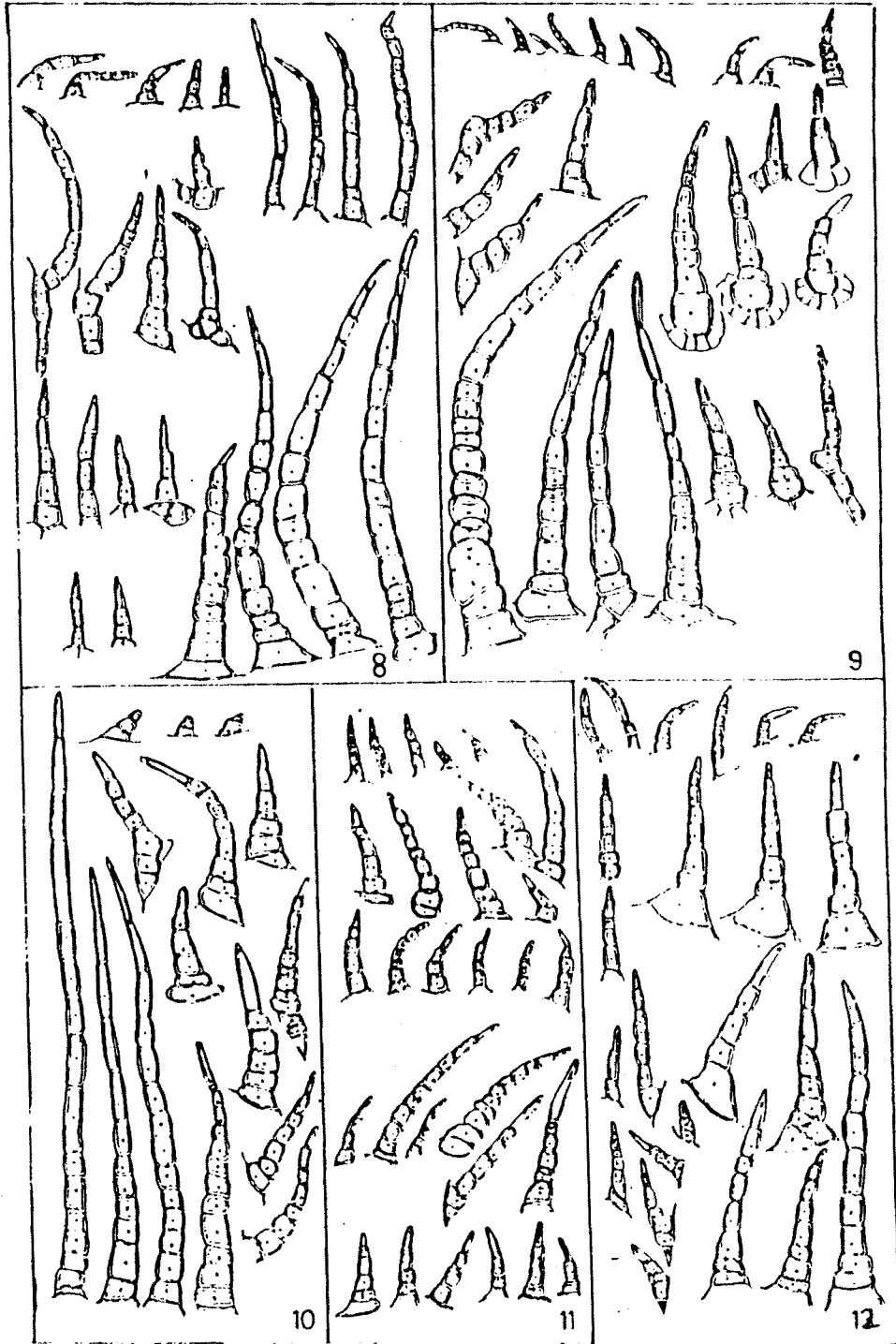
12. C. noorjahaniae
13. C. sahyadrica
14. C. maccannii
5. Trichomes short 1-5 celled, hooked.
15. Brachystelma edulis
16. B. species.

Text figure-XXVIII



Figs 1-7: 1 *Brachystelma edulis* 2 *B. species* 3 *C. hirsuta* 4 *C. huberi*
5 *C. attenuata* 6 *C. noorahaniuae* 7 *C. maccannii*

Text figure XXIX



Figs 8-12: 8 *C. oculata* 9 *C. media* 10 *C. vincetofolia* 11 *C. sahynatica*
12 *C. maccanni*

Table - 8: Distribution of trichomes on plant parts of Ceropegia and Brachystelma.

Sr. No.	Name of Species	Stem	Petiole	Leaf	Peduncle	Pedicel	Bract	Calyx	No. of Cells	Average length & breadth at base of hair um
1.	<u>C. attenuata</u>	+	+	+	+	+	+	+	1-8	336 x 105
2.	<u>C. bulbosa</u> var. <u>bulbosa</u>	-	-	-	-	-	-	-	-	-
3.	<u>C. bulbosa</u> var. <u>lushii</u>	-	-	-	-	-	-	-	-	-
4.	<u>C. hirsuta</u>	+	+	+	+	+	+	+	5-21	1556 x 126
5.	<u>C. huberi</u>	-	-	+	+	-	-	-	3-8	798 x 94
6.	<u>C. jainii</u>	+	+	+	+	+	+	+	1-6	336 x 126
7.	<u>C. juncea</u>	-	-	-	-	-	-	-	-	-
8.	<u>C. maccannii</u>	+	+	+	+	+	-	-	4-8	336 x 84
9.	<u>C. media</u>	+	+	+	+	-	-	-	2-19	504 x 126
10.	<u>C. noorjahaniae</u>	+	+	+	+	-	-	-	2-9	462 x 84
11.	<u>C. oculata</u>	+	+	+	+	+	-	-	3-5	336 x 84
12.	<u>C. sahyadrica</u>	+	+	+	+	+	-	-	3-11	630 x 126
13.	<u>C. vincaefolia</u>	-	-	+	+	-	+	+	2-16	462 x 126
14.	<u>C. woodii</u>	-	-	-	-	-	-	-	-	-
15.	<u>Brachystelma edulis</u>	+	+	+	-	+	+	-	1-5	252 x 42
16.	<u>B. species</u>	+	+	+	-	+	+	+	2-4	210 x 42

VI) Starch-grains

They are of common occurrence in all the parts of the plant of Ceropegia and Brachystelma species except succulent species. It seems to be major food reserve in both genera. Both the species possess tuber and parenchymatous tissue of tubers is packed with starch grains. The starch grains from tubers of various species are represented in text Figure XXX Figs. 1-12.

Starch grains are excentric and show striations around central nucleus. Largest starch grains were observed in C. huberi, C. vincaefolia, C. juncea. Smaller starch grains were observed in C. bulbosa. The starch grains show uniform structure in all the species. They range in shape from oval, spherical to elliptical.

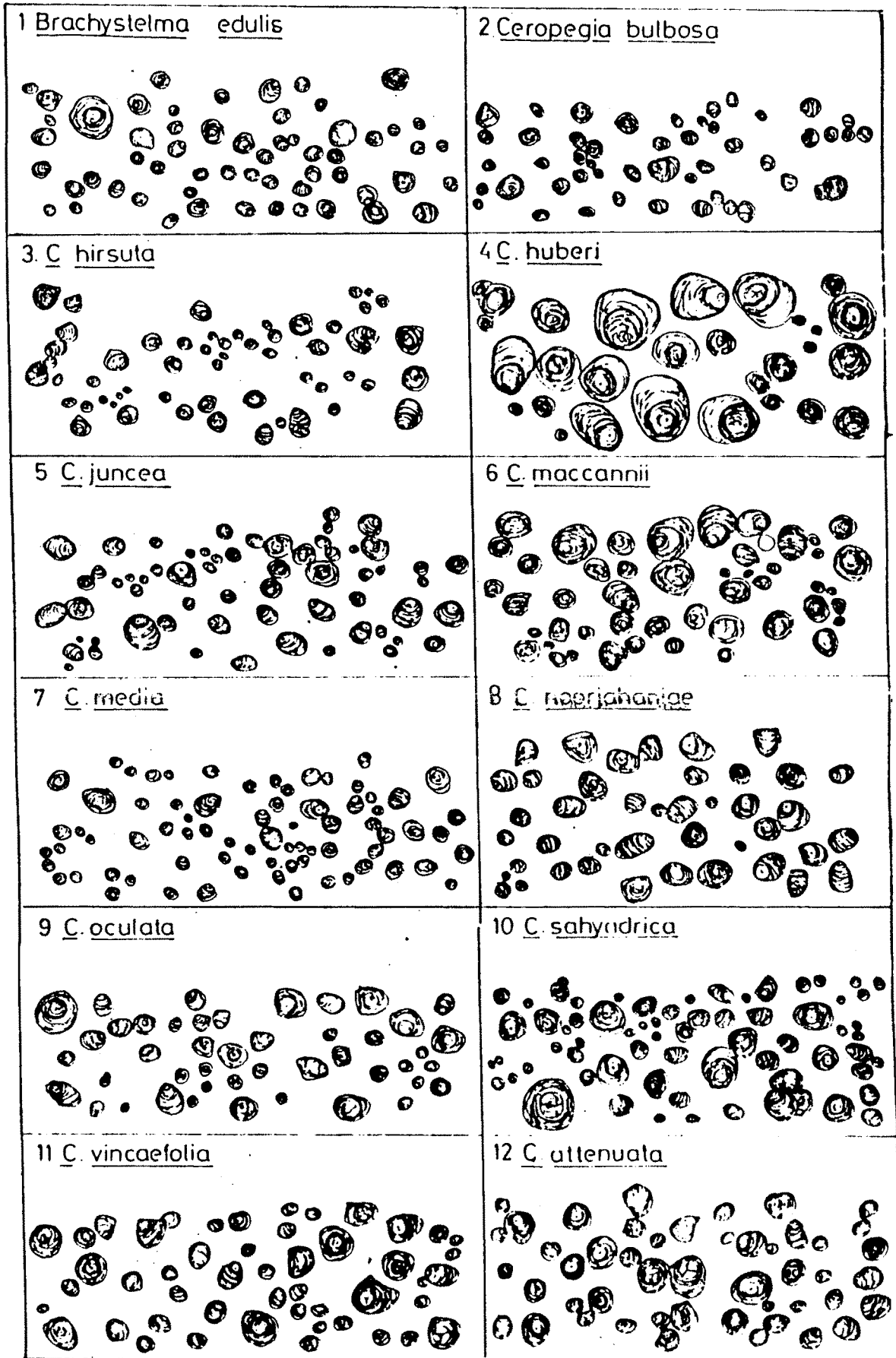
The starch grains are also observed in outer aerial parts such as stem, petiole & leaf. Starch grains are present in parenchyma associated with cellulose fibres in cortex of stem. Pith parenchyma also possess many starch grains. Starch grains in abundance in stem tissue were observed in C. hirsuta, C. jainii, C. oculata, C. media. The abundance of starch grains in stem tissues varies with species. Parenchyma around lateral bundles of petiole contains starch grains and form starch sheath around the vascular bundle. Similarly below central bundle the parenchymatous cells just below ventral phloem contain starch grains and form sheath.

It is interesting to note that no distinct starch grains of regular size and shape were observed in aerial parts of succulent

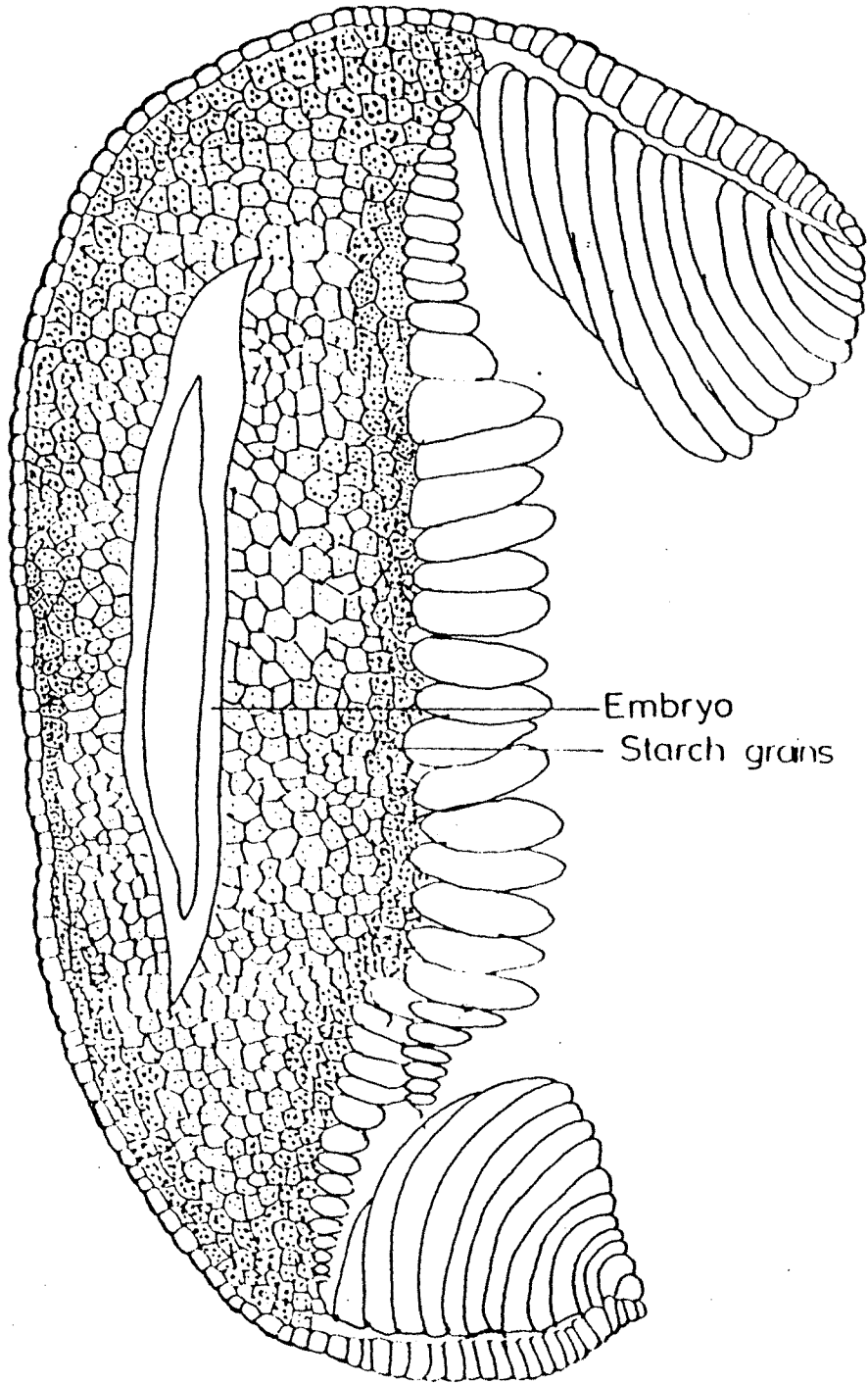
species such as C. bulbosa var. bulbosa, C. bulbosa var. lusitii and C. juncea. Starch like substance were stained by I₂KI solution but they lack usual morphology. These species are found to be CAM.

Seeds also store starch as a food reserve (Text Fi. XXXXI)
Carbohydrates were localized by PAS reaction given by Jensen (1990)
The peripheral cells of endosperm, just below epidermis are fully packed with starch grains while inner cells contain few or no starch grains. The starch from inner endosperm cells is utilized by developing embryo.

Text figure-XXX



Text figure XXXI



T.S. of seed X 280