OBSERVATIONS
1. **Argyreia nervosa** (Burm. f.) Boj.

*Argyreia nervosa* is commonly known as elephant creeper, samudrapalaka in Sanskrit and Samandar-ka Pat in Hindi. It is used in gleet, gonorrhoea, strangury and chronic ulcers.

It is a woody liana having polychasial cymes and each flower with a leafy bract. The calyx is persistent and covers the whole fruit up to maturity (Fig. 1). Fruit is an indehiscent globose, glabrous capsule (Fig. 2).

To study structural changes the ovaries and fruits at their sequential developmental stages were collected and sorted as follows:

<table>
<thead>
<tr>
<th>Sl No</th>
<th>Average length in mm</th>
<th>Average breadth in mm</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.50</td>
<td>2.00</td>
<td>Ovary from bud</td>
</tr>
<tr>
<td>2</td>
<td>2.00</td>
<td>2.50</td>
<td>Ovary from open flower</td>
</tr>
<tr>
<td>3</td>
<td>5.00</td>
<td>5.60</td>
<td>Young fruit stage</td>
</tr>
<tr>
<td>4</td>
<td>7.00</td>
<td>8.00</td>
<td>Developing fruit stage</td>
</tr>
<tr>
<td>5</td>
<td>10.00</td>
<td>11.00</td>
<td>Developing fruit stage</td>
</tr>
<tr>
<td>6</td>
<td>12.00</td>
<td>14.50</td>
<td>Mature fruit stage</td>
</tr>
<tr>
<td>7</td>
<td>15.50</td>
<td>18.00</td>
<td>Ripened fruit stage</td>
</tr>
</tbody>
</table>
Ovary:

Bicarpellary ovary is four celled having one ovule in each (Fig. 6) on parietal placenta. At the terminal region, there is no chamber, only central axis and two dorsal median bundles extend upto the tip (Fig. 5). Just below the terminal region four chambers are seen (Fig. 6) and both dorsal median bundles are found in the surrounding ovary wall near the dorsal septa. The basal region of ovary shows incomplete fusion of the carpels while towards the middle and terminal parts both the carpels fuse completely (Fig. 26). The shape of the basal axial tissue mass is squarish and all the four septa detach from it (Fig. 30) at the base. The extreme base of ovary has 2 dorsal medain and 4 central bundles. Out of these 4 central strands, 2 strands after branching develop into 4 placental strands and the rest two extend separately in both the ventral septae. There is no vascular supply in dorsal septae.

Ovary Wall:

It is parenchymatous and differentiated into outer epidermis, outer hypodermis, mesoderm, inner hypodermis and inner epidermis. These zones have different cell shapes and size.

Outer epidermis:

It is unilayered, the cells are rectangular or slightly tabular with centrally placed nuclei (Fig. 20) and a thin cuticle on the outer side. This surface is atriocomatous and stomata are not developed at this stage (Fig. 20).
**Outer hypodermis:**

It is 2-3 layered compactly arranged parenchymatous zone. The cells are rectangular, sometimes tangentially elongated. The cells divided periclinal and anticlinal are observed here (Fig. 7). The cells are densely filled with centrally placed nuclei.

**Mesoderm:**

It consists 14-18 layered zone of thin walled large parenchymatous cells without intercellular spaces (Fig. 7). Cells are polygonal, isodiametric in shape. Two dorsal median bundles are seen near inner hypodermis. Laticifers are present in this zone. Periclinal and anticlinal divisions are observed in this zone.

**Inner hypodermis:**

It is 3-4 layered zone of more compactly arranged small parenchymatous cells (Fig. 7). These cells are rectangular or slightly tangentially elongated with large nuclei.

**Inner epidermis:**

It consists single layered rectangular parenchymatous cells (Fig. 7), which are astomatic, atrichomatous and covered with a thin cuticle from the inner side.
Septum and Placentation:

At the extreme terminal region septae are not seen. The ovule chambers remain beneath the terminal region, where the septae are seen they are attached to the axis only up to middle region (Fig. 6), whereas towards the basal region they become separated from the axis (Fig. 30). Each septum is 15-20 layered thick which is bounded by unilayered epidermis. The septa appears as the direct projection from the ovary wall (Fig. 30). Each ventral septum has one vascular supply.

Placentation is parietal and found at the base of the ovary which attaches with the one septa. One placentum is found in each chamber. It is wavy towards the locule and having one vascular supply.

Development of Capsule:

Capsule is developed from the fertilized ovary. The pericarp developed from the ovary wall is distinguished into outer epicarp, middle mesocarp and inner endocarp, the ovules develop into seeds.

Epicarp:

It is 4-5 layered developed from outer epidermis and outer hypodermis of ovary wall (Fig. 34 b). The outer epidermis is unilayered parenchymatous. The cells are rectangular, tabular (Figs. 9,11,13,15) and sometimes tangentially elongated. It is covered with smooth cuticle, but at some places it is slightly striated. The cell walls appear beaded in surface view from young fruit stage (Fig. 23).
These beaded thickenings are more at the terminal region, less in middle and again more at the basal region of the fruit. These surface cells are pentagonal, hexagonal, rectangular, isodiametric and sometimes elongated (Fig. 21-25). These surface cells divide in all the planes. This layer is stomatic and atrichomatous. The mature stomata are paracytic (Fig. 27), hemiparacytic (Fig. 29) and anomocytic with 3-5 subsidiary cells (Fig. 28). Abnormalities in stomata are found from the young fruit stage like smaller stomata than normal size; one guard cell small; one guard cell with pore (Fig. 32); both the guard cells degenerated and only a pore present (Fig. 31); and some stomata are elongated. Frequency of stomata is more in young fruit than that in mature fruit as observed in a constant microscopic field (Graph. 37). Stomata are not found in the terminal region (Fig. 25). The outer epidermal cell areas gradually increase from ovary to mature stage while decrease at ripened stage as observed in surface and sectional views (Graphs. 35, 38). Just after the outer epidermis 3-4 layers become thick walled sclerenchymatous (Figs. 13, 15). These sclerenchyma are polygonal, isodiametric or oval in shape with simple pits and narrow or wide lumens (Fig. 34a). They develop from the outer hypodermis of ovary wall. Their thickening starts from young fruit stage. These cells separate from one another at ripening stage (Fig. 15). Periclinal and anticlinal divisions are seen in these cells upto developing stages.

**Mesocarp:**

It is the largest zone of the pericarp having 18-40 layered, large thin-walled parenchyma with intercellular spaces (Figs. 9-14, 34b). It develops from the mesoderm of ovary wall. Anticlinal and periclinal divisions are observed here. Laticifers are observed with epithelial cells in this region (Figs. 10, 14, 34b).
Mesocarpic cells disorganised at ripened stage (Fig. 13). Two dorsal median bundles are present near endocarp. 60-100 lateral vascular bundles are also observed in developing and mature fruits (Figs. 12, 14). The cell areas gradually increased from ovary to ripened stage (Graph. 39), and number of cell layers are also increased from ovary to mature stage.

**Endocarp:**

It is 3-5 layered compactly arranged thin-walled parenchymatous zone (Fig. 12) which develops from inner hypodermis and inner epidermis of ovary wall. It becomes thick-walled parenchyma at maturity (Figs. 14, 34b). It is bounded by unlayered parenchymatous inner epidermis which has rectangular, elongated cells densely filled with cytoplasm in young fruit. Their tangential walls are thicker than the radial walls. It is covered with thin cuticle. This layer is astomatic and artichomatous (Fig. 33). The inner epidermal cell areas are gradually increasing from ovary to ripened stage (Graphs. 36, 40). At the basal region of the fruit incomplete fusion of carpels are noticed (Fig. 34c). At this region separation of the carpel is clearly seen in epicarpic and mesocarpic zones (Fig. 17) but this separation is not found in endocarp. It gradually decreases and completely disappears at the middle and terminal regions.

**Septum, placentation and axis:**

Placentae are found attached to the septum just above the extreme basal region (Figs. 18, 34c). They become completely separated from one another at the extreme basal region of fruit (Fig. 19). The placental cells are found, loosely arranged when the fruit is mature (Fig. 19).
Septae are 30-40 cell layers thick and bounded by unilayered epidermis from both sides which is found to be in continuation of the inner epidermis. All the four septae appear completely separated from the axis at the base of developing and mature stages. Dorsal septae are completely attached with fruit wall up to extreme base. Ventral septae are partially separate from fruit wall only at the base while they attached completely at upper regions. Septal cells completely disorganise at dry stage. Each ventral septum has two vascular strands. These two vascular strands develop after branching of single vasculature of ovarian ventral septal bundle. There is no vascular supply in dorsal septa.

Central column or axis is not found at the extreme basal region, it appears in upper basal or middle (Figs.3,4) and terminal regions of the fruit. The axial cells are thick-walled loosely arranged parenchyma.
Argyrela nervosa (Burm. f.) Boj.

(Figures : 1-10)
Explanation to the figures: 11 to 19

11. A portion of T.S. of developing fruit wall with epicarp and mesocarp.

154x. (arrow head showing anticlinal division)

12. A portion of T.S. of developing fruit wall with mesocarp and endocarp.

154x.

13. T.S. of epicarp and mesocarp of mature fruit. 240x.

14. T.S. of mesocarp and endocarp of mature fruit. 240x.

15. T.S. of epicarp of ripened fruit. 240x.

16. Seed attached with placenta at the base of fruit. 62x.

17. T.S. of a potion of base of the mature fruit showing incomplete fusion of carpel in mesocarp. 154x.

18. T.S. at the base of the mature fruit showing (at arrow head) placenta attached to the ventral septa. 48x.

19. T.S. at the base of mature fruit showing all four placentae separate from each other. 48x.

Abbreviations Used:

e: epithelial cell; en : endocarp; ep: epicarp; iep: inner epicarp; la: laticifer; lvb: lateral vascular bundle; me: mesocarp; oe: outer epidermis; p: parenchyma; pl: placenta; scl: sclerenchyma, se: seed; st: stomata; vs: ventral septum.
Arqyreia nervosa

Explanation to the figures: 20 to 25

Outer epidermis from different stages in surface view (Magnification 200x):

20. Ovary stage.
21. Developing fruit stage.
22. Young fruit stage.
23. Basal region of young fruit stage, showing beaded cell wall.
24. Mature fruit stage.
25. Terminal region of developing fruit stage without stomata.
Argyreia nervosa

Explanation to the figures: 26 to 34a

26. Morphology of a mature ovary. 5x.
27. Paracytic stomata. 328x.
28. Anomocytic stomata. 328x.
29. Hemiporacytic stomata. 328x.
30. Schematic presentation of T.S. ovary at the upper basal region showing septae, placentae and ovules. 33x.
31. Stomata with both the guard cells degenerated. 328x.
32. Stomata with one guard cell and pore. 328x.
33. Inner epidermis of mature fruit in surface view. 205x.
34a. Macerated sclerenchyma of epicarp. 410x.

Abbreviations Used:
a: axis; b: basal part; ca: calyx; dmb: dorsal median bundle; ds: dorsal septum; m: middle part; o: ovule; ow: ovary wall; pl: placenta; plb: placental bundle; sb: septal bundle; t: terminal part; vs: ventral septum.
Argyreia nervosa

Explanation to the figures: 34b to 34c

34b. A portion of transverse section of fruit wall, 400 x.

34c. Schematic representation of basal portion of mature fruit showing pericarp, seeds, placenta, axis and septae. 5x.

Abbreviations Used:

a: axis; dmb: dorsal median bundle; ds: dorsal septum; e: epithelial cell; ep: epicarp; ic: inner cuticle; ifc: incomplete fusion of carpel; iep: inner epicarp; la: laticifer; me: mesocarp; oc: outer cuticle; oep: outer epicarp; p: parenchyma; pe: pericarp; pl: placenta; sb: septal bundle; scl: sclerenchyma; se: seed; vs: ventral septum.
Arqyreia nervosa

Explanation to the graphs : 35 to 37

35. Outer epidermal cell areas in micron from surface view of different stages.

36. Inner epidermal cell areas in surface view of different stages.

37. Frequency of normal stomata of different stages, showing reduction towards ripened stage in a constant microscopic field.
Argyreia nervosa

Explanation to the graphs: 38 to 40

38. Epicarpic cell areas measured in sectional view of different stages.
39. Mesocarpic cell areas measured of different stages in sectional view.
40. Endocarpic cell areas measured of different stages in sectional view.
**Epicarpic Cells Area in Sectional View**

- Epicarpic cells area in sectional view in micron

**Mesocarpic Cells Area in Sectional View**

- Mesocarpic cells area in sectional view in micron

**Endocarpic Cells Area in Sectional View**

- Endocarpic cells area in sectional view in micron

Stages

- Stages

**Notes:**

- Page 38
- Page 39
- Page 40
2. *Ipomoea obscura* (L.) Ker - Gawl

*Ipomoea obscura* (L.) Ker-Gawl. is an annual twinning herb. It is known as Vachagandha in Sanskrit. Leaves of this plant are aromatic and mucilagenous. Flowers are solitary and white with violet throat. Calyx is persistent, pubescent which covers nearly half length of fruit (Fig. 82). Ovary is bicarpellary, syncarpous, superior with two ovules in each chamber on axile placenta. Fruit is green, glabrous, globose capsule with acute tip and opens by four valves (Figs. 83,84).

For a detailed developmental study of pericarp, different developmental stages of flowers and fruits were taken as follows:

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Average length in mm</th>
<th>Average breadth in mm</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>0.75</td>
<td>0.50</td>
<td>Ovary from bud</td>
</tr>
<tr>
<td>2.</td>
<td>1.00</td>
<td>0.75</td>
<td>Ovary from open flower</td>
</tr>
<tr>
<td>3.</td>
<td>1.10</td>
<td>0.85</td>
<td>Young fruit stage</td>
</tr>
<tr>
<td>4.</td>
<td>2.50</td>
<td>2.00</td>
<td>Developing fruit stage</td>
</tr>
<tr>
<td>5.</td>
<td>5.00</td>
<td>3.50</td>
<td>Developing fruit stage</td>
</tr>
<tr>
<td>6.</td>
<td>13.00</td>
<td>9.20</td>
<td>Mature fruit stage</td>
</tr>
<tr>
<td>7.</td>
<td>13.00</td>
<td>9.20</td>
<td>Ripened fruit stage</td>
</tr>
</tbody>
</table>
**Ovary:**

At the extreme base of ovary two central and six peripheral vascular bundles are observed. Both the central vascular bundles after branching produce four bundles, one furnished in each placentum. Out of six peripheral, two dorsal median, two ventral and two are septal bundles. But at the extreme tip, only dorsal median bundles are seen (Fig. 41). Ovules and chambers are not seen in extreme tip and bicarpellary stylar gap is present. All the cells of this region are parenchymatous.

Ovary is globose and tapering into acuminate apex. Persistent calyx adheres tightly to the base of the ovary during further development. In the basal and middle regions, ovary is bilocular with two ovules borne in each locule (Fig. 81). At the base of ovary, due to growth of axial tissues between the two ovules of each locule appears false four chambered. Growth of these axial tissues start from the middle region of the ovary (Fig. 45). Towards apical region ovules are not observed due to the closing of ovular chambers.

**Ovary Wall:**

The ovary wall is about 6-8 cell layers thick and parenchymatous. These layers show diversity with regards to size and shape of the cells (Fig. 43), and thus so differentiated into outer epidermis, mesodermis, inner hypodermis and inner epidermis.
**Outer epidermis:**

It is the outermost layer of the ovary wall, which is constituted of elongated and/or rectangular cells. The cells of the outer epidermis always divide anticlinally. The tangential walls are thicker than their radial walls. In surface view the cells are polygonal, isodiametric or irregular in shape (Fig. 50). The cell walls are thin, arched and straight. A thin and wavy cuticle covers this layer. Paracytic and anomocytic stomata are present but hairs are totally absent.

**Mesoderm:**

Next to the outer epidermis 3-5 cell layers thick parenchymatous zone is that of the mesoderm (Fig. 43). Its cells are large vacuolated and loosely arranged with deeply stained cytoplasm, and laterally or centrally placed large spherical nuclei. There are two dorsal median bundles and two ventral vascular bundles seen in the middle region of mesoderm, while only two dorsal median bundles reach upto extreme terminal region of the ovary. Druses are found in some cells.

**Inner hypodermis:**

The next zone beneath the mesoderm is 2-3 layered inner hypodermis. Its cells are parenchymatous, compactly arranged and filled with dense cytoplasm containing spherical, centrally placed nuclei (Fig. 43). These cells have thicker tangential walls than their radial walls and show anticlinal divisions. These cells are vacuolated towards the septum but densely filled with cytoplasm at locular zone.
Inner epidermis:

The innermost single layered inner epidermis consists of tangentially elongated, rectangular and compactly arranged parenchyma cells (Fig. 43). It is devoid of stomata and hairs. A thin cuticle covers this layer.

Septum:

Lateral walls of each carpel are called septae. Breadth of septum is broad at the base, becomes thinner towards the middle part and again broad at the apical region. It is 11-12 layered thick with two peripheral epidermal layers. The septal cells are thin walled parenchymatous and polygonal in shape. These cells are vacuolated with laterally placed nuclei towards the axis in the middle region but densely filled with cytoplasm at the basal region. One vascular bundle is present in dorsal side of each septum (fig. 81). Both the parenchymatous epidermal layers of the septum are found in continuation with inner epidermis of the adjacent loculi. These epidermal cells are rectangular with centrally placed large nuclei. Anticlinal divisions are seen in these layers. Stomata and trichomes are absent in cells of epidermal layers.

Placentum:

Only in the basal region of each carpel two placentae are borne on the axis. The placenta consists of epidermal layer which is wavy at both ends (Fig. 44). Placental epidermis is astomatic and atrichomatous.
**Axis of the ovary:**

The central core of ovary consists of large, elongated or spherical thick-walled parenchyma cells (Fig. 45). These masses of central tissues gradually increase in length of each chamber from the middle to basal region (Figs. 45, 44). Due to formation of these false septum like growth, the base of ovary appears to be four chambered.

**Structure of the developing and mature pericarp:**

Fertilization of ovary is the first step in the fruit development. The longitudinal growth of the fruit wall is due to enlargement of its cells of which it consists. Enlargement of the cells present in different tissue zones of the pericarp is parallel to the long axis of the fruit and their subsequent divisions are perpendicular to it. Growth in the circumference is due to the anticlinal divisions or tangential enlargement of cells in the peripheral layers.

After fertilization ovary develops into a capsule where wall is differentiated into epicarp, mesocarp and endocarp.

**Epicarp:**

It is unilayered in all stages and develops from the outer epidermis of ovary wall (Figs. 47-49, 87b). These cells are tabular, elongated and compactly arranged having tangential walls thick and radial walls thin. It is atrichomatous and stomatic. In surface view the cells are polygonal, isodiametric or irregular in shape in all the stages (Figs. 51-54). Cells walls are thin, curved/arched, straight
in all the stages but sinuous walls are observed in the terminal part of the mature fruit (Figs. 55, 59). Stomata observed fall under seven types namely anomocytic with 3-6 surrounding cells (Figs. 59, 64). Paracytic stomata the subsidiary cells may be contiguous at both ends (Fig. 57), contiguous at one end (Fig. 58), or non-contiguous at any ends (Fig. 62), and one subsidiary cells may be horse-shoe shaped (Fig. 67). Two types of staurocytic stomata are observed. One type of staurocytic stomata with four subsidiary cells oriented in a crossed position to the pore, depending on whether one arm of the cross formed by the radial wall of the subsidiary cells is in line with the line of closure of the guard cells (Fig. 69) or another at 45° to it (Fig. 66). Diacytic (Figs. 60, 63); laterocyclic (Fig. 61); hemiparacytic (Fig. 68); and anisocytic (Fig. 76) stomata are also observed.

The abnormalities of stomata like degeneration of the guard cells and contiguous stomata have been observed. The degeneration of guard cells and the degeneration of the guard cells with pore are seen in the epidermis of developmental to mature stages. Stomata with both the guard cells degenerated (Fig. 65); a single guard cell with pore (Fig. 70); and one guard cell smaller than other (Fig. 77) are observed. In contiguous stomata all the guard cells degenerated (Fig. 73) or three guard cells are degenerated (Fig. 72); or three guard cells degenerate and one may be disappeared (Fig. 71). Different types of contiguous stomata like superimposed (Fig. 74), placed at right angle to each other (Fig. 78); juxtaposed overlapped (Fig. 79); obliquely placed (Fig. 75) and superimposed displaced (Fig. 80) are noticed from different stages.

The frequency of stomata decreases towards maturity and ripened stage (Graph. 88) in a constant microscopic field due to elongation and enlargement of the epidermal cells.

In mature fruit the stomatal frequency decreases from basal to
terminal parts. The cell areas of outer epidermis gradually increase up to mature stage but decrease towards the dry stage (Graphs. 89, 91) due to shrinkage.

The epidermal layer is covered with thick and striated cuticle. These striations flow out from the stomata i.e. at right angles to the pore (Fig. 57); parallel to long axes of the pore (Fig. 58). They extend in all directions from the stomata (Fig. 64). These striations are mostly linear while corrugating are seen in terminal part of mature epicarp (Fig. 59).

**Mesocarp**:

The cells between outer epidermis and inner hypodermis of ovary wall constitute the middle region of the pericarp called mesocarp. It is 3-5 layered thick zone from the early stages of the fruit development (Figs. 48,49,87b). These cells are thin walled, loosely arranged with centrally placed nuclei. The shapes of these cells are oval in developing, and polygonal and isodimetric in mature stage. Two dorsal median and two ventral vascular bundles are present in mesocarp near the endocarp. 8 lateral vascular bundles develop in mesocarp. Sphaeraphides are present in some cells of this zone. Laticifers with epithelial cells are present. Abundant lysigenous cavities are formed just below the epicarp or in outer layer of mesocarp from 4th stage which are tangentially elongated (Fig. 49).

During the development of the fruit wall no increment in the number of mesocarpic layers could be seen. The mesocarpic cells in the stages 4th and 5th show gradual enlargement and vacuolation. At maturity the mesocarpic parenchyma show intercellular spaces and their cell walls disorganisation. The cell areas gradually increase up to maturity but decrease at ripened stage (Graph. 92).
**Endocarp:**

It is 5-7 layered and develops from the inner hypodermis and inner epidermis of the ovary wall. Inner epidermal cells divide anticlinally, whereas inner hypodermal cells divide anticlinally as well as periclinally and enlarge in size. They are highly vacuolated and get thickened from the 4th stage. Towards maturity it is differentiated into 3 sub-zones as outer, middle and inner. Outer sub-zone is 1-2 layered which develops into highly sclerenchymatous endocarpic zone (Figs. 49, 87b). At maturity, endocarpic cells are heavily lignified and are with narrow or broad lumen. These sclereids show diversity in their morphological characters, i.e. shape, size and wall thickening (Fig. 87a). Out of these sclereids some are thin-walled simple and with large lumen. Some are thick-walled, simple and with large or small lumen, some are forked and some are with one or both ends acute. Next to this, the middle sub-zone is 3-4 layered. The cells of this sub-zone are also sclerenchymatous but less lignified than those of the outer zone (Fig. 87b). The inner sub-zone, or the innermost layer is inner epidermis which is thick-walled parenchymatous with tangentially elongated cells in the developing stages (Figs. 48, 87b); towards maturity they may be oblong, rectangular and slightly elongated (Fig. 49). This layer is astomatic, atrichomatous (Fig. 56) and covered with thin and smooth cuticle. The cell areas of inner epidermis gradually increase upto maturity but decrease at the dry stage due to shrinkage of cell wall (Graphs. 90, 93). Here sigmoid curves for the growth of all outer and inner epidermal cell areas are obtained observed in surface view. The same type of sigmoid curves are reported for the growth of all three pericarpic zones when the cell areas are measured in sectional view (Graphs. 91-93).
**Septum:**

Septum is 11-12 cell layers thick. It is lined on either side by its own uniseriate epidermal layers and they are found in continuation of inner endocarpic layer of adjacent loculi upto young fruit stage. The epidermis of the septum is astomatic and atrichomatous. Septae in the ripened fruit are completely separate from the pericarp. This separation has started from developing fruit stages (Fig. 47). The parenchyma present in between epidermal layers of the septum show elongation, vacuolation, disorganisation and loose arrangement with more intercellular spaces (Fig. 47). In the dorsal side of each septum single vascular bundle is seen (Figs. 46, 87c).

**Placentum:**

It is found only at the base of the fruit (Fig. 87c). In each locule two placentae are seen. It consists of epidermal cells which are tangentially elongated parenchyma containing spherical nuclei. Placental cells are compactly arranged. Each placentum has one vascular supply nourishing the developing seed. Placental epidermis is astomatic and atrichomatous.

**Axis of the fruit:**

It is found only at the basal and middle regions (Figs. 45, 46). In early stages of fruit development the spherical or elongated parenchymatous cells contain granular cytoplasm and spherical nuclei. During the development of the fruit
the axial parechyma become thick-walled and show enlargement, high vacuolation and form large intercellular spaces among them. Towards apical region of developing and mature fruit, axis is not seen, only a gap formation is found in the centre (Fig. 42). All cells of this region are parenchymatous but central gap or hole is surrounded by 4-5 layered small and thick-walled cells, out of these, inner 1 or 2 layers are lignified.

**Dehiscence of the capsule**:

Dehiscence of the fruit occurs when the mature fruit is light yellow in colour and the tissues are dry and air filled. Dehiscence of the ripe capsule is valvular opening into 4 valves (Figs. 83, 86). The splitting of the ripe capsule is longitudinal i.e parallel to the whole length of pericarp and the septae are completely detached from it. The ripe capsule dehisces into two steps, primarily loculicidal i.e. splitting into two halves through mid-locule zone or dorsal vasculature or dorsal dehiscence zone (Fig. 85). Then each half splits into two through their ventral vasculature or ventral dehiscence zone. At the same time septa completely detach from the fruit wall (Fig. 86). In the place of dehiscence zone, structure of pericarp is weakened at epicarpic and mesocarpic regions. To preserve delicate and thin walled cells, sclerenchymatous endocarpic layers are discontinued at this zone and filled with thick walled parenchyma. Due to water loss and shrinkage of weak cells in the mid-locule and the ventral zones, the dry capsule dehisces from both inner and outer sides of the pericarp.
Ipomoea obscura

Explanation to the figures: 41 to 49

41. T.S. of extreme tip of ovary showing 2 dorsal median bundles and central stylar gap. 120x.

42. T.S. of extreme tip of mature fruit with central gap. 192x.

43. A portion of T.S. of ovary wall. 460x.

44. T.S. at the base of ovary showing placentum with ovule, septum and growth of axial tissue towards ovary wall. 192x.

45. T.S. central portion of ovary, showing 4 ovules and axis at middle region. 154x.

46. T.S. basal portion of young fruit with seed, placenta axis and axial tissue growth. 120x.

47. T.S. a portion of fruit wall with septum showing separation of septum starting at 5th developing fruit stage and the septal cells disorganise. 192x.

48. T.S. a portion of developing fruit wall. 384x.

49. T.S. a portion of mature fruit wall. 192x.

Abbreviations Used:

a: axis; atg: axial tissue growth; cg: central gap; dmb: dorsal median bundle; en: endocarp; ep: epicarp; ie: inner epidermis; ien: inner endocarp; ih: inner hypodermis; l: lycigenous cavity; md: mesoderm; me: mesocarp; men: middle endocarp; o: ovule; oe: outer epidermis; oen: outer endocarp; pl: placenta; s: septum; sb: septal bundle; se: seed.
Ipomoea obscura

Explanation to the figures: 50 to 56

Outer epidermis from different stages: (in surface view:

50. Ovary stage. 328x.

51. Young fruit stage. 328x.

52. Developing fruit 4th stage. 328x.

53. Developing fruit 5th stage. 328x.

54. Mature fruit. 164x.

55. Terminal portion of mature fruit with sinuous walls. 164x.

56. Inner epidermis of mature fruit stage. 328x.
Ipomoea obscura

Explanation to the figures : 57 to 80

(Magnification 410x)

57, 58. Paracytic stomata at developing stages with cuticular striations.

59. Anomocytic stomata with sinuous walls and corrugated cuticle in terminal region of mature stage.

60, 63. Diacytic stomata at developing stages.

61. Laterocyclic stomata at young fruit stage.

62. Paracytic stomata at developing stage.

64. Anomocytic stomata with striations at mature stage.

65. Stomata with both the guard cells degenerated at mature stage.

66, 69. Staurocytic stomata at mature stage.

67. Paracytic stomata with one guard cell horse-shoe shaped at mature stage.

68. Hemiparacytic stomata at mature stage.

70. Stomata with single guard cell and pore at developing stage.

71-75 & 78-80. Contiguous stomata at mature stage.

76. Anisocytic stomata at young stage.

77. Stomata with one guard cell smaller at mature stage.
Ipomoea obscura

Explanation to the figures: 81 to 87a

81. Schematic representation of bichambered ovary with 4 ovules of middle region. 50x.

82. A mature capsule with calyx. 2.5x.

83. Schematic representation of dehisced capsule. 2.5x.

84. Top view of a dehisced capsule. 2x.

85. Schematic representation of first step of dehiscence of fruit wall into two halves as loculicidal at middle region. 5x.

86. Schematic representation of final step of dehiscence of fruit wall into four valves and septum detached from the wall. 5x.

87a. Diversity of endocarpic sclerenchymatous cells. 400x.

Abbreviations Used:
a: axis; ca: calyx; ddz: dorsal dehiscence zone; dmb: dorsal median bundle; f: fruit; o: ovule; oe: outer epidermis; ow: ovary wall; s: septum; sb: septal bundle; se: seed; v: valve; vdz: ventral dehiscence zone; vvb: ventral vascular bundle.
**Ipomoea obscura**

Explanation to the figures: 87b to 87c.

87b. T. S. a portion of fruit wall 400x.

87c. Schematic representation of basal portion of mature fruit showing pericarp, seeds, placenta, axis, septae and axial tissue growth 6.5 x.

**Abbreviations Used:**

a: axis; atg: axial tissue growth; dmb: dorsal median bundle; ep: epicarp; ie: inner cuticle; ien: inner endocarp; l: lysigenous cavity; me: mesocarp; men: middle endocarp; oc: outer cuticle; oen: outer endocarp; pe: pericarp; pl: placenta; s: septum; sb: septal bundle; se: seed; vvb: ventral vasular bundle.
Ipomoea obscura

Explanation to the graphs : 88 to 90

88. Frequency of normal stomata of different stages. Here frequency of stomata is reduced towards the maturity and ripened stages in a constant microscopic field.

89. Outer epidermal cell areas in surface view of different stages.

90. Inner epidermal cell areas in surface view of different stages.

(Note : Here a sigmoid graph is found in both outer and inner epidermal cell areas.)
**Ipomoea obscura**

Explanation to the graphs: 91 to 93

91. Outermost epicarpic cells area in sectional view of different stages.

92. Mesocarpic cell areas of different stages.

93. Innermost endocarpic cell areas of different stages in sectional view.

(Note: Here sigmoid graph is found of epicarpic, mesocarpic and innermost endocarpic cell areas.)
Stages

Epicarpic cells area in sectional view in micron

Mesocarpic cells area in sectional view in micron

Inner epidermal cells area in sectional view in micron

91

92

93
3. **Merremia gangetica** (L.) Cufod.

*Merremia gangetica* is a creeping annual herb, rooting at the nodes, clothed with scattered long soft hairs. Leaves are reniform, glabrous and petiolate. Flowers are small, yellow, axillary, few (2-3) together on a very short peduncle. Bracts small, ovate, acute and hairy. Sepals slightly hairy on the back, strongly ciliate on the margins. Calyx persistent, nearly half the length of the fruit (Fig. 94). Fruit is grey, subglobose, glabrous, 4 seeded capsule which opens by 4 valves by valvular dehiscence (Fig. 104).

For a detailed developmental study of pericarp, different developmental stages of ovaries and fruits were taken as follows:

<table>
<thead>
<tr>
<th>Sl No</th>
<th>Average length in mm</th>
<th>Average breadth in mm</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>1.00</td>
<td>0.95</td>
<td>Ovary from bud</td>
</tr>
<tr>
<td>2.</td>
<td>1.20</td>
<td>1.00</td>
<td>Ovary from open flower</td>
</tr>
<tr>
<td>3.</td>
<td>1.50</td>
<td>1.40</td>
<td>Young fruit stage</td>
</tr>
<tr>
<td>4.</td>
<td>2.20</td>
<td>2.00</td>
<td>Developing fruit stage</td>
</tr>
<tr>
<td>5.</td>
<td>4.00</td>
<td>3.50</td>
<td>Developing fruit stage</td>
</tr>
<tr>
<td>6.</td>
<td>4.20</td>
<td>3.80</td>
<td>Mature fruit stage</td>
</tr>
<tr>
<td>7.</td>
<td>4.20</td>
<td>3.80</td>
<td>Ripened fruit stage</td>
</tr>
</tbody>
</table>
Ovary:

Bicarpellary ovary is bichambered syncarpous, superior having 2 ovules in each on axile placenta (Fig. 99), abnormality like unilocular one ovuled ovary is also seen. Six vascular bundles are present at the extreme base of the ovary. Outer two vascular bundles extend upto terminal region as dorsal median bundles. Two central bundles constitute the two septal bundles (one in each septum). Two bundles producing four placental bundles, which nourish the ovules. At the base of ovary, due to extension of central axial tissues between two ovules of each chamber appears false four chambered. These extensions start from the middle region of ovary (Figs. 97,98). There is no chamber at the terminal region, only two dorsal median bundles are seen.

Ovary Wall:

It is parenchymatous and differentiated into outer epidermis, mesodermis, inner hypodermis and inner epidermis. These zones have different cell shapes and size.

Outer epidermis:

It is unilayered, constituted columnar, squarish or rectangular cell shapes, (Fig. 95) with densely filled cytoplasm and laterally placed nuclei towards inner side. A thin and smooth cuticle covers this layer. Stomata are present but hairs are totally absent. These stomata are anomocytic and paracytic. Periclinal divisions are seen in epidermal cells.
**Mesoderm:**

It consists of a 3-5 layered zone of parenchymatous cells with deeply stained cytoplasm (Fig. 95) and centrally placed nuclei. These cells are polygonal to isodiametric in shape and compactly arranged. Two dorsal median bundles and two developing ventral vascular bundles are observed here. Sphaeraphides may be seen in some cells.

**Inner hypodermis:**

It is a 2-3 layered zone of rectangular and more compactly arranged parenchymatous cells (Fig. 95). These cells are slightly smaller than mesodermal cells. These cells are densely filled with cytoplasm and centrally placed nuclei.

**Inner epidermis:**

It is unilayered and consists of tangentially elongated cells. It is astomatic and atrichomatous (Fig. 95). Anti-clinal divisions are seen in this layer. It is covered with thin and smooth cuticle from the inner side. These cells appear rectangular in surface view.

**Septum and Placentum:**

At the extreme terminal region septa is not seen. The ovule chambers remain beneath the terminal region where the septa is seen attached to the axis. It is broad at both the ends and thin in middle portion (Fig. 98). It is 8-9 cell
layers thick and cells are thin-walled large polygonal parenchymatous cells which are vacuolated. These cells are larger than the mesodermal parenchyma. It is bounded by unilayered peripheral epidermal cells from both the sides which are incontinuation of inner epidermis of ovary wall of the adjacent loculi. These epidermal cells are rectangular in shape. One vascular bundle is found in each septum. Sphaeraphides are present in some septal cells.

Placentation is axile and found at the base of the ovary (Fig. 99). Two placentae are found in each chamber. It is slightly wavy towards the ovule and each has one vascular supply.

**Fruit development:**

It is developed from fertilized ovary. Ovary wall develops into pericarp and ovules into seed. Pericarp is divisible into epicarp, mesocarp and endocarp.

**Epicarp:**

It is bilayered and developed due to periclinal divisions in unilayered outer epidermis of ovary wall. Epicarp of young fruit of middle zone becomes bilayered, but at the terminal part upto developing stages only unilayered epicarp is seen. It becomes bilayered at maturity. The outer layer is parenchymatous (Figs. 96, 100-101, 107). These cells are elongated, isodiametric or polygonal. It is covered with thick and highly striated cuticle (Fig. 107). These striations start from the 4th developing stage. In surface view these cells are rectangular, cell
walls are slightly thick, straight and arched. The cell walls appear beaded, like in *Argyreia nervosa*. This layer is stomatic and atrichomatous. The mature stomata are anomocytic with 4-6 subsidiary cells, paracytic and contiguous stomata are also seen. Cell areas gradually increase from ovary to mature stage both as seen in surface and sectional views. Inner layer of epicarp becomes thick-walled. These thickenings remain up to developing stages and at maturity it becomes sclereified. So, outer layer of epicarp is parenchymatous but inner becomes sclerenchymatous (Figs. 100, 101, 107). These cells are different in shape and with wide lumen (Fig. 105).

**Mesocarp:**

It's having 3-5 layered zone of the pericarp. These parenchymatous cells are thin-walled, polygonal, isodiametric in shape with intercellular spaces (Figs. 96, 100-101, 107). Rhomboidal crystals are present in some mesocarpic cells. Two dorsal median and two ventral vascular bundles are present which are conjoint, collateral and closed. 32-36 lateral vascular bundles develop in mesocarp (Fig. 96). The cell areas gradually increase from ovary to mature stage. Laticifers with epithelial cells are present in mesocarp (Fig. 96).

**Endocarp:**

It develops from the inner hypodermis and inner epidermis of ovary wall. It is 4-6 layered thick zone of pericarp (Fig. 96, 100-101, 107). Outer 3-5 layers are sclerenchymatous (Fig. 107) and innermost layer or inner epidermis is parenchymatous. These cells are different in shape (Fig. 106). But this epidermis
is bilayered thick-walled parenchymatous near septum. This layer is atrichomatous and astomatic and covered with thin and smooth cuticle.

**Septum and Placentation:**

Placentae are found at the base of the fruit. Each placentum has one vascular supply. All four placentae are attached to the axis (Fig. 108). The placental cells are found to be loosely arranged when the fruit is mature.

Septum is 11-13 cell layers thick and bounded by bilayered wall. These layers are in continuation of inner epidermis of endocarp from which outer layer is parenchymatous whereas inner one is sclerenchymatous. Sphaeraphides are seen in septum. Only two septae are present here (Fig. 108). At the extreme base of the fruit, it looks like four chambered due to extention of axial tissue in between two septae (Fig. 108). One vascular supply is present in each septum. Septal cells are disorganised at mature stage except in outer layers of septa.

**Dehiscence of the capsule:**

When fruit becomes dry and light brown in colour, it dehisces. Here dehiscence is of valvular type (Figs. 104, 109). Dehiscence zones are found in dorsal and ventral regions (Figs. 102, 103) which appear during developmental stages. The sclerenchymatous tissues of endocarp discontinue at their dorsal and ventral regions. In these regions small thin or thick-walled parenchymatous cells without intercellular spaces are found. The splitting of the ripe capsule is longitudinal through their dorsal and ventral vasculature (Figs. 102, 103). Dehiscence starts from endocarp and due to water loss and shrinkage of weak cells in the mid-locule and the ventral zones, the dry capsule dehisces concurrently from mesocarp and epicarp and opens into four valves simultaneously (Fig. 109). At this time septae do not separate from the fruit wall, but they break due to pressure and at last detach from the fruit wall.
Merremia qanqetica

Explanation to the figures : 94 to 103

94. A mature capsule with calyx. 7x.

95. A portion of T.S. of ovary wall with dorsal median bundle. 80x.

96. A portion of T.S. of developing fruit wall. 200x.

97. T.S. of ovary at middle showing ovules, axis and dorsal median bundle. 120x.

98. T.S. of ovary at middle region with axis, ovules and ventral vascular bundle. 120x.

99. T.S. of ovary at base showing axis, placenta, ovule, septum and axial tissue growth in between two ovules of each chamber. 120x.

100. A portion of T.S. of developing fruit wall at stage 5. 300x.

101. A portion of T.S. of mature fruit wall. 400x.

102. T.S. of fruit wall with ventral dehiscence zone. 236x.

103. T.S. of fruit wall with dorsal dehiscence zone. 500x.

**Abbreviations Used:**

a: axis; atg: axial tissue growth; b: basal part; ca: calyx; cdmz: dorsal dehiscence zone; dmb: dorsal median bundle; e: epithelial cell; en: endocarp; ep: epicarp; ie: inner epidermis; ih: inner hypodermis; la: laticifer; lvb: lateral vascular bundle; md: mesoderm; me: mesocarp; o: ovule; oe: outer epidermis; p: parenchyma; pl: placenta; s: septum; scl: sclerenchyma; t: terminal part; vdz: ventral dehiscence zone; vv: ventral vascular bundle.
**Merremia gangetica**

Explanation to the figures: 104 to 109

104. Schematic representation of dehisced capsule. 4X.

105. Sclereids of epicarp. 164X.

106. Sclereids of endocarp. 164X.

107. T.S. a portion of fruit wall. 328X.

108. Schematic representation of basal portion of mature fruit showing pericarp, seeds, placenta, axis, septae and axial tissue growth between two seeds of the locule. 20X.

109. Schematic representation of dehisced capsule wall into four valves and septum detaches from the wall. 12X.

**Abbreviations Used:**

a: axis; atg: axial tissue growth; ca: calyx; cdz: dorsal dehiscence zone; dmb: dorsal median bundle; en: endocarp; ep: epicarp; ic: inner cuticle; me: mesocarp; oc: outer cuticle; pe: pericarp; pl: placenta; plb: placental bundle; s: septum; sb: septal bundle; se: seed; v: valve; vdz: ventral dehiscence zone; v vb: ventral vascular bundle.
4. **Merremia hederacea** (Burm. f.) Hall. f.

*Merremia hederacea* is an annual twinning herb bearing small, numerous, yellow flowers. Persistent calyx covers half the length of the fruit (Fig. 110) at maturity. Gynoecium is bicarpellary, syncarpous, bichambered, superior ovary with two ovules in each chamber on axile placenta. Capsule is light brown, broadly ovoid, somewhat 4-angled, glabrous (Fig. 111) and open by four valves i.e. by valvular dehiscence (Fig. 126).

For a detailed developmental study of pericarp, different developmental stages of flowers and fruits were taken as follows:

<table>
<thead>
<tr>
<th>Sl No</th>
<th>Average length in mm</th>
<th>Average breadth in mm</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>1.75</td>
<td>1.50</td>
<td>Ovary from bud</td>
</tr>
<tr>
<td>2.</td>
<td>2.00</td>
<td>1.75</td>
<td>Ovary from open flower</td>
</tr>
<tr>
<td>3.</td>
<td>2.20</td>
<td>2.00</td>
<td>Young fruit stage</td>
</tr>
<tr>
<td>4.</td>
<td>3.50</td>
<td>3.40</td>
<td>Developing fruit stage</td>
</tr>
<tr>
<td>5.</td>
<td>4.00</td>
<td>4.00</td>
<td>Developing fruit stage</td>
</tr>
<tr>
<td>6.</td>
<td>4.50</td>
<td>5.00</td>
<td>Mature fruit stage</td>
</tr>
<tr>
<td>7.</td>
<td>4.50</td>
<td>5.00</td>
<td>Ripened fruit stage</td>
</tr>
</tbody>
</table>
**Ovary**:

At the extreme base of the ovary 6-8 vascular bundles are present. But at the extreme tip only two dorsal median bundles are seen. In the middle part of the ovary two dorsal, median, two ventral and two septal bundles are present.

**Ovary wall**:

It is parenchymatous and differentiated into outer epidermis, mesoderm (ground tissue), inner hypodermis and inner epidermis (Fig. 112).

**Outer epidermis**:

It is outermost layer of the ovary wall, which is unilayered and constituted by columnar thin walled cells having dense cytoplasm and prominent nuclei (Fig. 112). A thin and wavy cuticle covers this layer, which is astomatic and atrichomatous.

**Mesoderm (ground tissue)**:

It is 7-8 layers thick zone having large parenchymatous cells with intercellular spaces (Fig. 112). These cells are having deeply stained cytoplasm and prominent nuclei. These cells are polygcnal to isodiametric in shape. Two pro-ventral vascular bundles and two dorsal median bundles (Fig. 112) are present. Cells divide frequently both anticlinally and periclinally.
**Inner hypodermis:**

It is 6-7 layers thick zone having compactly arranged small parenchymatous cells (Fig. 112). These cells are polygonal, slightly squarish in shape with prominent nuclei.

**Inner epidermis:**

It is unilayered consisting of rectangular compactly arranged parenchyma cells (Fig. 112) which is astomatic and atrichomatous. It is covered with smooth cuticle from the inner side. The shape of these cells are rectangular to polygonal in surface view.

**Septum and Placentation:**

Only two septae are present here (Fig. 113). It is broad at both the ends and become narrow in the middle. It is 8-9 layered thick with thin-walled polygonal parenchyma cells including two peripheral epidermal layers. Septal cells are densely filled with cytoplasm and centrally placed nuclei. Sphaeraphides are seen in some septal cells. Each septum has two vascular bundles at their both ends. The central axial tissues have elongated and small spherical deeply stained thick-walled parenchymatous cells. These cells gradually increase from middle to basal part between the two ovules of each chamber, and appear false four chambered at the base of the ovary.

Placentum is found at the base of the ovary. It's having parenchymatous cells. Sphaeraphides are found in some cells. Ovules are sessile and
attached with placenta at the base of the ovary. Each ovule has been furnished with a separate vascular trace.

**Fruit development:**

After fertilization ovary develops into a capsule and ovary wall into pericarp which is differentiated into epicarp, mesocarp and endocarp.

**Epicarp:**

Epicarp of the fruit is bilayered at maturity. At the young fruit stage it is unilayered (Fig. 115) and during developing stages it becomes bilayered. The outer layer of epicarp is parenchymatous (Fig. 129) which is developed from outer epidermis of ovary wall. These cells are rectangular, sometimes elongated in shape, cell walls are straight, arched and sometimes less sinuous in surface view. The cell walls are beaded at maturity (Fig. 125). This layer is covered with thick and striated cuticle and is atrichomatous and stomata are found rarely when present they are of paracytic type. Inner layer of epicarp is sclerenchymatous at maturity which is developed from outermost layer of young fruit by periclinal divisions. Primarily, cells of this layer are thinwalled parenchymatous (Figs. 116,117), gradually they become thick-walled, and finally lignified (Figs. 119,129). These cells are columnar in shape in sectional view. The macerated cells of this layer are different in shape. They are sinuous, thick-walled with narrow or wide lumen (Fig.127).
Mesocarp:

It is 15-16 cells layered thick and develops from mesoderm of ovary wall. These cells are large parenchymatous with intercellular spaces (Figs. 118, 129). Sphaeraphides are present in some cells. Periclinal and anticlinal divisions are seen in this zone. So, here, number of cells and cell areas both increase gradually. Two dorsal median bundles (Fig. 122) and two ventral vascular bundles (Fig. 121) are conjoint, collateral and closed type. 52-56 lateral vascular bundles are also embedded in mesocarp which are also conjoint and collateral. A number of laticifer with epithelial cells are found in mesocarp (Fig. 122).

Endocarp:

Endocarp develops from the inner hypodermis and inner epidermis of ovary wall. It is 7-9 cell layers thick (Figs. 120, 129). Endocarp is again differentiated into 3 sub-zones. Outer 3-4 layers gradually transform into sclerenchyma (Fig. 129). This differentiation starts from developing stages. The macerated cells of this sub-zone are different in shape and size. These cells are mostly thick-walled, pitted and with wide or narrow lumen (Fig. 128). The middle sub-zone is 3-4 cell layers thick which is composed of thick-walled parenchyma and compactly arranged cells (Fig. 129). In this sub-zone, the cells size is gradually decreased from outer to inner layers. Inner epidermis is unilayered and thick-walled parenchymatous (Fig. 129), while at the dorsal side it is bilayered (Fig. 122). These cells are rectangular or slightly elongated. Inner epidermis is astomatic, atrichomatous and covered with thin and smooth cuticle.
Placentam and Septum:

Placentation is axile and found at the base of the fruit. Each placentum has its own vascular trace. All the four placentae are attached to the axis. Placental tissue has large elongated and small spherical thick-walled parenchymatous cells. Each septum is 13-14 layered thick and bounded by unilayered epidermis. The cells of this layer are slightly thick-walled, parenchymatous and rectangular in shape. Septal cells are large, thin walled, parenchyma cells, these cells become disorganised from 5th developing stage of the fruit. Sphaeraphides are seen in some septal cells. Two vascular bundles are found in each septum towards two ends.

Dehiscence of the capsule:

The dehiscence of the capsule is valvular and open into four valves (Fig. 126) simultaneously as in Merremia gangetica. Dehiscence zones are found in dorsal (Fig. 123) and ventral (Fig. 124) sides. Upto young fruit stage dehiscence zones do not appear, it's found in next developing fruit stages. The sclerenchymatous zone of endocarp discontinues at these zones and it's filled with thin-walled small parenchyma without intercellular spaces. The splitting of the capsule valves are longitudinal to the whole length of the fruit wall through their dorsal and ventral vasculature (Figs. 123, 124). The dehiscence starts from endocarp and due to water loss and shrinkage of weak cells of this zone, dehiscence of the capsule extends through mesocarp and epicarp. At the same time septa detaches from the fruit wall.
**Merremia hederacea**

Explanation to the figures: 110 to 117

110. A mature fruit with calyx. 5x.

111. A mature capsule. 8X.

112. T.S. of ovary wall at dorsal side. 378X.

113. T.S. of ovary at middle region. 94X.

114. T.S. of ovary wall with septa at ventral side. 302X.

115. T.S. a portion of fruit wall at young stage. 302X.

116. T.S. a portion of developing fruit wall at stage 4. 326X.

117. T.S. a portion of developing fruit wall at stage 5. 192X.

**Abbreviations Used:**

a: axis; b: basal part; ca: calyx; dmb: dorsal median bundle; en: endocarp; ep: epicarp; ie: inner epidermis; f: fruit; ie: inner epidermis; ih: inner hypodermis; m: middle part; md: mesoderm; me: mesocarp; oe: outer epidermis; s: septum; sb: septal bundle; t: terminal part.
Merremia hederacea

Explanation to the figures: 118 to 124

118. T.S. a portion of mature fruit wall. 192X.
119. T.S. a portion of fruit wall with epicarp, mesocarp and outer endocarp at ripened stage. 192X.
120. T.S. a portion of fruit wall with mesocarp and endocarp at ripened stage. 236X.
121. T.S. mature fruit wall at ventral side. 192X.
122. T.S. a mature fruit wall of dorsal side. 192X.
123. T.S. fruit wall with dorsal dehiscence zone. 120X.
124. T.S. fruit wall with ventral dehiscence zone. 302X.

Abbreviations Used:

ddz: dorsal dehiscence zone; dmb: dorsal median bundle; e: epithelial cell; en: endocarp; ep: epicarp; ie: inner epidermis; ien: inner endocarp; la: laticifer; me: mesocarp; men: middle endocarp; oen: outer endocarp; p: parenchyma; scl: sclerenchyma; vb: ventral vascular bundle.

s: septum;
vbz: ventral dehiscence zone;
**Merremia hederacea**

Explanation to the figures: 125 to 129

125. Outer epidermis of mature fruit. 410X.

126. Schematic representation of dehisced capsule. 5X.

127. Macerated sclerenchyma of epicarp. 410X.

128. Macerated sclerenchyma of endocarp. 410X.

129. A portion of T.S. of fruit wall of middle region. 328X.

**Abbreviations Used:**

e: epithelial cell; ep: epicarp; ic: inner cuticle; in: inner endocarp; la: laticifer; me: mesocarp; men: middle endocarp; oc: outer cuticle; oen: outer endocarp; s: septum; v: valve.
5. *Ipomoea aquatica* Forsk.

*Ipomoea aquatica* Forsk is an annual to perennial trailing herb, rooting at the nodes. Calyx is persistent, glabrous and less than half the length of the fruit. Flowers are solitary or 3-4 in cyme and pink in colour. Ovary is bicarpellary, syncarpous with 2-4 pubescent ovules. Fruit is light green, ovoid glabrous capsule (Fig. 138) which opens by four valves. A mature capsule measures 0.6-0.8 cm. in length and 0.5-0.6 cm. in breadth. Seeds are 2-4 minutely pubescent.

**Structure of the pericarp:**

Transverse section of the fruit is showing pericarpic distinctions into epicarp, mesocarp and endocarp.

**Epicarp:**

It is 1-2 layered zone of parenchyma. The cells of the outer epidermis are slightly tangentially elongated and compactly arranged (Figs. 130, 140). These cells are densely filled with cytoplasm and centrally placed nuclei. Their cell walls are thin from all sides. It is atrichomatous and stomatic. In surface view epidermal cells are thin-walled, squarish, slightly elongated, rectangular, tetragonal and polygonal in shapes. Their epidermal cell wall nature is similar to that of *Ipomoea obscura* (Figs. 54, 55). Cell areas are larger at the basal region than
middle and terminal. Five types of mature stomata are observed here. They are anomocytic with 3-6 epidermal cells, staurocytic, laterocyclic, paracytic and hemiparacytic. Four types of paracytic stomata and two types of staurocytic stomata are reported here, similar to *L. obscura* (Figs. 57,58,62,67 & 66,69). It is covered with thick and striated cuticle. These striations are found more in terminal region which flow out from the stomata in all directions. Abnormalities of stomata as smaller stomata; contiguous stomata as superimposed, and superimposed displaced stomata are observed. The stomatal frequency is more at the basal region and it gradually decreases in the terminal region. The tangential cell walls of inner layer of epicarp are thicker than their radial walls. Anticlinal divisions are seen in some cells.

**Mesocarp:**

Mesocarp is 6-8 layered thick zone (Figs. 130,131,140). These cells are thin-walled with small or no intercellular spaces. Shapes of these cells are isodiametric, polygonal, hexagonal or irregularly arranged. Laticifers with epithelial cells are seen throughout the mesocarp (Figs. 130,131,140). Two dorsal median bundles (Fig. 132) two ventral vascular bundles (Fig. 133) and 32-36 lateral vascular bundles are present. These vascular bundles of conjoint and collateral type. Mesocarpic cell areas are more in middle region and less towards the basal and terminal regions.

**Endocarp:**

It is 4-5 layered thick (Figs. 131,140). Outer 2-3 layered zone is
sclerechymatous (Fig. 140). These cells are heavily thickened and show diversity in their morphological characters i.e. shape, size, wall thickenings with narrow or broad lumen. They are simple one and acute and sinuous wall with broad or narrow lumen (Fig. 141). Inner epidermis is unilayered parenchymatous but bilayered inner epidermis is observed at the dorsal and ventral regions or at the dehiscence zone (Fig. 131). These cells are thin-walled tangentially elongated. The cell areas of inner epidermis are more in the middle portion than in the basal and terminal portions of fruit. The inner epidermis is astomatic and atrichomatous. The cell shapes are elongated, rectangular in surface view, and their cell walls are slightly sinuous (Fig. 139).

**Septum and Placentum:**

Septum is 16-18 cell layers thick. It is lined on either side by its own epidermis. These epidermal layers are incontinuation of inner layer of endocarp (Fig. 133). Septal epidermis is unilayered (Fig. 134). Cells of this epidermis are rectangular or slightly elongated and cell walls are thick at both the sides i.e. on radial and tangential sides. These cells are densely filled with cytoplasm and covered with thin and smooth cuticle. The parenchymatous cells of septum which are present in between the epidermal layers are polygonal, isodiametric, vacuolated and disorganised at maturity (Fig. 133) and loosely arranged with more intercellular spaces (Fig. 134). Two vascular bundles are present in each septum at both the ends. Septum is thick at both the ends as 16-18 cell layers and thin at the middle as 6-8 cell layers.

Placentum is found only at the base of the capsule. Two placentae are seen in each locule. It consists of unilayered epidermis. These epidermal
cells are rectangular in shape. These placental cells are loosely arranged with large intercellular spaces (Figs. 135-137). Each placentum has its own single vascular bundle (Figs. 135-137). Placental epidermis is astomatic and atrichomatous and covered with thin cuticle.

**Axis of the capsule:**

It is thick and large at the basal region and gradually becomes thinner towards the middle (Fig. 134) and terminal portions. These cells are highly vacuolated, smaller with large intercellular spaces at the basal region. Towards the middle and terminal portions these axial tissues become thick-walled parenchymatous with less intercellular spaces and it reaches upto extreme tip.

The base of the capsule appers four chambered due to excess growth of the axial tissues in between each chamber, gradually the axial tissues growth reduces towards the middle (Fig.134), and completely disappears in the terminal region.

**Dehiscence of the capsule:**

Dehiscence is valvular and opening is into four valves concurrently as in *Merremia gangetica* and septae are completely detached from the fruit wall.
Ipomoea aquatica

Explanation to the figures: 130 to 137

130. T.S. a portion of fruit wall with epicarp and mesocarp. 300X.
131. T.S. a portion of fruit wall with mesocarp and endocarp. 300X.
132. T.S. a portion of fruit wall at dorsal side. 154X.
133. T.S. a portion of fruit wall at ventral side with septum. 95X.
134. T.S. of axis with septum at middle region. 48X.
135. T.S. of placenta with seed at the base of the fruit. 48X.
136. Placentae fused with axis at the base of the fruit. 48X.
137. Septum and placentae fused with axis at the base of the fruit. 48X.

Abbreviations Used:
a: axis; dmb: dorsal median bundle; e: epithelial cell; en: endocarp; ep: epicarp; ie: inner epidermis; la: laticifer; me: mesocarp; pl: placenta; plb: placental bundle; s: septum; se: seed; v vb: ventral vascular bundle.
Ipomoea aquatica

Explanation to the figures: 138 to 141

138. A mature capsule with calyx. 4X.
139. Inner epidermis of mature fruit in surface view. 205X.
140. A portion of T.S. of fruit wall at its middle. 323X.
141. Macerated sclereids of endocarp. 410X.

Abbreviations Used:
ca: calyx; e: epithelial cell; en: endocarp; ep: epicarp; f: fruit; ic: inner cuticle; la: laticifer; me: mesocarp; oc: outer cuticle; oc: outer cuticle; st: stomata.
6. **Ipomoea fistulosa** Mart. ex choisy

*Ipomoea fistulosa* mart-ex choisy is a hedge shrub with milky juice. Leaves are broadly ovate. Flowers are in terminal, umbellate cyme. Calyx is persistent and less than half the length of the fruit (Fig. 142). Ovary is bicarpellary bichambered, synacarpous with 2-4 ovules. Fruit is light brown, globose, pubescent capsule (Fig. 143) which opens by four valves. A mature fruit measures 1.0-1.2 cm. in length and 0.6-0.8 cm. in breadth. Seeds are 2-4 and hairy. Out of four seeds, one or two degenerated seeds are also reported.

**Structure of the pericarp**:

Anatomy of the capsule is showing pericarp differentiated into epicarp, mesocarp and endocarp.

**Epicarp**:

It is 6-8 layered zone (Fig. 147). Which is differentiated into three different sub-zones i.e. outer, middle and inner epicarp. The outer epicarp having bilayered tangentially elongated and compactly arranged parenchymatous outer epidermis. The cells of outer layer of this epidermis having thicker tangential walls than radial wall. In surface view these cells are rectangular, quadrangular,
isodiametric in shape (Fig. 146). There cell walls are thin, arched, straight, but cell walls are also found in beaded form in middle region as in Argyreia nervosa (Fig. 23). Their cell areas are large at the basal region than terminal while smallest in middle region. The epidermal layer is stomatic and trichomatous. Paracytic stomata are most common but anomocytic and anisocytic stomata are also found. Frequency of stomata is more in basal region. Trichomes which are small, unicellular with acute tips are observed above this layer (Fig. 146) The length of the trichomes is 252.50-265.95 micron and breadth is 25.51-30.15 micron. Frequency of these trichomes is more in the basal region of the fruit than middle and rarely or no trichomes in the terminal region. This layer is covered with thick and highly striated cuticle. These striations ooze out above the surface like small papillae. 2-3 layers of middle epicarp has thin-walled, tangentially elongated or rectangular and compactly arranged parenchyma. These layers are also interspersed with laticifers (Fig. 147). 2-3 layered cells of inner epicarp are sclerenchymatous. These cells are rectangular, isodiametric or slightly radially elongated. Macerated cells of these layers are simple with wide or narrow lumen or with slightly sinuous wall (Fig. 145).

Mesocarp:

It is 3-4 layers thick zone(Fig.147). Cells of these layers are thin-walled vacuolated parenchyma which are mostly isodiametric, polygonal in shape with intercellular spaces. Two dorsal median bundles, two ventral vascular bundles and 16-20 lateral vascular bundles are embeded in mesocarp.
**Endocarp:**

It is 4-5 layered parenchymatous zone (Fig. 147). Cells of outer 2-3 layers are slightly thick-walled and rectangular or tangentially elongated in shape with very less or no intercellular spaces. These cells are less vacuolated. The innermost layer is inner epidermis. It has also slightly thick-walled parenchyma which appear tangentially elongated in sectional view. These cells are rectangular, elongated, hexagonal, pentagonal and irregularly arranged (Fig. 148) and in surface view cell walls are arched, straight, slightly thick and covered with thin and smooth cuticle. This layer is astomatic and atrichomatous.

**Septum and Placentation:**

Septum is 12-14 cell layers thick. It is bounded by unilayered epidermis from both sides which are incontinuation of inner epidermis of pericarp. These epidermal cells are thick-walled parenchyma, compactly arranged, filled with dense cytoplasm and centrally placed nuclei. Septae are thick towards the fruit wall but thin towards the axis. Rest of the cells of septum except epidermis are thin-walled parenchyma which are isodiametric, polygonal in shape with large intercellular spaces and irregularly arranged. Only one vascular bundle is present in each septum towards the fruit wall. Placentum is found only at the base of the fruit (Fig.144). Two placentae are seen in each chamber. Each placentum is bounded by unilayered thick-walled epidermis. These epidermal cells are rectangular or slightly elongated in shape. Placental cells are thin-walled, polygonal, isodiametric and loosely arranged with intercellular spaces. Placental epidermis is astomatic and atrichomatous.
Axis of the fruit:

It is thick and large at the base of the fruit and thinner towards the middle. At the terminal region axis is very thin and short. There is no chamber in terminal region, only 2 dorsal median bundles reach up to this region. The axial cells are thick-walled parenchymatous, highly vacuolated with large intercellular spaces at the base. Towards the middle and terminal regions these cells become more thick-walled and with less intercellular spaces. At the terminal region there is no chamber, but bilayered parenchymatous outer epidermis is present. Just inside this, lignified zone is found and then thick-walled parenchyma which is interspersed with laticifers.

Dehiscence of the capsule:

The dehiscence of this fruit is valvular; it opens into four valves simultaneously similar to Merremia gangetica. Here septae are completely attached up to maturity but during dehiscence, septae detach from the fruit wall due to shrinkage and mechanical pressure. So at the same time fruit wall splits and septae detach.
Ipomoea fistulosa

Explanation to the figures: 142 to 148

142. A mature fruit with calyx. 2.5X.
143. A mature capsule. 3X.
144. L.S. of mature fruit. 2.5X.
145. Macerated sclerenchyma of epicarp 164X.
146. Outer epidermis in surface view showing trichomes and stomata. 328X.
147. A portion of transverse section of fruit wall. 410X.
148. Inner epidermis in surface view. 328X.

Abbreviations Used:

b: basal part  ca: calyx; en: endocarp; f: fruit; ic: inner cuticle; iep: inner epicarp; la: laticifer; m: middle part; me: mesocarp; mep: middle epicarp; oc: outer cuticle; oep: outer epicarp; pe: pericarp; pl: placenta se: seed; t: terminal part; tr: trichome.
7. *Ipomoea hederifolia* L.

It is an annual twinning herb with trilobed leaves. Pinkish flowers are in umbellate cyme. Calyx is long hairy and persistent (Fig. 149). Pistil is bicarpellary with two stigma. Ovary is bichambered, pubescent with two ovules on each axile placenta. The fruit is green to brown, globose, pubescent capsule (Fig. 150) and it measures 6.0mm in length and 5.5mm in breadth. It opens by four valves (Fig. 156).

**Fruit anatomy:**

In transection the fruit is somewhat circular in shape and has basal axile placenta. The zone of dehiscence is very clear in the mature fruit. The fruit wall is 9-10 layers thick end distinguished into outer epicarp, middle mesocarp and inner endocarp.

**Epicarp:**

It's having unilayered parenchymatous epidermis, which is covered with uniform, thick and striated cuticle(Fig.155). These cells appear tangentially elongated, tabular or rectangular and compactly arranged in transection (Fig. 151). These cells are polygonal, isodiametric, sometimes elongated and irregularly arranged in surface view (Fig. 163). The cell areas are large at the basal region.
than middle and terminal. The cell walls are thin, straight and arched. Only one type of trichome is observed on the fruit wall in its middle and terminal parts whereas in the basal part, there are no trichomes. These trichomes are unicellular, straight, long celled, thick walled with acute tips and smooth surface (Fig. 164). Frequency of the trichomes, increases from middle to terminal part. The size of these trichomes is 976.95-979.35 micron in length and 21.71-21.95 micron in breadth. Cuticular striations flow out in two lateral groups from the stomata i.e. at right angles to the pore (Fig. 160); they extend in all directions from the stomata (Fig. 157); and are found extending in all directions from the base of the trichome (Fig. 164). These striations are linear.

There is no definite pattern of orientation of stomata on the epidermis. They are oriented irregularly in various directions. Frequency of stomata gradually decreases from basal to terminal parts. Four types of mature stomata are observed here, namely paracytic, anomocytic, anisocytic and hemiparacytic. The anomocytic stomata are monocyclic surrounded by three to five epidermal cells (Fig. 157). These cells are nearly similar to other epidermal cells. The anisocytic stomata are monocyclic and are surrounded by a ring of three subsidiary cells of which one is distinctly smaller than the remainings two (Fig. 163). The paracytic stomata are either monocyclic or partly or completely amphicyclic. The monocyclic paracytic sotmata are flanked by two subsidiary cells parallel to the long axis of the guard cells. The subsidiary cells may be contiguous at both ends; or non-contiguous at one end; or non-contiguous at both the ends (Fig. 160). The hemiparacytic stomata have only a single subsidiary cell placed parallel to the long axis of the pore (Fig. 161). It may be longer or shorter than the guard cells. Sometimes stomata are found in groups (Fig. 158, 159), and contiguous juxtaposed stomata are also reported (Fig. 162).
Mesocarp:

It is 3-4 layered thick (Figs. 151,155) parenchymatous zone. These cells are thin walled with less or no intercellular spaces. A number of laticifers are present with epithelial cells (Fig. 155). These cells are mostly polygonal, isodiametric, highly vacuolated, with laterally placed nuclei and irregular arrangement. Two dorsal median bundles, two ventral vascular bundles and 28-36 lateral vascular bundles are present. These are conjoint and collateral type. But at the terminal region only two dorsal median bundles are seen. There are no laticifers in terminal region. At the terminal region outer 1-2 layers have larger and highly vacuolated cells and rest 5-6 layers are of smaller, thick walled parenchyma cells with less intercellular spaces. These cells are polygonal and isodiametric.

Endocarp:

It is 4-5 layered thick (Figs. 151,155). Outer 3-4 layers are sclerenchymatous. These cells are highly thickened and different in shape and size. These endocarpic macerated cells are with sinuous walls and are forked (Fig. 165). There lobes are so nicely fitted in each other that a compact endocarpic cell pattern is formed. This zone is discontinued at the median dorsal and ventral region, where dehiscence zone is developed. Inner epidermis is unilayered; parenchyma shows tabular and rectangular cells with centrally placed nuclei but size of these cells is smaller than outer epidermal cells. This layer is astomatic and atrichomatous. The cells are mostly elongated and cell walls are thin, smooth, straight and arched (Fig. 166) in surface view.
Septum and placentum:

It is 10-12 layers thick at both the ends, whereas 6-8 layers thick in the middle. Its has unilayered epidermis bounding on both sides and in incontinuation of inner epidermis of fruit wall (Fig. 152). Cells of this epidermis are elongated thin walled. These cells are densely filled with cytoplasm and centrally placed nuclei. It is covered with thin and smooth cuticle. The parenchymatous cells of septum are isodiametric, polygonal, highly vacuolated and loosely arranged with more intercellular spaces (Fig. 152). Two vascular bundles are present in each septum at its dorsal and ventral sides. Septae may be completely detached from fruit wall at ripening. Placenta is found only at the base of the fruit. Two placentae are present in each locule. It consists of unilayered epidermal cells which are elongated. Placental cells are loosely arranged with small intercellular spaces which disorganise at ripening. Its epidermis is astomatic, atrichomatous and covered with thin cuticle. Each placentum has a single vascular supply.

Axis:

It is small and thick at the basal region, and attached to the septae and placentae. At the extreme terminal region, there is no axis, only a central gap is seen (Fig. 154).

Dehiscence of the capsule:

Dehiscence is valvular and opens into four valves simultaneously at their ventral and dorsal dehiscence zone (Fig. 153) through their dorsal median and ventral vasculature as in Merremia gangetia. Here septa attaches upto maturity and during dehiscence, it detaches mechanically.
Ipomoea hederifolia

Explanation to the figures : 149 to 154

149. A mature capsule with calyx. 5.5X.
150. A mature capsule. 8.75X.
151. T.S. a portion of fruit wall. 384X.
152. T.S. of fruit wall at ventral side with septum. 192X.
153. T.S. fruit wall with dehiscence zone. 378X.
154. T.S. of extreme tip of fruit with a central gap. 48X.

Abbreviations Used:

b: basal part  ca: calyx; cg: central gap; ddz: dorsal dehiscence zone; en: endocarp; ep: epicarp; f: fruit; la: laticifer; m: middle part; me: mesocarp; p: parenchyma; s: septum; sb: septal bundle; scl: sclerenchyma; t: terminal part; tr: trichome.
Ipomoea hederifolia

Explanation to the figure: 155
155. A portion of transverse section of fruit wall. 400x.

Abbreviations Used:
e : epithelial cell, en: endocarp; ep: epicarp; ic: inner cuticle; la: laticifer;
me: mesocarp; oc: outer cuticle.
Ipomoea hederifolia

Explanation to the figures: 156 to 166

156. Schematic diagram of a dehisced capsule. 4X.
157. Anomocytic stomata. 328X.
158-159. Stomata in groups. 328X.
160. Paracytic stomata. 328X.
161. Hemiparacytic stomata. 328X.
162. Contiguous juxtaposed stomata. 328X.
163. Outer epidermis of mature fruit with anisocytic stomata. 328X.
164. Unicellular trichome with thick-walled and acute tip and cuticular striations flowing out from the base of trichome. 164X.
165. Macerated sclerenchyma of endocarp. 400X.
166. Inner epidermis in surface view. 328X.

Abbreviations Used:
s: septum; v: valve.
8. *Ipomoea nil* (L.) Roth

*Ipomoea nil* is called Krishnabia in Sanskrit and Kalanda in Hindi. It is a twinning herb with hairy stem, 3 lobed, cordate leaves and persistent calyx (Fig. 167). Flowers are axillary, solitary or 2-3 in cymes. A mature capsule measures 10-11mm. in length and 8-9 mm. in breadth. It is globose, glabrous, beaked (Fig. 168) and develops from bicarpellary, or tricarpellary syncarpous, 2-4 chambered ovary with one or two ovules in each chamber. Seeds are 4-8 and glabrous. Capsules, 3 chambered with 3 or 6 seeded and 4 chambered with 4 or 8 seeded conditions are also found.

**Structure of the fruit wall:**

Pericarp is 9-11 cell layers thick (Fig. 176) and it's classified into outer single layered epicarp, middle 4-5 layered thick mesocarp and inner 4-6 layered thick zone of endocarp.

**Epicarp:**

It is the outermost single layer of the fruit wall. Its cells are vacuolated and highly cutinised on their outer tangential walls (Figs. 170, 176). These cells are tangentially elongated parenchyma in transection. It is atrichomatous.
and stomatic. These stomata are irregularly arranged on the fruit surface. Here, five types of mature stomata are reported, these are laterocyclic (Fig. 173), hemiparacytic, anisocytic, anomocytic and paracytic. Out of these five types, frequency of paracytic stomata is more. In paracytic stomata one guard cell horse-shoe shaped is also reported. Abnormalities in stomata like smaller size (Fig. 174), large stomata are found (Fig. 175). The outer epidermal cells are mostly polygonal, isodiametric and rectangular and their walls appear straight and arched in surface view. Rhomboidal crystals are found in some epidermal cells. Cuticle is striated and flowing out from the guard cells of the stomata.

**Mesocarp:**

It is 4-5 cells thick. A number of laticifers occur with epithelial cells in this zone (Fig. 170, 176). These mesocarpic cells are mostly polygonal, isodiametric in shape and, compactly arranged. These cells are thin-walled parenchyma. Two dorsal median bundles, two ventral vascular bundles and 32-36 lateral vascular bundles are found in this zone. The dorsal and ventral vascular bundles are larger than the lateral ones. These bundles are conjoint and collateral with endarch protoxylem. At the extreme terminal region only two dorsal median bundles are found.

**Endocarp:**

It is 5-7 layers thick (Fig. 170, 173) and differentiated into 3 separate sub-zones, outer, middle and inner. The outer sub-zone is 2-3 cell layers thick, highly lignified and their macerated cells are of different shape and size (Fig. 177).
The cell walls of these cells are smooth and simple. The middle endocarp is 2-3 cell layers thick and its cells are less lignified than those of the outer endocarp. These cells are rectangular or tangentially elongated. The innermost sub-zone of the endocarp is unlayered thick-walled parenchyma. The cells are tangentially elongated. This layer is astomatic, atrichomatous and covered with thin and smooth cuticle. These outer and middle sub-zones of endocarp are not continuous at the dorsal and ventral sides of the carpel which later functions as zone of dehiscence (Fig. 171).

**Septum, Placentum and Central Axis:**

Septum is 10-14 cell layers thick. It is bounded by unlayered septal wall. These septal epidermal cells are mostly rectangular or slightly elongated thick-walled parenchyma, which are covered on their outer tangential walls with thin and smooth cuticle. The cells of the septum except epidermal cells are isodiametric, polygonal and compactly arranged or with less intercellular spaces. Each septum has two vascular bundles at its two ends (one towards pericarp and the another towards axis). Septum is completely detached from the fruit wall during dehiscence (Figs. 178, 179) but is attached with axis. Placenta is found only at the base of the fruit. It is bounded by unlayered epidermal walls. The polygonal parenchyma of the placenta are compactly arranged. Each placenta having its own vascular supply. Here the number of septae vary from 2-4 in different fruits i.e. bichambered-tetrachambered. One or two placentae are found in each locule. The central column of the fruit is thick and large at the base. A cleavage or gap is formed in the central column (Figs. 178, 179). This central gap
continues upto extreme tip. In beak of the fruit there is no such gap formation, but intercellular spaces are found among the parenchyma.

**Dehiscence of the capsule:**

The dry capsule dehisces into four valves (Fig. 178) in bichambered or tetrachambered conditions. Here dehiscence is similar to *Ipomoea obscura*, as first loculicidal i.e. splitting into two halves through mid-locule zone or dorsal vasculature then each half splits into two through their ventral vasculature and finally produce four valves and at the same time septae detach from the pericarp.

But in trichambered conditions it dehisces into three valves (Figs. 172, 179). and septae separate completely from the wall (Fig. 169) so here dehiscence is loculicidally septifragal (Fig. 179).
Ipomoea nil

Explanation to the figures: 167 to 171

167. A mature capsule with calyx. 3.25X.
168. A mature capsule. 3.75X.
169. Septum exposed with axis and seeds. 5.5X.
170. T.S. a portion of fruit wall. 384X.
171. T.S. fruit wall with dehiscence zone. 307X.

Abbreviations Used:

a: axis; b: basal part; be: beak; ca: calyx; ddz: dorsal dehiscence zone; e: epithelial cell; ep: epicarp; f: fruit; ien: inner endocarp; la: laticifer; m: mesocarp; men: middle endocarp; oen: outer endocarp; s: septum; se: seed; st: stalk of the fruit; t: terminal part.
**Ipomoea nil**

Explanation to the figures: 172 to 177

172. Schematic diagram of a dehisced capsule showing 3 valves and septum. 3.5X.

173. Laterocytic stomata. 328X.

174. Stomata with smaller guard cells. 328X.

175. Large stomata. 328X.

176. A portion of transverse section of fruit wall. 328X.

177. Macerated sclerenchyma of endocarp. 410X.

**Abbreviations Used:**

- e: epithelial cell
- ep: epicarp
- ic: inner cuticle
- ien: inner endocarp
- la: laticifer
- me: mesocarp
- men: middle endocarp
- oc: outer cuticle
- oen: outer endocarp
- s: septum
- v: valve
Ipomoea nil

Explanation to the figures: 178 to 179

178. Schematic diagram of middle of a dehisced capsule with 4 valves, four seeds and two septae. 8X.

179. Schematic diagram of middle of a dehisced capsule with 3 valves, 6 seeds and 3 septae. 7.5X.

Abbreviations Used:

cg: central gap; ddz: dorsal dehiscence zone; dz: dehiscence zone; s: septum; sb: septal bundle; se: seed; v: valve; vdz: ventral dehiscence zone; vvb: ventral vascular bundle.
9. *Ipomoea pestigridis* L.

It is an annual twinning herb, clothed with long spreading hairs. It is used as cattle fodder both as green and hay. Being rich in protein, calcium and phosphorus, leaves are employed in form of poultice to boils, sores, pimples and carbuncles. Roots are used as purgative, contain resin. Flowers are sessile 3-7 in a head. Bracts are leafy, long and persistent. Calyx is hairy peresistent (Fig. 180) and covered the whole capsule. The fruit is a green to brown globose, glabrous capsule (Fig. 181) measures 4-5 mm in length and 4.5-5mm in breadth which develops from bicarpellary, syncarpous, bichambered superior ovary with two ovules in each on axile placenta. Seeds are four, grey, minutely velvety. Dehiscence is valvular.

**Fruit anatomy:**

Anatomy of the fruit is showing 8-10 layered thick pericarpic zone in tranverse section which is differentiated into outer epicarp, middle mesocarp and inner endocarp.

**Epicarp:**

It is the outermost parenchymatous single layer of the pericarp. Its
cells are highly vacuolated, and cutinised on their outer and inner tangential walls (Fig. 183). Their cell contents become thin. These cells are tangentially elongated and tabular in transection and covered with thick and striated cuticle on their outer tangential walls. In surface view the epicarpic cells appear large rectangular, hexagonal and pentagonal with small nuclei. The anomocytic and paracytic stomata are common in the epicarp. The walls are thick, straight and arched. Frequency of stomata gradually decreases from basal to terminal regions. The anomocytic stomata are monocyclic surrounded by 3-6 epidermal cells. The paracytic stomata are either monocyclic or partly/completely amphicyclic (as in L. obscura). Trichomes are not found on this fruit surface.

**Mesocarp:**

It is 2-3 layered thick (Fig. 183) parenchymatous. Cells are tangentially elongated thin-walled with less or no intercellular spaces. Lysigenous cavities are present just below the outer epidermis of epicarp (Fig. 183). These cells are vacuolated and with less cytoplasm. Rhomboidal crystals of calcium oxalate are found in some cells of this zone. Two dorsal median bundles, two ventral vascular bundles and 20-24 lateral vascular bundles have been observed. These bundles are conjoint and collateral. These vascular bundles are seen in the basal region but towards the terminal region of the fruit only two dorsal median and two ventral vascular bundles are present.

**Endocarp:**

It is 4-6 layered thick (Fig. 183) and differentiated into 3 sub-zones.
Outer 1-2 layers are highly lignified sclerenchyma and their cells are radially elongated. Middle 2-3 layers are less lignified sclerenchyma and isodiametric to polygonal in shape. They are absent on the dorsal and ventral sides of the fruit. These macerated endocarpic sclerenchyma are observed in their various shapes. They are simple with broad or narrow lumen (Fig. 182) and some are with one or both ends acute. The inner epidermis is unilayered with thick-walled parenchyma. Their cells are tangentially elongated having cytoplasm and centrally placed nuclei. This layer is astomatic, atrichomatous and covered with thin and smooth cuticle.

**Septum, Placentum and Central Column:**

It has radially elongated cells as the boundary layers and 3-5 layers of parenchyma in between. The peripheral layers of the septum appear unilayered thick. Septal vascular bundle is embedded in the dorsal side of the septum. As the fruit dries, central cells of the septum appear vacuolated and mostly isodiametric, polygonal and thin-walled whereas peripheral layers are of thick-walled cells and covered with thin and smooth cuticle. Septum is attached with fruit wall upto maturity but appears separate during dehiscence stage due to mechanical pressure. Placentae as in the basal region are two in each locule. Placentae having unilayered peripheral layers and loosely arranged inner cells. These inner cells are irregular in their size and shape. Each placentum has one vascular strand and embedded in the loosely arranged tissue.

The central column is fused with the placental tissue at the base, it gradually becomes thin towards the middle and finally disappears and the fruit tip looks like monolocular without central column and seeds. These axial cells are
thick-walled parenchyma and appear diverse in shape.

**Dehiscence of dry capsule:**

The ripe capsule splits first in loculicidal fashion. The loculicidal splitting is due to the presence of thin-walled parenchyma cells in the dorsal dehiscence zone. On either side of dehiscence zone, the endocarp is composed of multilayered sclerenchyma. After that it splits through ventral sides through ventral vascular bundles and at the same time septae completely detach from the fruit wall and finally four valves are produced as in Ipomoea obscura.
Ipomoea pestigridis

Explanation to the figures: 180 to 183

180. A mature capsule with calyx. 3.5 X.

181. A mature capsule. 3.5X.

182. Sclerenchyma of macerated endocarp. 328X.

183. A cellular portion of transverse section of fruit wall. 328X.

Abbreviations Used:

b: basal part ca: calyx; ep: epicarp; f: fruit; ic: inner cuticle; ien: inner endocarp; l: lysigenous cavity; m: middle part; me: mesocarp; men: middle endocarp; oc: outer cuticle; oen: outer endocarp; t: terminal part.
Ipomoea sinensis (Desr.) Choisy

Ipomoea sinensis is a twinning herb, sparingly clothed with long spreading hairs. Leaves are simple 2-3, long petiolate and cordate. Flowers are small, white in colour and 1-3 in axillar cymes. Calyx is hairy and persistent (Fig. 184). Capsule is green, ovoid, glabrous, developing from bicarpellary, bichambered, syncarpous, superior ovary with two ovules in each on axile placenta. A mature fruit measures 0.8-0.9 mm in length and 0.7-0.8 mm in breadth (Fig. 185). Seeds are four, villose with long and silky hairs at the margin.

Structure of the pericarp:

Fruit wall is 10-11 cell layers thick (Figs. 187, 198) and it is arbitrarily classified into single layered outer epicarp, middle 2-3 cell layers thick mesocarp and inner 6-7 layered endocarp.

Epicarp:

It is unilayered with thick-walled parenchymatous cells. These cells are tangentially elongated in transverse section (Figs. 187, 198). These
cells are densely filled with cytoplasm and centrally placed nuclei. Tangential walls are thicker than radial. This layer is atrichomatous, stomatic and covered with thick, linear striated cuticle. The striations in surface view appear to flow out in two lateral groups from the stomata i.e. at right angles to the pore, they extend in all directions from the stomata. There is no definite pattern of orientation of stomata on the epidermis. Frequency of stomata gradually decreases from basal to terminal parts. Stomatal index is also lowest in the terminal part of the fruit. Five types of mature stomata are observed on this outer epidermis. These stomata are paracytic, anisocytic, anomocytic, laterocyclic and hemiparacytic type. The anisocytic stomata are monocyclic surrounded by three to five epidermal cells (Fig. 196). More than one cycles of subsidiary cells are also noted (Fig. 195). The anisocytic stomata are monocyclic (Fig. 197). The paracytic stomata are either monocyclic or partly or completely amphicyclic. In paracytic stomata the subsidiary cells may be contiguous at both ends; or non-contiguous at one end; or non-contiguous at both the ends. The completely amphicyclic paracytic stomata are flanked by four to five subsidiary cells, two on each side of the guard cells placed parallel to the pore (Fig. 191). Laterocyclic stomata are similar to paracytic stomata, in which the two lateral subsidiary cells surrounded the guard cells completely (Fig. 190). The hemiparacytic stomata have only a single subsidiary cell placed parallel to the long axis of the pore (Fig. 192). It may be longer or shorter than the guard cells. The general abnormalities observed include
contiguous stomata, juxtaposed (Fig. 194) and juxtaposed overlapped stomata.
(Fig. 193). The outer epidermal cells are polygonal, isodiametric, sometimes
elongated and irregularly arranged (Fig. 189). The cell walls are thin straight
and arched. The epidermal cell frequency is more in the basal region, then
terminal and less in middle region in a constant microscopic field; i.e. cell
areas are just opposite to the cell frequency.

Mesocarp:

Mesocarp is 3-4 layered thick (Fig. 198) and its cells may contain
cytoplasm. Lysigenous cavity also may occur in the cells of mesocarp (Fig.
198). These latex producing cavities are found mostly in middle mesocarp.
The outer 2-3 layered cells are isodiametric, polygonal, compactly arranged
and thin-walled parenchyma while the cells of innermost layer of mesocarp
are slightly thick-walled tangentially elongated parenchyma. Two dorsal median
bundles, two ventral vascular bundles and 24-36 lateral bundles are observed.
These bundles are conjoint and collateral. At the extreme tip central column
(axis) and only two dorsal median bundles are found.

Endocarp:

It is 6-7 layers thick and differentiated into three subzones; outer,
middle and inner endocarp. The outer endocarp is 3-4 layered thick highly
lignified (Fig. 187, 198). Thus the outer endocarp is made up of compactly arranged sclerenchyma. These macerated sclerenchyma are observed in their various shapes (Fig. 201). They are simple forked at one end and/or with sinuous walls. The middle endocarp is 2-3 layered which is also sclerenchymatous. The cells of these layers are smaller and less lignified than outer endocarpic cells (Fig. 198). The innermost layer of inner endocarp is unilayered and thick-walled parenchymatous. Cells of this layer appear elongated and rectangular in sectional view and their walls appear arched and slightly sinuous in surface view (Fig. 200). The inner epidermis is astomatic, atrichomatous and covered with thin and smooth cuticle. At the dehiscence zone, endocarp consists of rectangular and tangentially elongated thick-walled parenchyma (Fig. 188).

**Septum, Placenta and Central axis**:

Septum has tabular cells at its boundary layers and 10-11 layers of parenchyma in between. The cells of the septum except boundary layers are isodiametric and polygonal. These cells are smaller towards the boundary. At the ripening these central cells appear vacuolated and finally disorganise. The cell wall of septal boundary layers are thickened. The cells of the boundary layers of the septum are mostly elongated with straight or angular ends in surface view (Fig. 199). Only one septal bundle is found in each septum towards the fruit wall. Septum is completely detached from the fruit wall during dehiscence of the fruit (Fig. 186). Placentum is found only at the
base of the capsule. Two placentae are present in each locule. Due to the growth of axial tissues in between two seeds of a locule it appears as false four chambered at the base, but these axial tissues do not touch the fruit wall at the basal region. Each placenta consists its boundary of epidermal layer which has thick-walled elongated parenchyma. The central cells of placenta are loosely arranged thin-walled parenchyma. Each placenta has its own single vascular bundle. The central column of the fruit is thick and large at the base of the fruit and it gradually becomes thinner towards the middle and terminal regions. These cells are thick-walled and loosely arranged parenchyma but in the centre of the axis these cells are compactly arranged. At the extreme terminal region locules disappear and only two dorsal median bundles and the central axial tissues can be observed.

**Dehiscence of the dry capsule:**

The ripe capsule dehisces as valvular and in 4 valves as in *Ipomoea obscura* described in this thesis. First it splits concurrently into two halves at their locules and then each splits into two and at the same time the fruit wall also completely detaches from the sep:um. These splittings are due to the presence of parenchyma cells in the dehiscence zone (Fig. 188). On either side of the dehiscence zone, the endocarp is composed of multilayered sclerenchyma. In the course of fruit ripening parenchymatous cells become vacuolated and mesocarpic cells appear shrunken. Due to such shrinkage, the capsule wall is pulled apart causing the separation of the fruit wall.
Ipomoea sinensis

Explanation to the figures: 184 to 188

184. A mature capsule with calyx. 1.75X.

185. A mature capsule. 3.5X.

186. Septum with axis. 4.5X.

187. T.S. a portion of fruit wall. 384X.

188. T.S. of fruit wall (endocarp) with dehiscence zone. 307X.

Abbreviations Used:

a: axis; b: basal part; ca: calyx; ddz: dorsal dehiscence zone; ep: epipercarp; f: fruit; ien: inner endocarp; l: lysigenous cavity; me: mesocarp; men: middle endocarp; oen: outer endocarp; s: septum; st: stalk of seed; t: terminal part.

m: middle part;
Ipomoea sinensis (Desr.) Choisy
(Figures : 184-188)
Ipomoea sinensis

Explanation to the figures: 189 to 198

189. Outer epidermis in surface view. 328X.
190. Laterocyclic stomata. 328X.
191. Amphicyclic paracytic stomata. 328X.
192. Hemiparacytic stomata. 328X.
193. Juxtaposed overlapped contiguous stomata. 328X.
194. Juxtaposed contiguous stomata. 328X.
195. More than one cycles of subsidiary cells. 328X.
196. Anomocytic stomata with three surrounding cells. 328X.
197. Anisocytic stomata. 400X.
198. A portion transverse section of fruit wall. 410X.

Abbreviations Used:

ep: epicarp; ic: inner cuticle; ien: inner endocarp; l: lycigenous cavity; me: mesocarp; men: middle endocarp; oc: outer cuticle; oen: outer endocarp.
Ipomoea sinensis

Explanation to the figures: 199 to 201
(Magnifications: 205x.)

199. Septal epidermis in surface view.

200. Inner epidermis in surface view.

201. Macerated sclerenchyma from outer endocarp.

*Merremia tridentata* is a prostate, slender biennial diffuse twinning herb. Leaves are sub-sessile and hastate. Flowers are yellow in colour and 1-3 in axillary cyme. Peduncles are long, slender. Sepals are long, lanceolate, acumulate with recurved point. Capsule is grey, subglobose, glabrous, developing from bicarpellary, bichambered, 1-2 ovules in each on axile placenta. It measures 4.5-4.7 mm in length and 6.0-6.2 mm in breadth (Fig. 203). Seeds are 2-4 and glabrous. Dehiscence of the capsule is valvular and it splits into four valves (Fig. 204).

**Structure of the fruit wall:**

Fruit wall is 6-7 layers thick (Fig. 208) and it is differentiated into epicarp, mesocarp and endocarp.

**Epicarp:**

It is unilayered with thick-walled parenchymatous cells. These cells appear tangentially elongated in transverse section. It is densely filled with cytoplasm and centrally placed nuclei. It is atrichomatous, stomatic and covered with thick and striated cuticle. Frequency of stomata is more in the middle region. Three types of mature stomata are found here, these are paracytic, anomocytic (Fig. 207) and anisocytic types. Abnormalities in stomata are like stomata smaller
than normal size, one guard cell smaller than other and contiguous stomata are reported. These contiguous stomata are juxtaposed and obliquely placed. The outer epidermal cells are pentagonal, rectangular, isodiametric and irregularly arranged (Fig. 202). Their cell walls are straight, arched and beaded. The epidermal cell areas are more in the middle region.

**Mesocarp:**

It is two layered thick zone of the thin-walled parenchymatous cells (Fig. 208). Lysigenous cavities are found in this zone. The cells are mostly elongated, compactly arranged and comparatively smaller than the cells of outer epidermis. Two dorsal median bundles, two ventral vascular bundles and 20-24 lateral vascular bundles are found. These are conjoint and collateral with endarch xylem. The dorsal and ventral vascular bundles are larger than the lateral ones. Out of these bundles only two dorsal median bundles have reached upto the terminal region.

**Endocarp:**

It is 3-4 layered thick. The cells of outer 2-3 layers are compactly arranged, highly lignified sclerenchyma. The macerated cells of these layers are observed in their various shapes. They are simple or forked and with wide lumen. The innermost layer of endocarp is unilayered and thick-walled parenchymatous (Fig. 208). The cells of this layer are tangentially elongated and larger than the outer epidermal cells and cell walls are arched in sectional view but highly sinuous in surface view (Fig. 206). This layer appears astomatic, atrichomatus and covered with thin and
smooth cuticle. The sclerenchymatous endocarpic cells are absent on the dorsal and ventral sides of the fruit.

**Septum, Placentum and Central axis:**

Septum is 8-10 layers thick which is bounded by unilayered, parenchymatous thick-walled epidermis from both sides. The cells of the boundary layers are elongated and compactly arranged. The cells of the septum except boundary layers are isodiametric, polygonal and loosely arranged thin-walled parenchyma. Only one septal bundle is found in each septum towards the fruit wall. Septum is attached to the fruit wall up to maturity but during dehiscence of the fruit wall it detaches completely from the pericarp due to mechanical pressure.

Placentae are found slightly above from the base of the capsule. Either one or two placentae are found in each locule. Due to the axial tissue growth in between two seeds of a locule at the base it appears as four chambers. The axial central column is large at the base and gradually smaller in middle and terminal regions and at the extreme tip it completely disappears.

**Dehiscence of dry capsule:**

Dehiscence of the dry capsule is valvular, i.e. opening by four valves simultaneously through their dorsal and ventral vasculature as in *Merremia gangetica* described previously in this thesis.
Merremia tridentata

Explanation to the figures: 202 to 208

202. Outer epidermis in surface view. 410X.

203. A mature fruit with calyx. 3X.

204. A dehisced capsule. 2X.

205. Different types of macerated sclerenchyma. 328X.

206. Inner epidermis in surface view. 200x.

207. Anomocytic stomata. 328X.

208. A portion transverse section of fruit wall. 328X.

Abbreviations Used:

ep: epicarp; ca: calyx; en: endocarp; f: fruit; ic: inner cuticle; ih: inner cuticle; l:
lysigenous cavity; me: mesocarp; oc: outer cuticle; s: septum; v: valve.