MORPHOLOGICAL STUDIES IN THE FAMILY CONVOLVULACEAE

V. Organogenesis of the Flower

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Organ development in the flower of three species, *Ipomoea batatus* Lamk, *I. purpurea* Roth. and *Jacquemontia paniculata* Hollier, has been investigated. The development is acropetal and is successive in sepals and simultaneous in all other organs. The early development is leaflike. The corolla tube in the later stages of development is formed by the toral and intercalary growth while the early growth is mainly due to the apical cells.

Introduction

The morphology of the floral parts and their anatomy has received little attention in the family Convolvulaceae. The organogenesis of the floral parts in members of other families has been worked out and a number of variations in the sequence of development of floral organs have been reported by many workers. Pfeffer (1872) noted that in Primulaceae the petals appear after the stamens. Hofmeister (1868) found that in *Rosa, Potentilla* and *Rubus* the primordia of carpels appear before those of the stamens, and in *Hypericum calycinum* the sepal primordia develop after those of the stamens. Coulter and Chamberlain (1903) reported that the petals are the last to develop in Cruciferae. Kenyan (1928) in *Ipomoea trifida* and Rao (1940) in *I. learii, I. staphylina* and *Evolvulus alsinoides* give contradictory reports regarding the sequence of the development of petal and stamen.

Material and Methods

The young flower apices and flower buds were collected locally and fixed in F.A.A. and preserved in 70 per cent alcohol. Following the customary methods of dehydration and embedding the material was sectioned at 8–10 μ thickness. The slides were stained with safranin-fast green and haematoxylin erythrosin and tannic acid-ferric chloride combinations.

Observations

Morphology

The flowers are arranged in pedunculate bracteate cymes. The sepals are five, persistent and fused at the base. The corolla is funnel-shaped showing induplicate valvate aestivation. Stamens are inserted on the corolla tube at the base alternately. The ovary is bi- or tricarpellary and bi- or trilocular, having two ovules in each locule.

Floral Organogenesis

The floral parts in the three species, *Ipomoea batatas*, *I. purpurea* and *Jacquemontia paniculata*, are arranged in an acropetal manner; the sepals differentiate in a successive manner while the other organs arise simultaneously.

Floral Apex

The floral apex is a dome-shaped, zonate and radial structure, 70–100 μ in height and 100–120 μ in diameter. Like the vegetative apex it has 2–3 tunica layers and a homogeneous mass of corpus but unlike that there is no group of central initial cells distinctive in size and shape in either tunica or corpus here (Figs. 1, 6).

Sepals

Initiation of a sepal in a median longitudinal section is by periclinal divisions in the second tunica layer heralded on the side of the floral apex. Subsequent divisions are both anticlinal and periclinal but in the outer tunica layer they are always anticlinal (Figs. 2, 7, 8). During the early phases of development the cells of the corpus also add to the tissue of the fast developing sepal. It should be noted that the floral apex at this time becomes more flat, about 30–40 μ in height and 120–160 μ in diameter (Fig. 2).

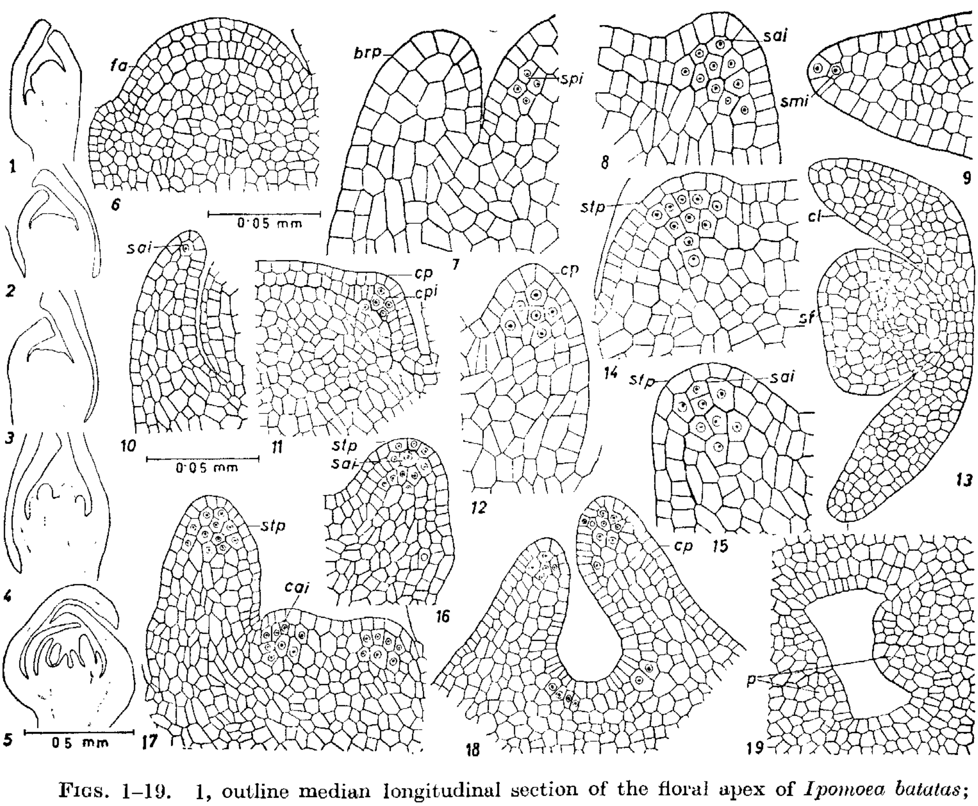
The apical growth of the sepal is initiated by apical and subapical initials and continues as long as the sepal primordium reaches an approximate height of 180–200 μ (Fig. 10). Further growth takes place by intercalary cell divisions and cell elongation. The development of the lamina is caused by the activity of the lateral marginal and submarginal initials situated on the two sides. The submarginal cell is triangular and cuts off cells by anticlinal divisions on adaxial and abaxial sides. The resultant cells divide both by anticlinal and periclinal divisions. The marginal initial divides only for a short period and further development is due to intercalary cell divisions and cell elongation (Fig. 9). Excessive growth in the margins of the sepals causes overlapping of the margins of the adjacent sepals.

Petals

After the initiation of sepals, the floral apex appears somewhat smaller and rounded mass of apical meristem measuring 100–160 μ in diameter and about 60–100 μ in height. At the time of initiation of corolla, the youngest sepal measures about 180–240 μ in height.

Early development of petals is just like that of sepals with apical and subapical initials being responsible for apical growth and marginal and submarginal initials for the lateral growth (Figs. 3, 11–13).

To start with the five petal primordia arise independently and hence they are polypetalous in this region, but a gamopetalous and epipetalous condition is brought about in the later stages of development (Fig. 13). Below the corolla and stamen primordia a rim of meristem develops which cuts off cells upward thereby increasing the size of the corolla tube. This process takes place for a shorter duration, further development of the corolla tube is due to toral and intercalary growth in the cells of that region. The growth



FIGS. 1–19. 1, outline median longitudinal section of the floral apex of *Ipomoea batatas*; 2–5, outline diagrams of the floral apices showing successive growth of floral organs; 6, cellular organization of floral apex in longitudinal section; 7–9, median longitudinal sections through the sepal initials and sepal primordia showing apical growth; 10, vertical transverse section of the edge of sepal showing marginal growth; 11–12, median longitudinal sections through the petal primordia showing apical growth; 13, transverse section of the young corolla tube at the place of staminal insertion; 14–16, median longitudinal section of the floral apex through stamen primordia showing apical growth; 17–18, same through carpel primordia; 19, a portion of transverse section of ovary showing development of placenta.

(*brp*, bracteole primordium; *ci*, carpel initial; *cl*, corolla lobe; *cp*, carpel primordia; *fa*, floral apex; *pp*, petal primordium; *sai*, subapical initial; *sf*, staminal filament; *smi*, submarginal initial; *spi*, sepal initial; *sp*, staminal primordium.)

continues up to the time of anthesis. The upper part of the corolla tube above the insertion of the stamens is formed partly by the apical meristem of the five separate petals and partly by the intercalary growth and cell elongation. The induplicate valvate arrangement of the petals is due to the enormous marginal growth in the free portion of the petals.

The Stamens

The five stamen primordia differentiate on alternate radii to the five petal primordia. The interval between the differentiation of the petal and stamen primordia is so little that it becomes difficult to demarcate them separately. At the time of stamen initiation the floral apex becomes more flat.

The initiation of the stamen primordium like that of sepal and petal is due to periclinal divisions in the second tunica layer (Figs. 14–16). But the stamen primordia can be differentiated by their rounded shape (Fig. 4). The stamen primordia develop rapidly to begin with but the growth slows down at the time when a short basal region which is the future filamentous part of the stamen differentiates (Figs. 5, 17).

Carpels

At the time of carpel initiation the stamen primordia are about 150–180 μ in height. At this stage the floral apex is a flat structure about 100–120 μ in diameter. The two carpels develop at the tip of the floral apex separately, but their margins approach one another and are oppressed with each other. In a longitudinal section, the carpels show a cup-shaped structure with a central depression. The carpel initiation starts with the periclinal division in the second tunica layer (Fig. 17). The early development of the carpel is just like that of the other parts of the flower. The apical growth takes place by the activity of the apical and subapical cells and the marginal activity by the marginal meristem (Figs. 5, 18). As the apical growth continues, the two primordia approach each other and fuse (Fig. 18). In later stages of development the two margins of each carpel curve ventrally and each fuses with the margin of adjacent carpel (Fig. 19). The fused margins grow into the ovarian cavity and form the placentae (Fig. 19).

Development of the style starts when the two carpels stop their marginal growth and approach each other to fuse. At this stage, the carpels grow mostly apically and form a narrow, long style. After the apical growth is over, the development of stigma starts which is a bifid or capitate structure.

Discussion and Conclusions

The ontogenetic studies in *Ipomoea batatas*, *I. purpurea* and *Jacquemontia paniculata* indicate that the order of development of floral parts is acropetal.

The mode of formation of the initials of each organ is essentially the same. All the floral organs, sepal, petal, stamen and carpel initiate at the edge of the floral apex by periclinal divisions in the second tunica layer and irregular divisions in the corpus cells. From the study of the development of various floral organs and the leaf it has been noticed that the manner of development of the floral organs from the floral apex is fundamentally similar to that of the development of leaf at the vegetative apex.

Regarding the sequence of origin of floral organs as mentioned earlier it is in the order of sepal, petal, stamen and carpel. Rao (1940) has also mentioned a similar sequence of development in *Ipomoea learii*, *I. staphylina* and *Evolvulus alsinoides*. However, Kenyan (1928) has described in *Ipomoea trifida* that the petals develop after the development of stamens simultaneously with the carpel initiation. She shows the protuberances for the petals on the dorsal sides of the stamens. It appears that she has confused these protuberances to be the petal primordia but actually these protuberances are the places where the stamens are inserted on the petals. Such type of differentiation may be possible in obdiplostamenous condition but it seems certainly difficult in Convolvulaceae. Since the difference in time between the petal and stamen differentiation is so short that it becomes difficult to demarcate the two primordia separately, but when carefully seen it will be noted that both petal and stamen primordia are present on different radii and petals differentiate before the stamens.

The corolla tube in the species described here is formed by the zonal or toral growth only, although Satina and Blakeslee (1941) in *Datura stramonium* regarded that the corolla tube is formed by ontogenetic fusion. In *Frasera corolianensis* (McCoy 1940) and *Phlox drummondii* (Miller and Wetmore 1946) the corolla is considered as arising by zonal or toral growth. Boke (1947) in *Vinca rosea* describes that the corolla tube is formed by both the processes, that is zonal growth and the ontogenetic fusion.

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* Not seen in original.