

GYNOECIAL COMPOSITION OF THE ASTERACEAE

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The gynoecium in the Asteraceae is usually bicarpellary but tri-, tetra- and pentacarpellary gynoecia have also been recorded in *Cosmos sulphureus*. Pentacarpellary and tetracarpellary gynoecia are reported in the family for the first time. Trends of evolution in the gynoecium in the family have been discussed in the light of the present observations. The presence of bilocular ovary with axile placentation in *Cosmos sulphureus* suggests that the basal placentation in the Asteraceae has been derived from an original axile placentation as the result of suppression of the septum, followed by complete reduction of an ovule and its locule along its vascular supply.

Key Words: *Cosmos sulphureus*: placentation.

To a student of evolutionary morphology, the flower of Asteraceae presents several thought provoking problems. The evolution of corolla, nature of the pappus, placentation and inferior ovary are subject of acrimonious debate and have been reviewed in earlier papers (Singh, 1994; Tiagi and Singh, 1972, 1981). The present work was undertaken with a view to have a better understanding of the the gynoecium and placentation in the family.

MATERIALS AND METHODS

Inflorescences of *Cosmos sulphures* were collected from DAV College, Abohar and fixed in FAA. Serial microtome sections, 10-15 micron thick, were cut and stained with crystal violet and erythrosin. In all the cases the floral buds were cleared by warming in 10 per cent solution of potassium hydroxide and subsequently in colourless lactic acid. The cleared buds were dissected under a stereoscope, to obtain a 3-dimentional picture of the vascular skeleton.

OBSERVATIONS

Cosmos sulphureus Cav.

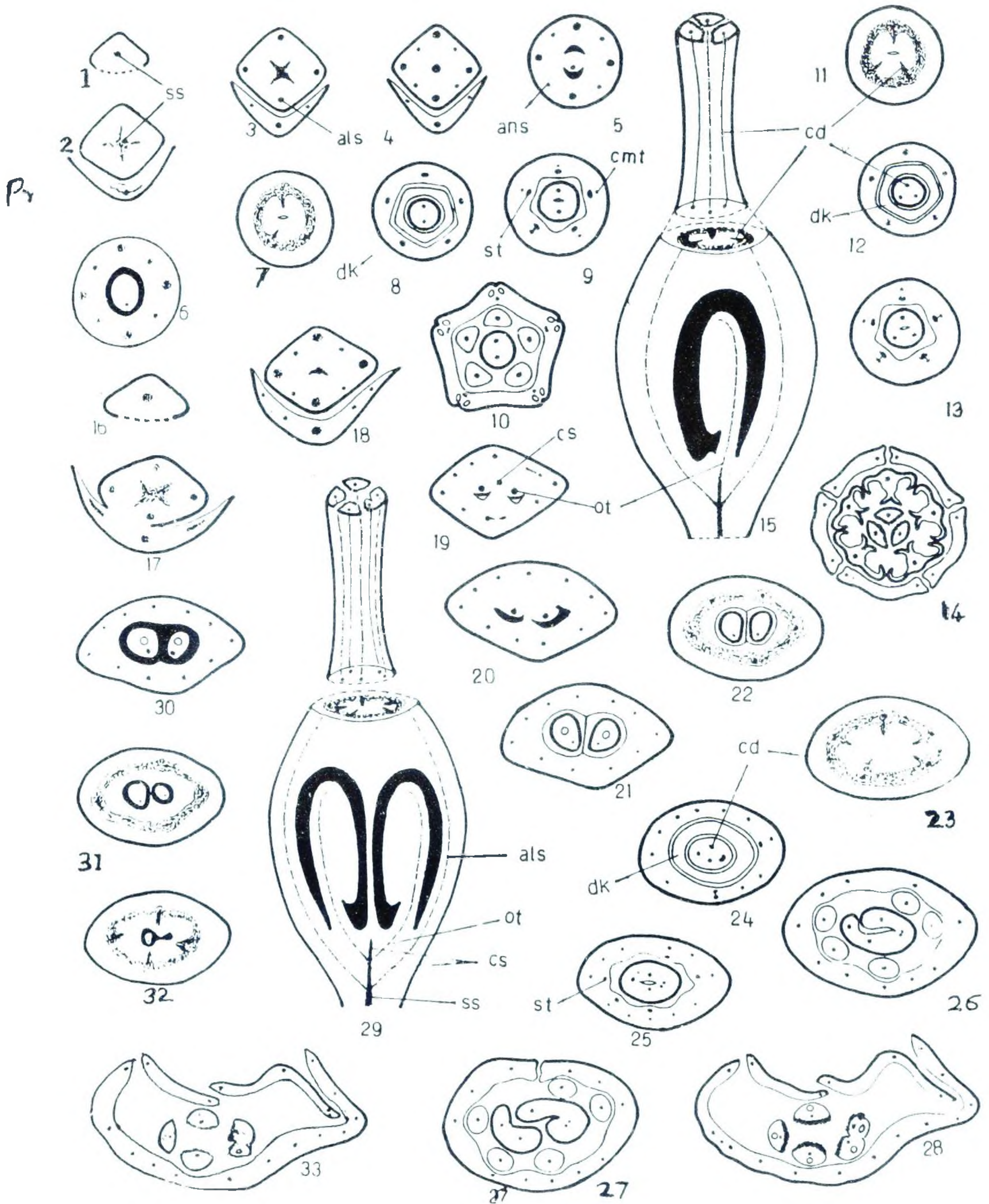
Disk Florets: The stelar strand (ss) gives out four strong traces into the ovary wall (Figs. 1-2). With a conspicuous lag, another four traces arise from the stelar strand in alternating positions (Figs. 3-4). The vascular tissue left in the centre (cs) forms a single ovular trace (ot) (Figs. 4-6). In the top of inferior ovary the traces in the ovary wall anastomose (Fig. 7) and then gives rise to two carpellary dorsal traces (cd) which extent into the style (Figs. 7-8). The

remaining vascular tissue reorganizes into five conspicuous alternipetalous traces. These traces split tangentially, the inner five are the staminal traces (st) and the outer five conjoint marginal traces (cmt) of the petals (Figs. 8-10).

In an abnormal disk floret three carpellary dorsal traces have been observed instead of normal two (Figs. 11-13). Such florets had three styler branches and each received a dorsal bundle (Fig. 14). The presence of three dorsal bundles and three styler branches suggests the presence of three carpels.

Ray Florets: Some abnormal ray florets have been observed (Figs. 15-27) with a bilocular ovary with one ovule in each locule. In such florets the central strand fade out after giving rise to two lateral ovular traces (ot) (Figs. 17-19). These ovular traces form the vascular supply of two ovules in different loculi (Figs. 19-21). The eight strands in the ovary wall as they traverse upward and undergo radial splitting and form eleven or more traces (Figs. 18-20). In the top of the ovary these traces anastomose to form a vascular plexus (Fig. 21). This plexus gives off five carpellary dorsal traces which extent into the style and then differentiate into eleven traces that enter into the corolla tube (Figs. 22-27). The five carpellary dorsal traces extent into the five stigmatic lobes. The presence of five dorsal carpellary traces and five stigmatic lobes indicate the pentacarpellary nature of the gynoecium.

A few ray florets are tetracarpellary but with five carpellary dorsal bundles in the style. Only four



Figures 1-35. *Cosmos sulphureus*: Figs. 1-10. Serial transverse sections (S.T.S.) of normal disk-floret from below upward, showing the divergence of vascular supply to the various floral parts; Figs. 11-14. S.T.S. of abnormal disk-floret showing tricarpellary gynoecium; Figs. 15-27. S.T.S. of abnormal ray-floret showing pentacarpellary gynoecium with bilocular and biovulate ovary; Fig. 29. L.S. abnormal ray-floret showing pentacarpellary gynoecium with bilocular and biovulate ovary (Diagrammatic reconstruction); Figs. 28-31. S.T.S. of ray-floret showing tetracarpellary gynoecium with bilocular and biovulate ovary; Figs. 32-33. Abnormal ray floret of *Cosmos sulphureus* showing penta- and tetracarpellary gynoecia, respectively; Fig. 34. Abnormal disk floret of *Tagetes petula* showing tricarpellary gynoecium; Fig. 35 (see text). (ss, stelar strand; cs, central strand; ot, ovular strand; als, alternipetalous strand; ans, antipetalous strand; cd, carpellary dorsal; cmt, compound marginal trace of petal; dk, disk; st, staminal trace).

stylar bundles reach to the top of the stigmatic lobes and the fifth extends only one-fourth length of the style and then fade out (Fig. 31). The ovary is bilocular at the base and above but unilocular in the middle (Figs. 28-30). Suppression of an ovule and its locule has also been observed.

DISCUSSION

Evolution of Gynoecium: The gynoecium of the asteraceous flower is usually composed of two carpels which are mostly median in position but occasionally they may be placed transversely or diagonally. The latter can be explained by assuming that the ancestral condition of the gynoecium in this family was pentacarpellary, a condition occasionally found in *Cosmos sulphureus* (Fig. 32). Tetra-carpellary gynoecium can be derived from pentacarpellary gynoecium by the fusion of a pair of antero-lateral carpels, a condition observed in some ray florets of *Cosmos sulphureus* (Fig. 33). By further fusion of the second pair of antero-lateral carpels tricarpellary gynoecium can be derived, a condition observed in some disk florets of *Cosmos sulphureus* and *Tagetes patula* (Singh, 1973) (Fig. 34). The occurrence of tricarpellary gynoecia besides *Cosmos sulphureus* has also been observed in *Helianthus annuus* (Joshi, 1934), *Wedelia calandulacea* (Sundararaja & Balsubraman Yam, 1957) and *Flaveria rependa* (Misra, 1957).

In one line of evolution, bicarpellary gynoecium can be derived from tricarpellary gynoecium by complete suppression of the posterior carpel along with its vascular supply. The two surviving carpels are thus lateral in position, a similar condition observed in several taxa, e.g., *Amberboa ramosa*, *Crepis sibirica*, *Elephantopus scaber*, *Lactuca macrorhiza*, *Launaea aspliniifolia*, *Prenanthes brunoniana*, *Sonchus arvensis* and *Sonchu oleraceus* (Singh, 1973). In the other line of evolution, bicarpellary gynoecium can be derived directly from pentacarpellary gynoecium by fusion of three carpels, one posterior and two postero-lateral, and two carpels of anterior side. The two carpels are thus median in position (Fig. 35). In most of the Asteraceae there are two carpellary dorsal bundles in the gynoecium but the stubs of three additional carpellary dorsal bundles have been observed in *Carpesium abrotanoides*, two in *Layia douglassi*

and one in *Carthamus tinctorius* (Singh, 1973). Thus, a gradual series in the suppression of the vascular supply of the original pentacarpellary gynoecium can be seen in different taxa of the family.

Placentation: The chief evolutionary processes which have been operative in considering the basal placentation of the Asteraceae as having been derived from an original axile placentation are suppression of the septum separating the two loculi followed by complete reduction of an ovule along with gradual reduction in its vascular supply. The stages of specialization are given below:

In *cosmos sulphureus* the ovary is bilocular with one ovule in each locule representing axile placentation. The central strand gives out two lateral ovular traces supplying the ovules in their respective loculi (fig. 32) and then terminates blindly soon after the departure of ovular traces. Suppression of one ovule and its locule followed by rupture of the septum in the middle of the ovary is also observed in few ray florets (Fig. 33). The ovary thus is bilocular at the base and above but unilocular in the middle. Several cases of bioovulate ovaries in *Senecio vulgaris* have been described (Small, 1916). The ovule in each locule has been regarded as lateral in position. Similar variations have also been reported in *Senecio discifolius* (Afzelius, 1924), *Arnica alpina* (Engell, 1970) and *Coreopsis stillmani* (Pandev & Singh 1982).

In *Tagetes patula*, the ovary is unilocular with a single basal ovule. The ovular trace arises as a lateral branch mostly on the anterior side and the ovular stub (ost) of the reduced ovule terminates blindly in the carpellary septum in the base of the abortive locule (Singh, 1973) (Fig. 34). A similar condition has also been reported in *Acanthospermum hispidum* (Tiagi & Manilal, 1964) *Verbesina crocata*, *Amberboa ramosa*, *Tricholepis radicans*, *Glossocardia bosvallea*, *Ageratum conyzoides*, *Galinsoga parviflora*, and *Cichorium intybus* (Tiagi & Singh, 1972). During further specialization there is complete suppression of the ovular stub and the central strand directly continues as the ovular trace as in majority of Asteraceae (Fig. 35). Vascular anatomy of the flower thus affords convincing proof of the origin of the basal ovule in the Asteraceae from an ancestral lateral position (see also Puri, 1952).

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