

FURTHER STUDIES WITH POLYFLORAL CALENDULAS¹

Walter Morgan and Ward Miller
Botany-Biology Department
South Dakota State University, Brookings

The condition of polyfloral blossoms on calendulas was first reported by the senior author (1967). Structural peculiarities of secondary and tertiary blossoms were described in detail. During the past year the authors, with the assistance of Professor Charles Taylor, have examined in close detail the locational origin and the microscopic structures of the secondary blossoms. Histological sections of the primary blossom stem and of the attached secondary stem were also prepared to permit a detailed study of vascularity patterns.

Normal calendulas

Calendulas, which are composites, have typical composite blossoms (Holman and Robbins, 1938). The blossoms have two kinds of flowers: the disks which make up the central part of the head and the rays which are around the edge of the head (Figure 1). The rays are female and the disks are bisexual. For the particular variety reported herein, the disks appeared brown and the rays were orange. Morphological characteristics of the typical ray are shown in Figure 2 and a cross-section relationship of the blossom structures to the stem is shown in Figure 3. Two common variations from this, which are available in commercial calendulas are (1) plants with blossoms having yellow instead of orange rays and/or (2) plants with either orange or yellow blossoms which appear to be composed entirely of rays — similar to the situation found in dandelions.

Orientation studies

Microscopic examination of the polyfloral calendula blossoms revealed that there were disk flowers outside of the rays; an unusual situation. Around the base of the primary blossom were three rows of involucre bracts. The stems of the secondary blossoms arose between the innermost and intermediate bracts. The branch (stem) of each secondary appeared to be an axillary bud arising from a phyllary where axillary buds normally do not arise. Thus the secondary stem arose from the base of the bract instead of arising as a growth from the base of a leaf. Usually the secondary blossoms were smaller and their rays were more yellow than were the orange rays of the primaries. An abnormal relationship of physiological gradients is summarized in table 1. No seeds have been observed to develop on secondary blossoms.

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Sometimes the ray flowers were found interspersed with the disk flowers. When arranged in the shape of a floret, these centrally located rays were classified as tertiary blossoms. The rays of the tertiaries were smaller (approximately 1/3 normal size) and always were much more pale, yellow, than were the peripheral orange rays of the primary blossoms.

Tissue examination

Two series of microscopic slides were prepared by the junior author. Thirteen transverse serial sections of a secondary stem were prepared and stained with safranin and fast green. The same stain was employed for 31 longitudinal serial sections. The longitudinal sections included portions of the secondary stem and of the receptacle. The water conducting xylem stained red and the phloem stained green. An examination of the vascularity indicated that the vascular bundles were arranged in rings, as was true also in the normal patterns. Longitudinally, the vascularity was continuous in both the polyflorals and normals. It was therefore concluded that the secondary blossoms were structurally similar to the primaries.

One hypothesis which could account for the phenomenon of secondary polyfloral growths is as follows. If the cortex or epidermal cells of the inflorescence dedifferentiated into meristematic tissue, adventitious (secondary) stems could have originated.

SUMMARY

In macroscopic and microscopic studies of secondary calendula blossoms, it has been learned that the unusual polyfloral growths are served by normal vascularity and do not appear to be teratogenic. Also described was the disorganization of ray and disk flowers in the polyflorals. With successive polyfloral growths (secondaries and tertiaries) there was a progressive loss of carotenoid pigments.

REFERENCES

- Holman, Richard and Wilfred Robbins. 1938. The parts of a typical flower in General Botany: John Wiley and Sons, 230-267.
- Morgan, Walter. 1967. A genetic polyfloral calendula. Proc. S.D. Acad. Sci., 46:77.

Table 1. Normal vs. Polyfloral Calendula Relationships.

Physiological Gradients	
Normal	Abnormal Polyfloral
Rim \Rightarrow Center	Outer \Leftarrow Rim \Rightarrow Center
Rays \Rightarrow Disks	Disks \Leftarrow Rays \Rightarrow Disks
Sterile \Rightarrow Fertile	Fertile \Leftarrow Sterile \Rightarrow Fertile

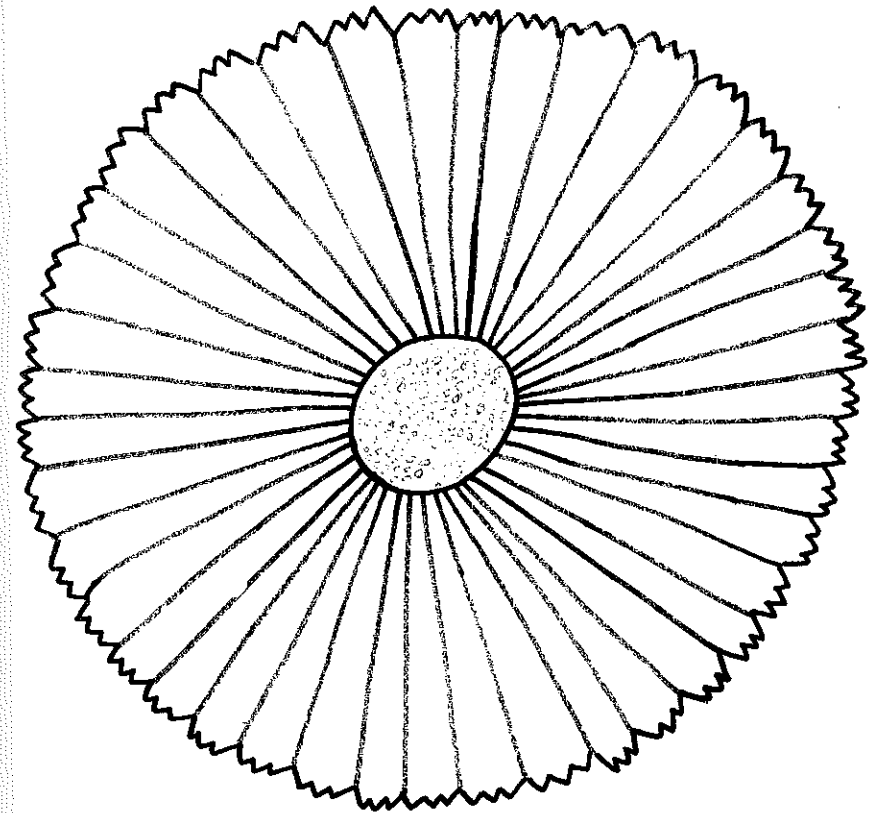


Figure 1. Typical normal calendula blossom with central disk flowers and peripheral ray flowers.

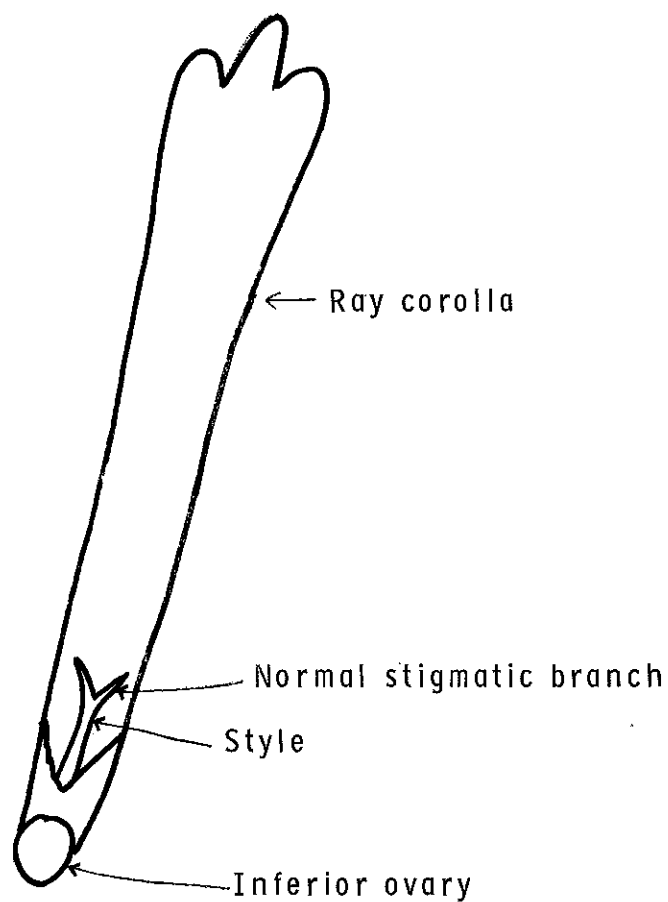


Figure 2. An individual ray flower from a calendula blossom. The seed develops at the base of the ray.

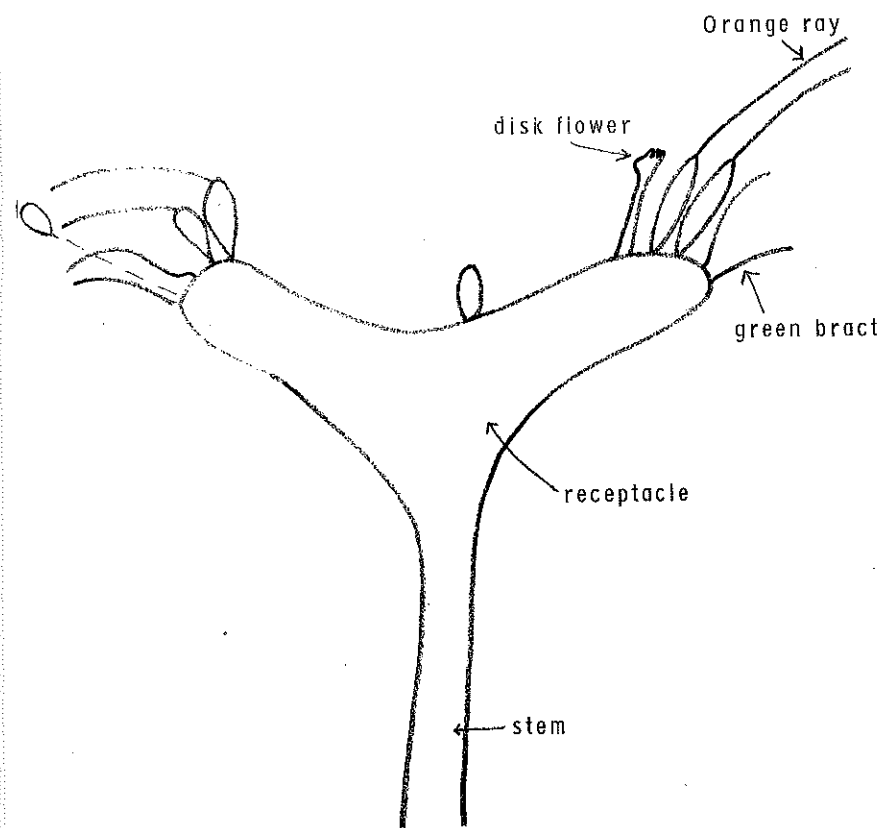


Figure 3. Diagrammatic cross sectional representation of a normal calendula blossom and stem. In polyfloral calendulas, disk flowers have been observed interspersed in the ray flower area and ray flowers have been observed to form tertiary florets in the disk flower area.