

ROOT APICAL ORGANIZATION IN SOME PLANTS OF VERBENACEAE

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ABSTRACT

Organization and behaviour of root apical meristems in four species of Verbenaceae are presented here. The apex showed two distinct types of organization and categorized into open and closed roots based on patterns of cell divisions and cell net analysis at the root pole. Evolutionary tendencies of the apical organizations were discussed.

Keywords: *Verbenaceae, Root Apical Organization, Open and Closed Roots*

INTRODUCTION

Variations in the pattern of apical initials and their ontogenetic relationship with the mature tissues led to many theories and interpretations. Nageli (1845 a, b), Hanstein (1868), Scuehepp (1917), Guttenberg *et al.*, (1955), Clowes (1950, 1953) recognized different types of arrangements and functions of initials/meristematic cells of the root pole. Several workers in the later half of last century studied root apical meristems in different plant groups and interpreted them in the light of these earlier workers. To understand the apical organization, functional aspects and evolutionary trends in verbenaceae were undertook and data are presented here.

MATERIALS AND METHODS

Root apical organization was studied in four species viz., *Clerodendrum inerme* Gaertn., *Duranta repens* Linn., *Petrea volubidis* Jacq. And *Verbena bipinnatifida* Nutt., of Verbenaceae. The stem cuttings were subjected to rooting and root tips were collected from them in three species except *Verbena*, in which roots were collected from well established plants. The collected materials were fixed in FAA, dehydrated through TBA series, embedded in paraffin and sectioned longitudinally at 5-7 μ m. These were stained with tannic acid-ferric chloride, safranin and light green combination. Photomicrographs were taken using Nikon E-400 (Antifungus type) microscope.

RESULTS AND DISCUSSION

Results

All the species showed two types of root apical organizations. The comparative diameter of root body, columella, peripheral part of root cap etc. are given in table-1.

Type I - *Clerodendrum*, and developing roots of *Verbena* showed a closed configuration having separate initials for the stele, cortex and columella and a rootcap-epidermis complex. Accordingly four zones are recognized at the root apex. The stelar initials (zone 1) are a narrow and slightly concave plate of 3-4 small isodiametric cells at the root pole (Figures 1-3).

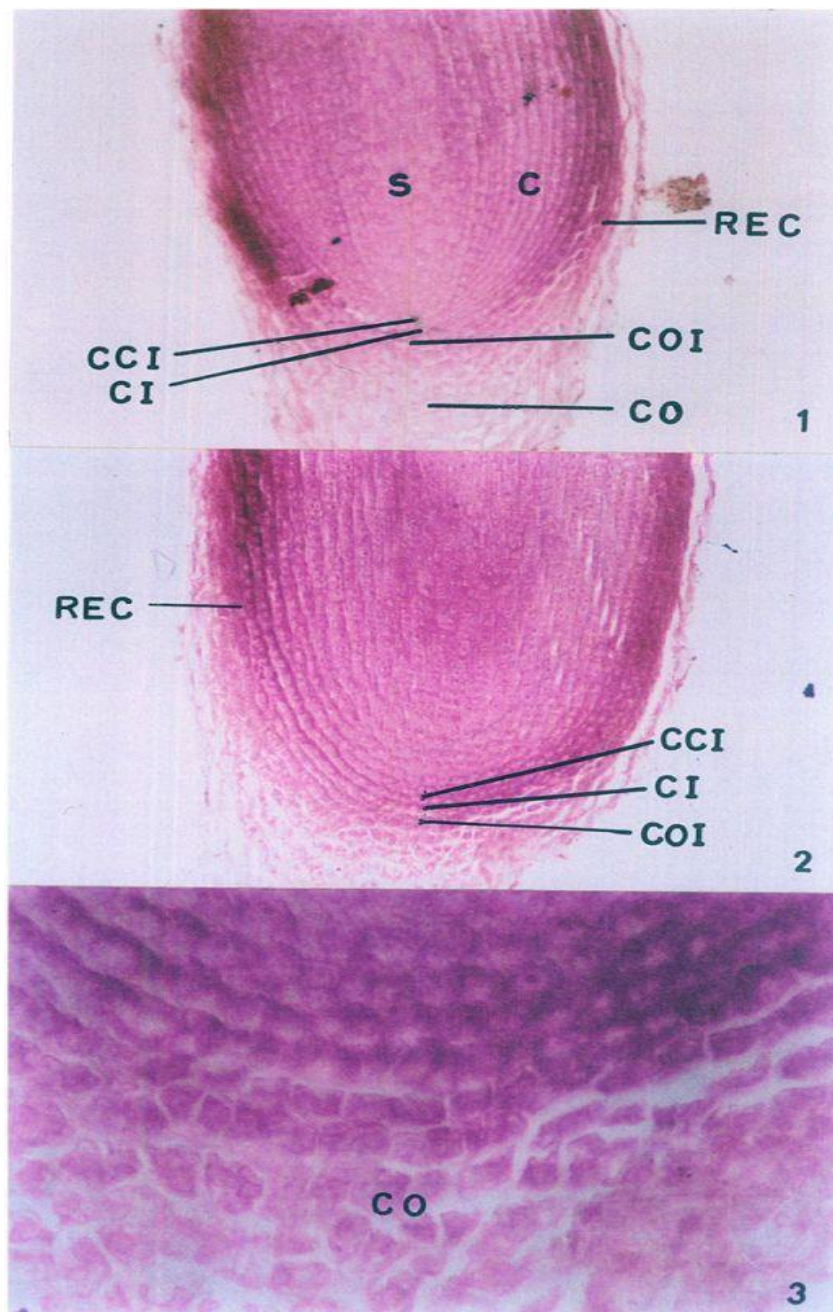
These are denser staining cells from which stele precursors differentiate proximally and which show Korper type of divisions. The cortical initials (zone 2) are a plate of 3-4 roughly retangular cells subjacent to zone 1 (Figures 1-3). The peripherally located cells in this tier divide by Korper divisions and form cortical precursors. The cortical cylinders broadens proximally due to occasional Korper divisions and differentiate into parenchymatous cells.

Subjacent to the zone 2 is present a plate of 6-7 (*Verbena*) or 4-5 (*Clerodendrum*) small rectangular cells represent the columella initials. These divide by transverse divisions and form the columella precursors distally. Their derivatives differentiate into paranchymatous columella.

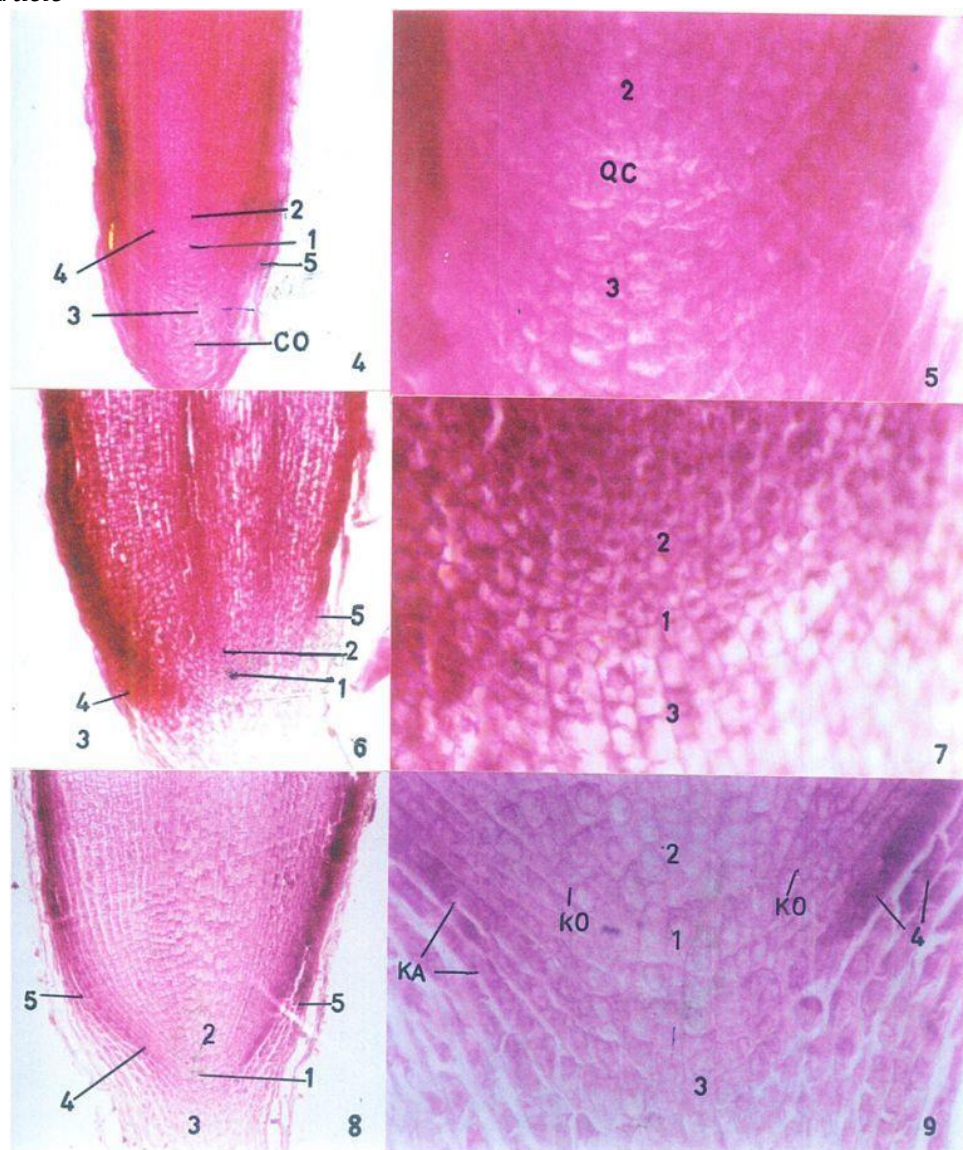
A complex of rectangular cells dividing anticlinically (proximally) and by Kappe patterns (distally) is present on the periphery of the root pole. The proximal derivatives of these cells divide further by

anticlinal divisions and differentiate into epidermis proximally. The distal derivatives contribute to the peripheral part of the cap.

Type II - The root apex in *Duranta*, *Petrea* and older roots of *Verbena* showed a common group of initials (zone 1) which are stained hemispherical group of cells forming precursors of stele (zone 2) proximally and columella cells distally (Figures 4, 6, 8). In *Duranta* the centrally located cells in this group are lighter (quiescent centre) than the peripheral ones. An inverted hollow cup of initials (as seen on either sides of zone 1 in L.S.) constitute the zone 4 (Figures 4-9). These initials are densely stained and show frequent korper divisions. The zone 5 is the rootcap-epidermis complex and resembles exactly to that described under type I.



Figures 1-3: Median longitudinal sections of roots of *Clerodendrum*
 (Figure 1-2 x 100; Figure 3 x 200)



Figures 4-9: Median L.S. of roots of *Duranta* (Figures 4, 5), *Petrea* (Figures 6, 7) and *Verbena* (Figures 8-9) (Figures 4, 6, 8 x 50; Figures 5, 7, 9 x 200)

(1, 2, 3, 4, 5 zones of the apex, C - Cortex, CCI - Central cylinder initials, CI - Cortical initials, CO - Columella, COI - Columella initials, kA - Kappe, KO - Korper, QC - Quiescent Centre, REC - Rootcap epidermis complex; S - Stele)

Table 1: Showing measurements of root body and root cap

Species	Length of columella (μm)	Width of columella (μm)	Width of peripheral part (one side) of root cap (μm)	Root body diameter (μm)
<i>Clerodendrum inerme</i>	260	80	29	137
<i>Duranta repens</i>	145	40	85	210
<i>Petrea vulubilis</i>	360	100	90	280
<i>Verbena bipinnatifida</i>	275	110	90	290

Discussion

Various theories have been proposed to interpret the cell divisions and consequent cell net at the root pole. Schuepp (1917) described the roots on the basis of cell patterns and orientation of cell division rather than cell destinies. Schuepp's concept is largely followed in the present report where Kroper and Kappe divisions distinguish the major tissue systems. However, a third pattern, the rib meristem pattern, is also described here which separates the columella region from the other zones of the apex.

Clerodendrum and *Verbena* developing roots showed the type I of organization with discrete initials for stele, cortex and columella whereas *Duranta*, *Pretrea* and mature roots of *Verbena* showed the type II of organisation with common group of initials for the stele and columella and an inverted cup of initials for the cortex. These two types broadly resemble the closed and open types described by Guttenberg (1960).

The columella is ontogenetically separate from the peripheral part of the cap (Spurr, 1949). The division patterns in columella initials and their derivatives are different than those exhibited by other initials and their derivatives. The stele and cortex initials and their derivatives showed Korper pattern, the epidermis-root cap complex the Kappe pattern and the columella showed a rib-meristem pattern. And this is in support of Spurr's conclusions.

The mature roots of *Duranta*, *Petrea* and *Verbena* showed an open type of configuration and developing roots of *Verbena* and mature roots of *Clerodendrum* showed a closed configuration. Haberlandt (1914) proposed the common group of initials type as advanced over the type with discrete initials. Esau (1962) and Sharma and Sharma (1988) suggested that the roots with common group of initials are primitive. The data are in agreement with the later group of workers.

REFERENCES

- Clowes FAL (1950).** Root apical meristems of *Fagus sylvatica*. *New Phytologist* **49** 248-267.
- Clowes FAL (1953).** The cytogenative centre in roots with broad columellas. *New Phytologist* **52** 48-57.
- Esau K (1962).** *Anatomy of Seed Plants* (John Wiley & Sons, New York).
- Guttenberg H von (1960).** Grundzuge der Histogenesehohererpflanzen. I. Die Angiospermen. In: *Handbuck der Pflanzenanatomie/ Band VIII, Teil 3* (Gebruder Borntraeger, Berlin).
- Guttenberg H von, Burmeister J and Brosel HJ (1955).** Studeiniiber die Entiwicklung des Wurzelvegetationspunktes der Dikotyledonen III. *Planta* **46** 179-200.
- Haberlandt G (1914).** *Physiological Plant Anatomy* (Mac Millan and Co., London).
- Hanstein J (1968).** Die Scheitelzellgruppe in Vegetationspunkt der Phanerogamen. *Festschr. Neiderrhein Gessell Noturund Heilkundi.* 109-143.
- Nageli CK (1845a).** Wachstumsgeschiehte von. *Delesseria hypoglossum*. *Zeitschrift für wissenschaftliche Botanik* **2** 121-137.
- Nageli CK (1845b).** Wachstumsgeschichte der laubundlebermoose. *Zeitschrift für wissenschaftliche Botanik* **2** 138-210.
- Schüepp O (1917).** Untersuchungeniiber Wachsthumknd Formwechsel von Vegetationspunkten. *Jahrbuche fu'r Wissenschaften Botanisch* **57** 17-79.
- Sharma M and Sharma KC (1988).** The ontogeny of apical organization and dormancy breaking in the roots of *Polyalthialongifolia* Benth & Hook F. *Beiträge zur Biologie der Pflanzen* **62** 405-414.