THE SHOOT APICES OF *CERCIS CANADENSIS* L.

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ABSTRACT. — The vegetative shoot of *Cercis canadensis* terminates in a low dome shaped apex with an average diameter of 80μ and an average height of 21μ. The apical promeristem organization corresponds to Popham's Type VII zonation, the Usual Angiosperm Type, consisting of a mantle, central mother cell zone, rib meristem and peripheral zone. The tunica consists of a single layer of cells. The seedling shoot apex does not differ markedly from that of the mature tree. The initiation of a leaf primordium is first indicated by periclinal divisions in the second cell layer. Axillary buds are initiated adaxial to the second or third youngest leaf primordium. There are no differences in the shape, size, or organization of the shoot apex which occurs in the axillary leaf bud and the shoot apex which occurs at the tip of an actively growing shoot. The floral promeristem, before initiation of floral parts, does not differ in shape, size, or organization from the vegetative shoot apex. The initiation of the first floral parts is accompanied by marked changes in the shape, size, and organization of the floral apex.

Since the publication of the first description of an angiosperm shoot apex in 1852, a great deal of research concerned with the shoot apex has been conducted; however, many areas remain relatively unexplored as for example very few survey studies have been attempted in a single family. There have been several comprehensive reviews of the various interpretations of the structure and activity of the shoot apex (Foster, 1939; Popham, 1951; Gifford, 1954; Wardlaw, 1957; Clowes, 1961; Romberger, 1963; Esau, 1965). Few species of the economically important Leguminosae have been studied. This investigation is concerned with the seedling and mature tree shoot apex, buds, and early leaf and flower development of the Redbud or Judas Tree, *Cercis canadensis* L.

In this paper "(vegetative) shoot apex" refers to the actively growing region at the tip of the stem and "axillary bud apex" refers to the meristematic region enclosed within the bud scales of axillary leaf buds.

MATERIALS AND METHODS

Vegetative shoot apices, axillary buds, and flower buds were collected between June 27, 1962 and July 23, 1963 from a single specimen of *Cercis canadensis* L. growing on the campus of Western Illinois University, Macomb, Illinois. Randolph's Modified Navashin Fluid (Johansen, 1940, p. 45) was used as the killing and fixing fluid. The material was transferred, without washing, directly to 70% ethyl alcohol. Dehydration and clearing were completed using a graded series of water, ethyl and tertiary butyl alcohol solutions (Johansen, 1940, p. 130). Serial sections, cut at 5μ, were stained by using a stock solution of Heidenhain's Iron Hematoxylin (Sass, 1958, p. 58) for 20 minutes and counterstaining for 20 seconds with a 0.2% alcoholic solution of fast green.

Seeds collected from the same tree in August, 1962 were forced to germinate in May and June, 1964 according to the method described by Afanasiev (1944). The vegetative shoot apex was collected from seedlings which had two or three expanded leaves. These apices were processed by the same procedure used for the material taken from the mature tree.

Observations and Results

The Vegetative Shoot Apex and Leaf Initiation. The vegetative shoot terminates in a low dome shaped apex. As measured from median or near median longitudinal sections above the level of the youngest leaf primordium, the apex diameter varies from about 45 to 105μ with the average being 80μ, and the height varies from about 4 to 44μ with the average being 21μ. The size of the apex increases during the plastochron, attaining maximum size just before the initiation of the next leaf primordium.

The organization of the apex may be adequately described in terms of the Tunica-Corpus Theory with a superimposed zonal structure. The tunica is composed of a single layer of cells which divide only anticlinally. The second and occasionally the third layer of cells could easily be mistaken for tunica layers but periclinal divisions are a regular feature its smaller, denser, less vacuolated cells arranged in four to five rows of these layers (Fig. 1). The term "mantle" is used to include the two or three surface layers in which some periclinal divisions occur. The corpus exhibits four zones: (1) the stratified cell layer(s) below the tunica, (2) a central mother cell zone, (3) a rib meristem, and (4) a peripheral zone (Figs. 1, 2). These zones are distinguishable on the basis of: (1) planes of cell divisions, (2) degree of vacuolation, (3) size of cells, (4) relative thickness of cell walls, and (5) density of the protoplasm as demonstrated by differential staining.

The central mother cell zone, composed of large, light staining, irregularly arranged cells, is centrally located beneath the mantle, usually in the third and fourth layers of cells from the summit. Below the central mother cell zone is a rib meristem consisting of four to six vertical columns of highly vacuolated cells. The peripheral zone, lateral to the cen-

Figure 1. — Longisection of a vegetative shoot apex of *Cercis canadensis* collected in June, illustrating zonation, periclinal divisions in layers 2 and 3 of the mantle, and the shell zone of early bud development. C — central mother cell zone; PZ—peripheral zone; R—rib meristem; M—mantle; SZ—shell zone; AB—axillary bud; arrows indicate periclinal divisions. X600.

Figure 2. — Diagrammatic representation of a median longitudinal section of a shoot apex illustrating zonation. M—mantle; CMCZ — central mother cell zone; PZ—peripheral zone; RM—rib meristem. Arrows indicate planes of cell division.

tral mother cell zone, is identified by which are more or less parallel to the tunica. During leaf initiation the general uniform cell arrangement of the peripheral zone becomes disorganized on the side of the apex where initiation occurs (Fig. 3). No cambium-like zone was observed in any of the apices studied.

FIGURE 3. — Longisection of a vegetative shoot apex at minimum size showing the disruption of the peripheral zone on the side of the apex where leaf primordium initiation occurs. X1,000.

The most conspicuous characteristic of the rib meristem and the peripheral zone is their stratified appearance, the result of repeated anticlinal cell divisions (perpendicular to the surface). Occasional periclinal cell divisions (parallel to the surface) increase the number of rows as the distance from the summit increases. There is no sharp line of demarcation between these two zones. In tracing the rows of cells of the rib meristem and peripheral zone toward the summit, it is found that they converge at the central mother cell zone in which cell divisions in various planes result in no definite pattern of cell arrangement.

Mitotic figures were rarely seen; therefore, no conclusions can be drawn concerning the relative mitotic activity of the various zones. Since the tunica layer never divides periclinally and is continuous over the surface of the primordium, it presumably gives rise to only the epidermal system of the shoot. The rest of the shoot must, therefore, arise from the corpus. The position of the central mother cell zone relative to the rib meristem and peripheral zone indicates that it is probably an initial zone from which the rib meristem and peripheral zone arise. The rib meristem appears to give rise to the pith; the foliar organs, vascular tissue, and cortex of the stem being derived from the peripheral zone.

When the last formed leaf primordium has attained a height of about 90μ, the next primordium is initiated on the opposite flank of the apex. The first indication of leaf initiation is the occurrence of periclinal divisions in the outer layer of the corpus (the second cell layer) (Fig. 4). Additional periclinal divisions accompanied by cell elongation parallel to the shoot axis forms a protuberance

FIGURE 4. — Longisection of a vegetative shoot apex at maximum size showing periclinal divisions (arrow) in the outer corpus layer of the right flank of the apex. These divisions indicate the initiation of a leaf primordium. X1,000.

FIGURE 5. — Longisection of a vegetative shoot apex illustrating the protuberance resulting from periclinal divisions and cell elongation in a very early stage of a leaf primordium. Note also the narrow cells resulting from anticlinal divisions and the enlarged cells of the tunica on the right flank. X1,000.

on the side of the apex (Fig. 5). Further divisions in various planes derange the stratified appearance of the leaf primordium and the peripheral zone on that side of the shoot apex (Fig. 3). Growth in length of the very young primordium continues primarily by anticlinal divisions of the corpus derivatives. The adaxial surface of the leaf primordium is delimited from the lateral surface of the shoot apex by several rows of elongated cells formed as a result of periclinal divisions in the peripheral zone. The characteristic zonation of the peripheral zone is reestablished as the primordium is delimited. The tunica layer, as a result of anticlinal divisions and cell enlargement, retains its identity as a discrete layer throughout leaf initiation and subsequent leaf development (Fig. 5). Further development of the leaf has not been investigated. At the onset of leaf initiation the shoot apex has reached its maximum size (Fig. 4), but by the time the peripheral zone has become disorganized, the apex is at its minimum size (Fig. 3).

The procambium of the leaf primordia is continuous with the stem procambium. Differentiation of the procambium appears to be acropetal into the leaf from the stem procambium since isolated procambial strands in the leaf primordia were not observed.

A preliminary study of the vegetative shoot apex of *Cercis canadensis* seedlings indicated that the seedling apex does not differ markedly from the vegetative shoot apices of the mature tree. Like the apices of the mature tree, the seedling apex is dome shaped but is somewhat larger since diameters varying from 60 to 126μ and heights from 7 to 60μ were recorded when measured from median or near median longitudinal sections above the youngest leaf primordium. The seedling shoot apex size varies during each plastochron.

The tunica is composed of a single layer of cells, since, as in the shoot apex of the mature tree, periclinal divisions occur in the subsurface layers. The zonation of the corpus of the seedling shoot apex (Fig. 6) is

FIGURE 6. — Longisection of a vegetative shoot apex of a seedling illustrating zonation of the apex. X1,000.

the same as in the mature tree. Leaf initiation and procambium differentiation does not differ from that in the mature tree.

The Promeristem of Axillary Leaf Buds. The axillary buds of *Cercis canadensis* are usually first discernible in the axil of the third youngest leaf primordium. Occasionally bud initiation may be detected during late plastochron in the axil of the second youngest leaf primordium. An early indication of axillary bud initiation is the formation of two to four curved rows of elongated cells adaxial to the leaf primordium (Fig. 1). This zone, the shell zone, occurs along the basal and lateral limits of the bud. Vacuolation of adjacent cells and the shell zone delimit from the apical meristem a small group of meristematic cells which becomes the axillary bud apex.

During the next plastochron the bud primordium becomes dome shaped. Only anticlinal divisions occur in the outer layer, the tunica; periclinal divisions occur in the second layer of cells. Growth, in volume, of the bud primordium is by divisions in various planes of the corpus cells. Zonation of the corpus, as described for the vegetative shoot apex, becomes obvious late in the same plastochron or early in the next plastochron. By the time the zonation of the corpus has become established, the diameter of the bud primordium approaches the average diameter of 80μ of the vegetative shoot apex.

The first bud scale primordium is initiated by the axillary bud apex associated with the fifth youngest leaf primordium, or occasionally with the fourth youngest leaf. In all observed axillary buds, the first bud scale was formed on the adaxial flank of the axillary bud apex. A shell zone is often seen low on the abaxial flank. In *Cercis canadensis* numerous superposed axillary buds are produced. In one case seven superposed buds were observed in the axil of a single leaf. Observations of axillary buds are limited to the first formed bud which is the largest and is positioned above and adaxial to the second and subsequent buds in the axil of the same leaf. Figure 7 shows

FIGURE 7. — Longisection of a vegetative shoot apex as well as the seven youngest leaf primordia showing various stages of bud development. The leaf primordia are numbered. S—shoot apex; AB—axillary bud. X70.

a vegetative shoot apex as well as the seven youngest leaf primordia in the axils of which are buds in various stages of development.

The relatively younger vegetative shoot apex of the axillary bud seems to be much more active in the initiation of bud scale primordia than the relatively older apical vegetative shoot apex is in initiating leaf primordia. Note in Figure 7 that the axillary bud associated with the seventh youngest leaf primordium has

at least eight bud scales. These eight bud scales were apparently initiated while the vegetative shoot apex was initiating three leaf primordia since the axillary bud in the fourth youngest leaf primordium has no bud scales. In the axil of the seventh youngest leaf primordium, the bud appears to be completely differentiated since several spirally arranged bud scales are present and the procambium is continuous with the procambium of the main shoot axis. No indication of the development of an axillary bud in the axil of any of the leaf primordia within an axillary bud was observed.

FIGURE 8. — Longisection of an axillary leaf bud associated with the seventh youngest leaf primordium. Note also the presence of a superposed bud. A—axillary bud apex; S—axillary bud scale; SB—superposed bud; PC—procambium. X70.

The Promeristem of Flower Buds. The leaves and flowers of *Cercis canadensis* are borne in separate buds. In early summer, a macroscopic examination of all buds does not allow precise determination of which are floral, but by mid to late summer the flower buds have developed sufficiently to be macroscopically distinguishable.

Identification of flower buds from serial longitudinal sections is not difficult. Flower buds contain numerous spirally arranged bud scales with a promeristem in the axil of each. Each promeristem will develop into a single, complete, perfect flower which will open the following spring. Comparison of Figure 9, a flower bud, with Figure 8, a leaf bud, shows three distinctive differences in leaf and flower buds. First, the flower bud is considerably larger. Second, bud scales are more numerous in flower buds. Third, only one promeristem occurs in a leaf bud but promeristems are numerous in flower buds. All the flower bud scale primordia originate from the apical meristem of the flower bud in the same manner that a leaf bud scale primordium originates from the leaf bud apex. A floral promeristem originates in the axil of the second youngest flower bud scale primordium in the same way an axillary bud primordium is initiated in the axil of a leaf primordium.

FIGURE 9. — Longisection of a flower bud collected in early July showing three floral promeristems and numerous flower bud scales. X70.

Until mid-July, the flower bud promeristem, as illustrated in Figure 10, cannot be microscopically distinguished from the vegetative shoot apex or the axillary bud apex on the basis of shape, size, tunica, or zonation of the corpus. The only distinguishing characteristic of the flower bud promeristem is the lateral organs produced. The first two primordia differentiate into bracts rather than leaves or bud scales. These bracts overlap and cover the promeristem, though not tightly.

FIGURE 10. — Longisection of the apical promeristem of a flower bud collected in July. Note the zonation of the apex and the formation of a flower promeristem in the axil of the third youngest bud scale. X800.

The production of the next two lateral organs in mid-July is accompanied by a change in the shape, size, and organization of the flower bud promeristem (Fig. 11). The apex becomes wider and nearly flat rather than dome shaped. The tunica layer remains discrete and, as described in all other apices of *Cercis canadensis,* the second and third mantle layers exhibit some periclinal divisions. The peripheral zones are no longer curved but are composed of four to six columns of dark

FIGURE 11. — Longisection of a floral promeristem after the initiation of the first two floral parts. Note the increased size, the reduction in the height of the dome, and the change in the zonation of the apex. Periclinal divisions are visible in the second layer. X800.

staining cells along both sides of the rib meristem. The rib meristem cells have elongated and the number of files of cells have increased to eight to ten. The initiation of floral organs beyond the first two primordia, presumably sepals, and further changes in the flower bud promeristem were not investigated. It is interesting to note, however, that all flower buds collected during the year show some promeristems which have ceased development soon after the development of the bracts. Even in the mature flower cluster can be found the imbricate bracts which enclose no visible floral parts.

DISCUSSION

The vegetative shoot apex of *Cercis canadensis* resembles that of other investigated members of the Leguminosae in having a dome shape. The apex is smaller than any of the other investigated genera of the family. Its average diameter of 80μ is the lower limit of the range reported for *Glycine max* (Sun, 1957, p. 163),

the smallest diameter previously reported in the family. Boke (1940, p. 77) reported that the height of the apex of *Acacia longifolia,* the shortest previously reported apex, varies from 21 to 77μ. The average height of 21μ, with a maximum of 44μ, of *Cercis canadensis* ranks its as the shortest apex in the family.

When determining sizes of apices, measurements are traditionally measured above the last formed leaf primordium. By using this method of measurement, apices show an increasing size during each plastochron. However, a somewhat distorted view of the apex size can result because the measured height of the promeristem may include only a small proportion of the promeristem region, often no more than the outer layer of cells. This is because the portion of the shoot apex which extends above the youngest visible leaf primordium is determined by the location of the leaf primordium on the promeristem. When leaves are initiated low on the flanks as in *Agropyron repens* (Sharman, 1945) a considerable proportion of the promeristem is above the young leaf primordium. However, problems of measurement arise when the leaf primordium is initiated high on the flanks of the shoot apex as in *Cercis canadensis* or when the apex shape is low domed or flat as in *Hibiscus syriacus* (Tolbert, 1961, p. 250). Problems of measuring shoot apices were encountered by Rouffa and Gunckel (1951a, p. 295) and problems concerning the difficulty of determining shoot apex sizes were discussed by Gifford (1954, p. 499). Esau (1965, p. 105) mentions the effect of the level of leaf primordium insertion on the shoot apex in relation to changes in shape of the apex during a plastochron. A comparison of Figures 1 and 4 will show that the promeristem regions in both apices are very similar but measurements above the youngest visible leaf primordium results in measuring only two cell layers in Figure 1 and in Figure 4 includes only the mantle and central mother cell zone.

The data obtained from the currently used method of determining what portion of the apex to include in measurements tend to indicate that the meristematic tissue is "used up" during the formation of a primordium and that during the next plastochron an almost entirely new apex is formed. Study of the apices used in this investigation indicates that the leaf primordium results from the production of additional cells and that the apex size after leaf initiation is not as changed as the measurements indicate. These statements are not intended to imply that the apex is a static entity for it is fully realized that it is a dynamic system as has recently been illustrated by Soma and Ball (1964). A method of determining the size of the entire shoot apex, meristematic initials and their immediate derivatives, regardless of the level of the insertion of the leaf primordium is much needed.

The Tunica-Corpus Theory is applicable to the shoot apex of *Cercis canadensis.* In this paper the term "tunica" is used in the strictest interpretation, "discrete, independent, and self-perpetuating surface layer whose cells divide exclusively in anticlinal planes" (Popham, 1951, p. 260). *C. canadensis* has a single

tunica layer. A single tunica layer was also reported by Slade (1957, p. 283) for *C. siliquastrum* and by Hostetter (1965, p. 276) for the mature dormant plumule of *C. canadensis*. No other investigated genus of the Leguminosae typically has one tunica layer; however, it is apparent that not all workers use the term in its strictest interpretation. It would be interesting to determine if one tunica layer is characteristic in all members of the genus *Cercis*. A tunica composed of a single layer is not common among the angiosperms, especially the dicotyledons. In a table prepared by Gifford (1954, p. 518), of the 172 species listed only 39 have a one layer tunica; 23 of these were reported for the 49 species of monocotyledons included in the table.

The present study of the shoot apex of *Cercis canadensis* shows that it is an addition to the growing list of angiosperms whose apex exhibits a pattern of zonation superimposed upon a tunica-corpus organization (Philipson, 1947, 1954; Popham and Chan, 1950; Popham 1951, 1960; Gifford, 1954; Sun, 1957; Clowes, 1961; Tolbert, 1961; Romberger, 1963). In the family Leguminosae reports of zonation have not been frequent. Only the apex of *Glycine max* (Sun, 1957, p. 164) has been described as being definitely zoned. In *Acacia longifolia,* Boke (1940, pp. 77, 79) reported that "The apex of the corpus is dominated by a group of cells which may be termed initials" and "the inner corpus cells give rise to the rib meristem". Stratification of the flanks in the shoot apex of *Pisum sativum* was reported by Reeve (1948a, p. 71) but in the same species, Mitra (1950, p. 212) observed no "evident zonation".

Although many names have been applied to the zones of the shoot apex, the terms of Popham and Chan (1950, p. 480) are used in this paper. The shoot apex of *Cercis canadensis* exhibits Type VII zonation, the Usual Angiosperm Type of organization, described by Popham (1951, p. 260). This is the same type of zonation described by Sun (1957, p. 164) for *Glycine max.*

Soma and Ball (1964) have shown that centrally located cells on the surface of the shoot apex of *Lupinus albus* are shifted toward the flanks during growth. This experiment illustrates that zonal patterns should be considered as descriptive devices and should not lead to a belief in a permanent cell population within the shoot apex.

Leaf initiation in *Cercis canadensis* is first indicated by periclinal divisions in the second layer of cells. In terms of the Tunica-Corpus Theory this is the outer layer of the corpus and in terms of Type VII zonation this is layer two of the mantle. There seems to be no general pattern of leaf initiation with respect to the tunica-corpus organization in the shoot apex of investigated members of the family Leguminosae. Leaves may be initiated in the "subepidermal layer" as described by Slade (1957, p. 283) for *Cercis siliquastrum* which has a single tunica layer. Three different locations of leaf initiation are cited for the Leguminosae apices with two tunica layers: (1) in *Lupinus albus,* the second tunica layer (Ball, 1949, p. 441); (2) in *Glycine max,* the outer corpus layer (Sun, 1957, p. 166); and (3)

in *Pisum sativum,* the second tunica layer and outer corpus layer (Mitra, 1950, p. 213). In *Acacia longifolia,* with three tunica layers, both the tunica and corpus are involved in leaf initiation (Boke, 1940, p. 79). Apparently the only uniform feature of leaf initiation, not only among the members of the Leguminosae but also of other dicotyledons, is that periclinal divisions usually do not occur in the outer layer of cells (Clowes, 1961, p. 35).

Procambium development of *Cercis canadensis* resembles that of most of the other investigated members of the family Leguminosae as well as most dicotyledons in that the direction of differentiation is acropetal. Hostetter (1965, p. 271) reported that in the mature dormant plumule of *Cercis canadensis* procambium appears to differentiate acropetally. Ball (1952, p. 179) reports that procambium differentiation in *Lupinus albus* is basipetal after surgical isolation of the stem tip from subjacent tissue.

The vegetative shoot apex of the seedling was found to vary from the vegetative shoot apex of the mature tree only in size. The seedling apex was slightly larger than that of the mature tree. Reeve (1948a, p. 74) found that the shoot apices of fully developed embryos, seedlings and adult plants of *Pisum sativum* differ little from one another. The adult shoot apex is more highly arched and has an increased number of tunica layers as compared to the fully developed embryo (Reeve, 1948b, p. 600). Apparently few investigations of this type have been carried out using dicotyledons. Among the monocotyledons, Abbe, et al. (1951, p. 751) has shown that the shoot apex of *Zea mays* increases exponentially in all dimensions affecting area. Apex zonation and cell size did not change. Ball (1941, p. 831) demonstrated a change from Type VII zonation, the Usual Angiosperm Type, of the seedling to Type VI zonation, the Opuntia Type which includes a cambium-like zone of cells, of the adult plants of *Phoenix canariensis.* The volume of the apex of *P. canariensis* decreased during development of seedling to adult plant. Similar changes in zonation and apex size has been reported for gymnosperms such as *Pseudotsuga taxifolia* (Allen, 1947, p. 208). It should be noted, however, that the study of the shoot apex of *Cercis canadensis* seedlings is only a preliminary study.

No differences in shape, size, or organization between the vegetative shoot apex and the axillary bud apex was found in *Cercis canadensis.* Sun (1957, p. 171) reported that in *Glycine max* the axillary bud apex was of smaller diameter than the vegetative shoot apex; no differences in apex organization were evident. The formation of the axillary bud apex in both *Glycine max* and *Cercis canadensis* followed the pattern described by Garrison (1949, p. 213) for *Syringa vulgaris* in which the bud apex is derived directly from the apical meristem of the main shoot being delimited by the formation of shell zone.

Rouffa and Gunckel (1951a, p. 297), in a study of the shoot apices of 54 species of the family Rosaceae, found a wide range of variation in apex sizes and concluded that "Much of the difference between active shoots and perennating buds may be

due to the perennating buds usually being axillary, but the range of variation is probably still significant." In five species, *Neillia sinensis* Oliv., *Stephanandra Tanakae* French., *Cotoneaster horizontalis perpusilla* Schneid., *Adenostoma sparsifolium* Torr., and *Prunus Laurocerasus Schipkaensis* Spaeth., Rouffa and Gunckel (1951b, p. 303) found that both the active shoots and perennating buds showed pith development typical of long shoots with cells arranged in long files. This type of pith development is also found in *Cercis canadensis*. A seasonal study of the vegetative shoot apex in *Hibiscus syriacus* conducted by Tolbert (1961, p. 254) correlated seasonal changes, in terms of long and short shoot development and dormant terminal buds, with pith rib meristem changes. The dormant shoot apex of *H. syriacus* is described as looking "as though it were arrested during the process of active growth", a description which also applies to *Cercis canadensis*.

Borthwick and Parker (1938) in a study of the influence of photoperiods upon the differentiation of meristems and the blossoming of Biloxi soybeans recorded some information concerning flower development. This is the only report on flower development of a member of the family Leguminosae, although Sunderland (1961) did make measurements of the rate of cell multiplication and expansion in the reproductive apices of *Lupinus albus*, but no information concerning the size, shape, or organization of the floral apex or the initiation of floral parts was given.

Borthwick and Parker (1938) did not describe the size or organization of the floral promeristem of soybean, but their investigation showed that the vegetative apex of soybean ceases producing leaves and rapidly initiates a series of spirally arranged small bracteal leaves. A bud develops in the axil of each bracteal leaf. After forming the primordia of a pair of prophylls, the promeristem of each bud gives rise directly to the various whorls of flower parts. Each bud gives rise directly to a single flower. This is essentially the same developmental sequence observed in each flower bud promeristem of *Cercis canadensis* except that the small bracteal leaves of soybean were developmental equivalents of flower bud scales in *C. canadensis*. The prophylls of soybeans are carried outward by the elongation of the pedicel whereas in *C. canadensis* the bracts remain at the base of the pedicel.

Summary

1. The vegetative shoot of *Cercis canadensis* terminates in a low dome shaped apex with an average diameter of 80μ and an average height of 21μ. The apex exhibits Popham's (1951, p. 260) Type VII zonation, the Usual Angiosperm Type of organization, consisting of a mantle, central mother cell zone, rib meristem, and peripheral zone. The tunica consists of a single layer of cells.

2. The leaf primordium is first indicated by periclinal divisions in the second cell layer.

3. Differentiation of the procambium is acropetal into the leaf from the stem procambium.

4. The seedling vegetative shoot apex differs from that of the mature tree only by being slightly larger.

5. Axillary buds, first indicated by a shell zone, are initiated adaxial to the second or third youngest leaf primordium. The shape, size, and organization does not differ from the vegetative shoot apex.

6. The floral promeristem before initiation of floral parts does not differ in shape, size, or organization from the vegetative shoot apex. The initiation of the first floral parts produces marked changes in the shape, size, and organization of the floral apex.

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