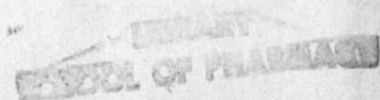


COMPARATIVE STRUCTURE OF SALIX AMYGDALOIDES, ANDERS AND SALIX  
NIGRA, MARSH.

By



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As the barks of various species of willow show great similarity of structure, it was made the purpose of this study to discover if possible whether structural characteristics could be discovered which would serve to distinguish the bark of the *Salix Nigra*, one of the species used in medicine, from that of *Salix amygdaloides*, our common peach leaved willow.

The *Salix* or willow is a very marked genus of plants and constitutes with the Poplar or *Populus* the order *Salicaceae*. Willows may be either trees or shrubs and vary in stature from a few inches to a hundred feet and grow most abundantly in cold or temperate climates of both hemispheres, generally in moist places.

The *Salix amygdaloides* Anders. or peach leaved willow is a small tree growing sometimes as high as seventy feet and having a diameter of two feet and a brown scaly bark. The leaves are lanceolate or ovate long acuminate at the apex and narrowed at the base. They are three and a half to five inches long and about one inch wide, sharply serrate and slender petioled. The stipules are commonly fugacious and the terminal on short lateral branches. The staminate is from one to two inches long, the pistillate is loose and spreading and the filaments are distinct and pubescent at the base. The scales are deciduous and the stigmas nearly sessile while the capsules are acute and glabrous. It grows on lake and river shores from Quebec to British Columbia, New York to Missouri and New

Mexico. The wood is soft, weak and light brown and has a weight of about twenty-eight pounds.

The *Salix nigra* Marsh is a tree with rough flaky bark of a dark brown color, attaining a maximum height of about one hundred and twenty feet and a trunk diameter of three feet. The leaves are narrowly lanceolate, acute or acuminate at the apex, narrowed at the base and a short petiole which when young is somewhat pubescent. They are glabrous and green above somewhat paler and sometimes pubescent on the veins beneath when matured. They vary in length from two and a half to five inches, in width from  $1/6$  to  $3/4$  of an inch. The stipules are various, persistent or deciduous, aments expanding on the leaves on short lateral branches. The staminate flower is from 1-2 inches long, the pistillate  $1\ 1/2$  to 3 inches long and spreading in fruit. The stamens number from three to seven and are distinct having their filaments pubescent below. The stigmas are nearly sessile scales deciduous, and the capsule ovoid acute, glabrous and about twice as long as its pedicel. It grows along the streams and lakes from New Brunswick to Western Ontario, Florida and California. It hybridizes with the *Salix alba*. The wood is soft weak light brown and weighs 28 pounds per cubic foot.

A cross section of the *Salix amygdaloides* taken from a stem having a diameter of about 16 millimeters and viewed with the lower power of a compound microscope shows the tissue (see Plate 1) from the outer cork to the primary wood regions in

the following manner:-

The outer or cork tissue is made up of two distinctive layers and occupies about one twentieth of the field while the adjoining tissue called the collenchyma covers about one-tenth.

The next tissue under consideration is the primary wood which is bounded on one side by the collenchyma and on the opposite side by the secondary bark and occupies about four times as much space as the collenchyma or about two fifths of the entire field. The secondary bark adjoins the primary and is easily distinguished from it by the medullary rays running through the former. It occupies just about as much space as the primary cortical tissue. Between the secondary bark and the wood is the cambium ring made up of a single layer of elongated cells. The thickness of the cork walls (see Plate 1) made it an impossibility to make out the form of the cells even with the high power of the microscope. The collenchyma tissue is made up of elongated thick walled cells varying in length from 27.9 to 33 $\mu$  and in width from 7.5 to 14.4 $\mu$  those next the cork being narrower than those nearest the primary cortical parenchyma cells. They all have granular contents, some being entirely filled others only partially so.

The elongated narrow cells are all of about the same shape and have a fairly uniform thickness of cell wall. The others are of different shapes some being nearly as wide as long and having somewhat thicker walls on the sides running the same direction as the length of the cells.

The primary cortical region is composed of different shaped cells having uniformly thin cell walls. Most of the cells have a greater length than breadth, the average length being  $34.5\mu$  and the breadth  $18.6\mu$ , though cells very nearly circular in shape occur at intervals throughout this tissue. The bast fiber cells which occur in masses in the primary bark are very closely packed thick walled cells round in form and having a small hole or lumen near the center. They are about  $11.4\mu$  thick and  $8.4\mu$  wide, the number in a group varies all the way from about 9 to 35 or 40. Through the microscope they appear to have a yellow color. The contents of the cells of the primary bark is a granular substance. In a few cells are found calcium oxalate in the form of rosette crystals occupying nearly the entire cell.

The secondary bark (see Plate 11) is for the most part made up of two kinds of cells, the large cells are called the sieve tubes and are surrounded by one or more smaller companion cells, the sieve cells have an average length of about  $22.5\mu$  and a breadth of  $15.3\mu$ , the length of the smaller cells is  $10\mu$  and width  $7\mu$ . The majority of them are smaller however than those of the primary, though they resemble them somewhat in shape. The bast fiber groups which occur more frequently in this tissue than in that of the primary bark, are in parallel rows for the most part. The characteristic of this tissue which serves to distinguish the primary from the secondary bark is that of the medullary rays cells which elongate

ina radial direction and occur in rows one cell in width.

The medullary ray is made up of cells,  $27.3\mu$  long and from 15 to  $30\mu$  wide. They have somewhat thickened walls and are with a few exceptions of irregular shape. The rows of ray cells occur about six or seven phloem cells apart. They pass through the circle of bast fibres dividing them into groups. A radial, longitudinal section (See Plate 111) cut through a stem of the *Salix amygdaloides* sixteen millimeters in diameter and viewed with the lower power of the microscope shows all that tissue between the outer cork and the wood tissue. The cork occupies about one-tenth of the field and the collenchyma about two-tenths, the primary bark four tenths and the secondary bark about three-tenths of the field under consideration. The cork as in the cross section is so dense that its structure could not be made out. The collenchyma tissue is made up of small thick walled cells, some being a trifle more oblong than circular so that the average length is  $10.5\mu$  and width  $9.3\mu$  of the upper collenchyma, while the lower has a length of  $9.3\mu$  and a width of  $29.8\mu$ . The cells increasing in size as they near the adjoining parenchyma region. The primary tissue is composed of rounded cells of uniform size and shape having walls much thinner than those of the collenchyma. This region is traversed by long bast fibers which showed in cross section as rounded groups.

The secondary bark tissue is composed of cells of about  $40.5\mu$  long and  $18.9\mu$  wide. The medullary ray tissue appears

in this section as a plate of cells perpendicular to that of the secondary tissue. The contents of the ray as well as the secondary tissue cells are granular.

A tangential longitudinal section of the *Salix amygdaloides* cut through the secondary bark and viewed with the high power (1 inch eye piece,  $1/6$  objective B and L) of a compound microscope shows (See Plate IV) the phloem parenchyma cells which are elongated thin walled cells part of them elongating in a radial direction the other tangentially. The medullary ray ends show in this section in groups of thick walled circular cells having a length of  $15.3-39.9\mu$  and a breadth of  $11.4$  to  $24.3\mu$ . The groups are one cell wide and contain from four to eight or ten cells. There are also rows of crystals bearing cells containing rhombic crystals of calcium oxalate. A cross section of the bark of the *Salix Nigra* cut from a stem of about 16 millimeters in diameter and viewed with the lower power (1 inch eye piece,  $2/3$  objective B and L, compound microscope) shows all that tissue between the outer cork and the wood (see Plate VII). The cork tissue is composed of two dense layers and covers about one-twentieth of the field. This is followed towards the inside by the cell tissue occupying about twice as much space as the cork. The thin walled parenchyma cells of the primary bark adjoins the collenchyma and covers about  $3/10$  of the field and the secondary bark together with the cambium ring which consists of a single layer of elongated cells occupy the remainder of the field.

The collenchyma tissue consists of elongated thick walled cells having a granular contents. Their average length is  $29.4\mu$  and their width about  $7.5\mu$ . Their length being a little over three times as great as the width. The cells nearest and adjoining the cork are not so wide as those near the primary bark, nor have they as thick walls. The thin walled cells of the primary cortical regions are of various shapes and sizes and have walls much thinner than those of the collenchyma region. The average length of these cells is  $36.6\mu$  and the width  $15\mu$ . The contents of the cells are for the most part granular. A few cells scattered through out this tissue contain rosette crystals of calcium oxalate occupying about the entire cell. At intervals throughout this tissue are distributed bundles of bast fibers, the bast fiber cell being very thick walled having only a small opening or lumen. These cells average about  $10.5\mu$  in length and  $11.4\mu$  in width being very near circular in shape. The number of cells in a group varies from seven to twenty or twenty-five being very closely packed with no intercellular spaces. The secondary bark tissue is made up of sieve and companion cells. The sieve cells are quite large cells of various shapes. The companion cells are the smaller cells which adjoin the sieve cells and have about the same thickness of cell wall. The marked difference between the primary and secondary regions are the rows of medullary ray cells which occur in the secondary. They are composed of cells elongated in a direction perpendicular to the

the elongation of the surrounding cells. The ray is only one cell in width and the cells are with a few exceptions of irregular shape, a few being quite regular. The rays cut the bast fiber groups which occur abundantly in this tissue into small groups. A radial longitudinal section of the bark of the *Salix nigra* (See Plate 1X) cut from a stem having a diameter of 16 millimeters shows when viewed by a compound microscope (1 inch eye piece,  $1/6$  objective) all that tissue between the outer cork and the primary wood. The cork is made up of two layers and occupies about  $1/20$  of the field the collenchyma adjoining this tissue occupies about  $3/20$ , the primary bark about  $1/4$  and the secondary bark the remainder of the field. The structure of the cork could not be made out on account of the density of the tissue. (See Plate 1X) The collenchyma region is made up of thick walled cells, the upper collenchyma cells occurring in radial rows and having a length of  $8\mu$  and a width of  $7\mu$ . They are all of about the same shape and have a uniform thickness of cell wall. The lower collenchyma cells are  $39\mu$  long and  $9.3\mu$  wide on an average, being much longer than the cells of the upper part of this region, and the cell wall thickness is about twice as great in the lower, compared with the upper. The cells are of various shapes some being very nearly round others much elongated. The cell wall thickening is about as uniform in the lower collenchyma as it is in the upper.

The primary parenchyma is made up mostly of rounded cells having thin walls and granular contents occupying in most cas-

es the entire cell. The length of the cells is  $16.5\mu$  and the breadth  $14\mu$ . The cells which occurred in the cross section (See Plate VII) in groups as small rounded thick walled cells appear at intervals in this region as elongated fibers averaging  $201.9\mu$  in length and  $18\mu$  in width. They gradually come to a point towards the ends and rhombic crystals of calcium oxalate appear in the cells at the sides. The cells adjoining the lower side of the fibers are of different shape from the other cells of this tissue, being about 3 or 4 times as long as broad. There are about three rows of them six or seven cells wide. The secondary, <sup>bark</sup> cells are about  $17\mu$  long and  $14.5\mu$  wide, have a granular content and thin walls of uniform thickness. The medullary ray tissue appears in this region as plates five or six cells wide. The cells are about  $30\mu$  long and  $27.3\mu$  wide and elongate in a direction perpendicular to the elongation of the surrounding tissue. The bast fibers are long, pointed at both ends, and about  $195\mu$  long and  $17.5\mu$  wide. They occur quite frequently in this tissue cutting the secondary bark into strips four or five cells wide. Rhombic crystals of calcium oxalate  $7.5\mu$  long and  $7.8\mu$  wide appear along the sides of the bast fibers.

A tangential longitudinal section cut through the secondary bark viewed with the high power (1 inch eye piece,  $1/6$  objective B and L) shows (see Plate X) the medullary ray ends in groups, from 4 to 8 or 9 appearing in a group; groups of crystal bearing cells containing rhombic crystals of calcium ox-

alate and the large phloem parenchyma cells  $54\mu$  long and  $18\mu$  wide part of them elongated radially and part longitudinally. The ray cells gradually decrease in size as you pass from one end to the other varying in size from  $30.9\mu$  to  $53\mu$  long and  $13.5$  to  $26.4\mu$  wide.

In comparing the different sections of the bark of *Salix amygdaloides* with similarly cut sections of the bark of *Salix nigra* a great similarity of structure was found. The principal differences were in the width of the cork tissue. The cork in the cross section of the *Salix nigra* section being greater than that of the *Salix amygdaloides*. The average length of the cells in the corresponding tissue of both barks average about the same. The corresponding cells of both barks when viewed in the radial longitudinal and tangential sections appear about the same size and shape. The cells below the bast fibers in the primary tissue of a radial longitudinal section of the *Salix nigra* are elongated and of different shape than the corresponding cells in a like section of the *Salix amygdaloides*. Outside of these few differences, characteristic structural markings could not be found.

Tangential Longitudinal Section of *Salix amygdaloides* stem.

16 mm diameter.

Tissue	Length	Breadth
Phloem Par. Cells.	54 $\mu$	18 $\mu$
Crystals	vary from 3.5-6.5 $\mu$	vary from 8.4-6 $\mu$
Ray Cells	" " 15.3-39.9 $\mu$	" " 11.4-24.3 $\mu$
Large Phloem Par. Cells	84.3 $\mu$	16.5 $\mu$

Cross Section of *Salix nigra*, Stem 16 mm in diameter.

Tissue	Length	Breadth
Cork		27.9 $\mu$
Collenchyma	29.4 $\mu$	77.5 .
Primary	36.6 " . . .	15.0 "
Bast fibers	10.5 .	11.4 .
Medullary Ray	26.4 .	12.9 .
Secondary	20.7 .	15.3 .
Lower Parenchyma	39.0 .	13.8 .
Large Vessels	41.4 .	34.8 .
Woody Vessels	18.0 .	9.6 .

Cross section of *Salix amygdaloides*. Stem 16 mm in diameter.

Tissue	Length	Breadth
Cork		24.0 $\mu$
Collenchyma	33.0 $\mu$	7.5
Lower Collenchyma	27.9	14.4
Primary	34.5	18.6
Bast fiber	11.4	8.4
Medullary Ray	27.3	upper 30 lower 15
Secondary	22.5	15.3
Large Vessels	39.0	37.5
Woods Vessels	15.0	8.4

Radial Longitudinal Section of Salix Nigra. Stem 16 mm diameter

<u>Tissue.</u>	<u>Length</u>	<u>Breadth</u>
Cork		34.5 $\mu$
Collenchyma	8 $\mu$	7
Primary	16.5	14
Bast fiber	201.9	18
Lower Collenchyma	39	9.3
	39	25.5
Medullary Ray	30	27.3
Crystals	7.5	7.8
Wood fibers	195	17.5
Secondary	17	14.5

Radial Longitudinal Section of *Salix amygdaloides*. Stem 16 mm  
in diameter.

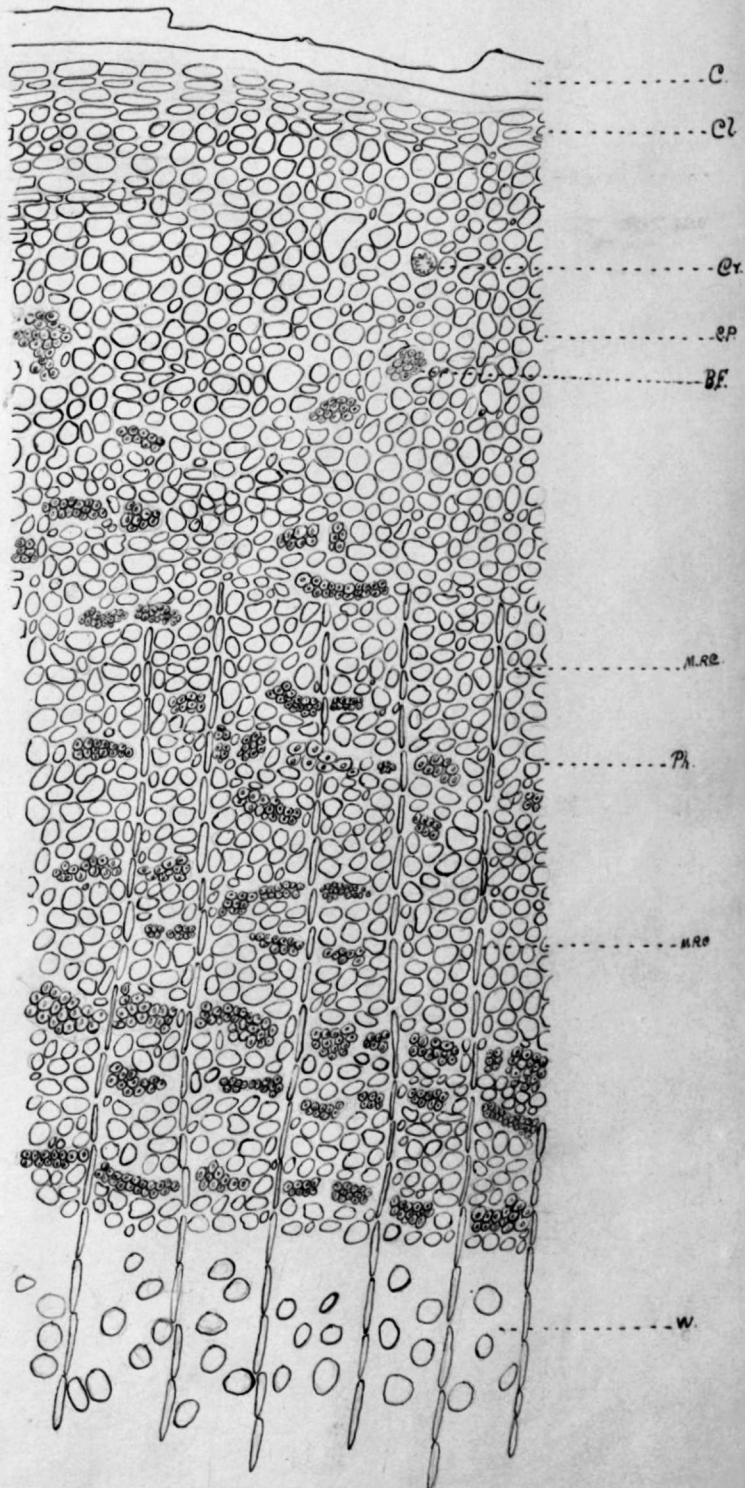
Tissue	Length	Thickness
Cork		34 $\mu$
Collenchyma	10.5 $\mu$	9.3
Lower Collenchyma	9.3	29.8
Primary Bark	34.5	20.4
Bast fibers	1.15 $\mu$	119
	40.5 $\mu$	18.9
Crystals	8.4	10.5
Medulary Ray	18	33
Wood fibers	497	42.5

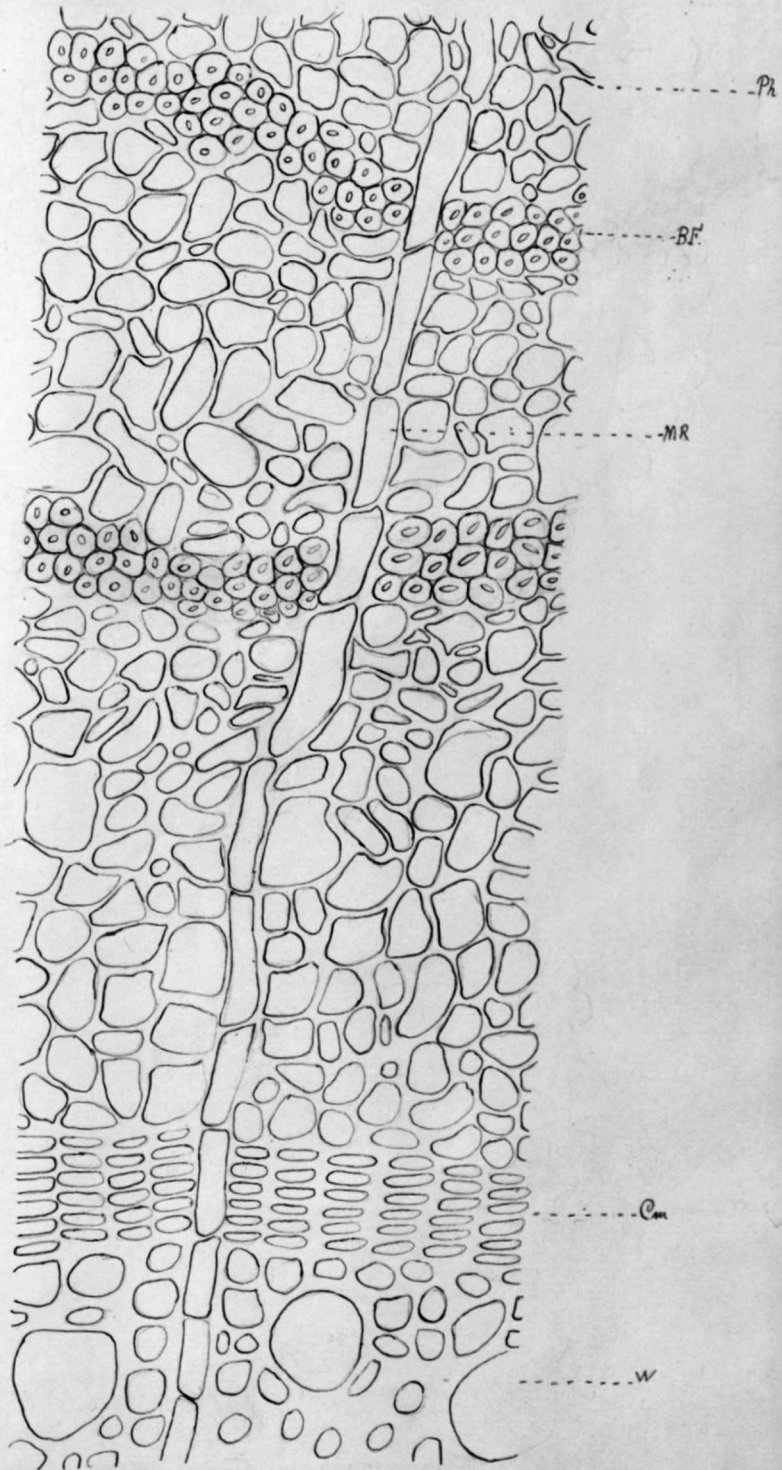
Tangential Longitudinal Section of *Salix nigra*.

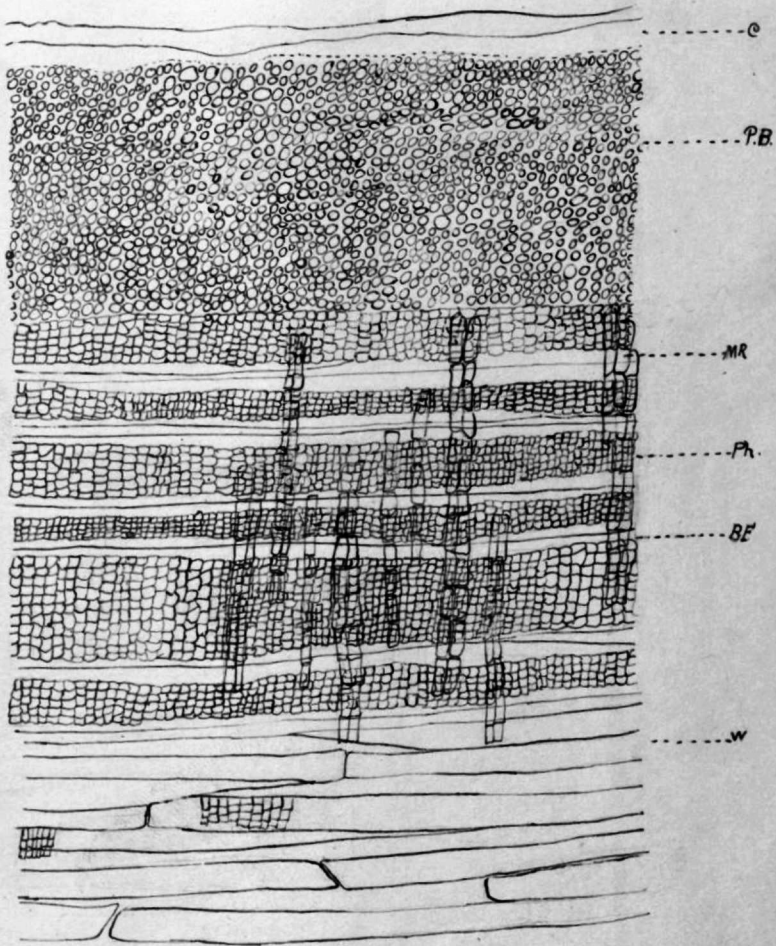
Tissue	Length	Breadth.
Phloem Parenchyma	61.2 $\mu$	27 $\mu$
Crystals	12.9	9
Medulary Ray cells	30.9 - 15.3	26.4 - 13.5
Large Phloem Parenchyma	85.5	18

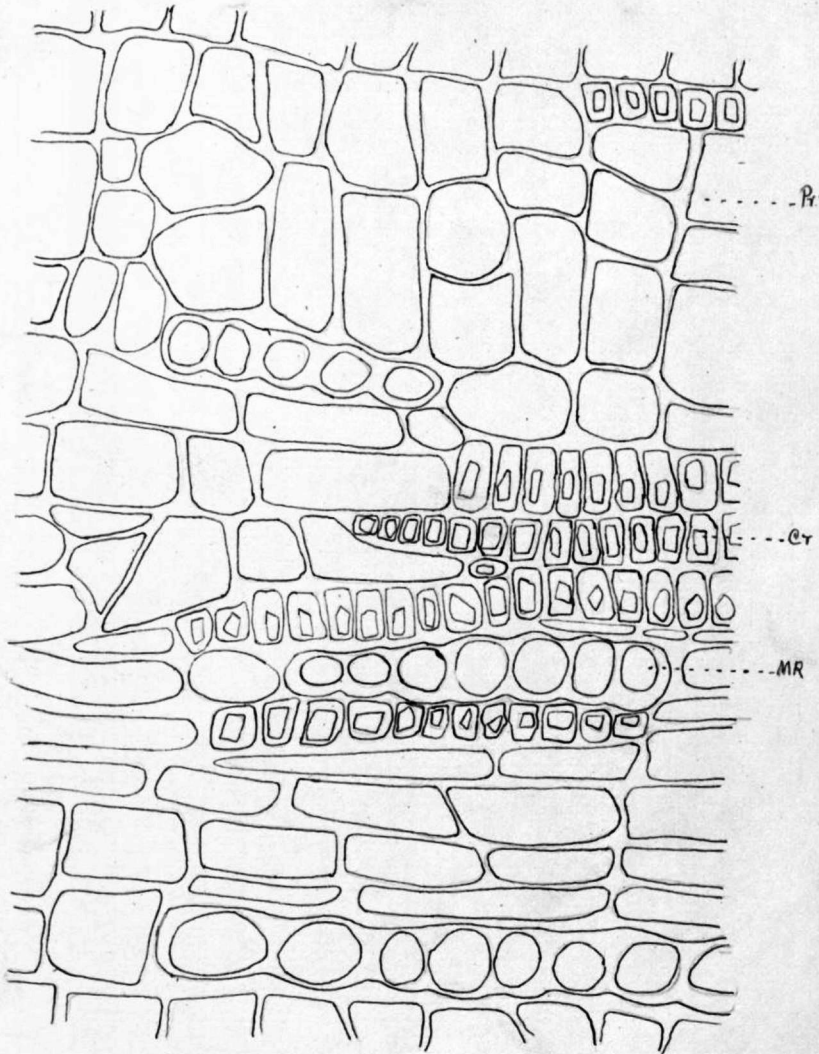
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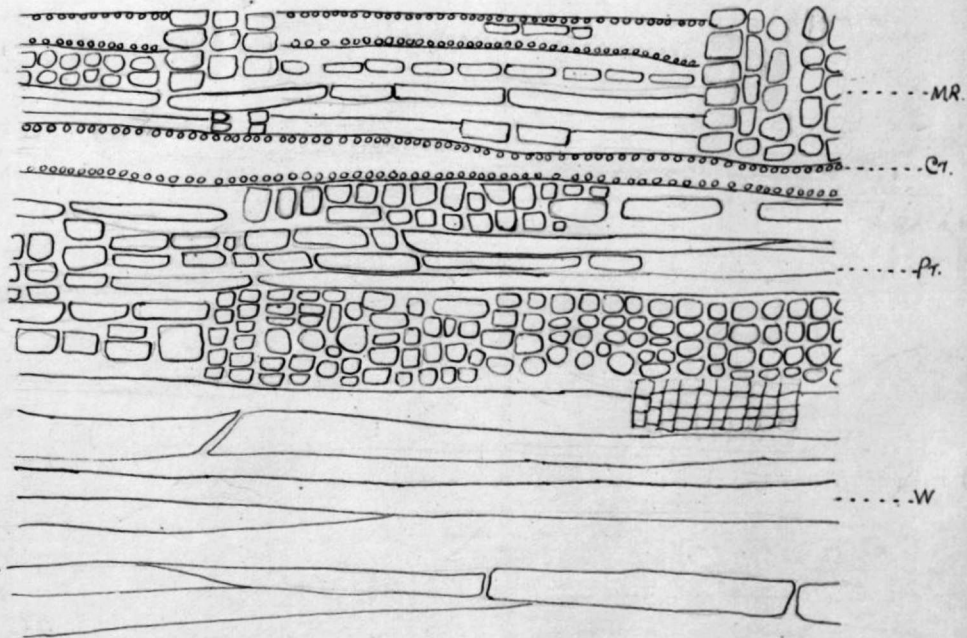
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2. U.S. Dispensatory, 18th edition p.1786.

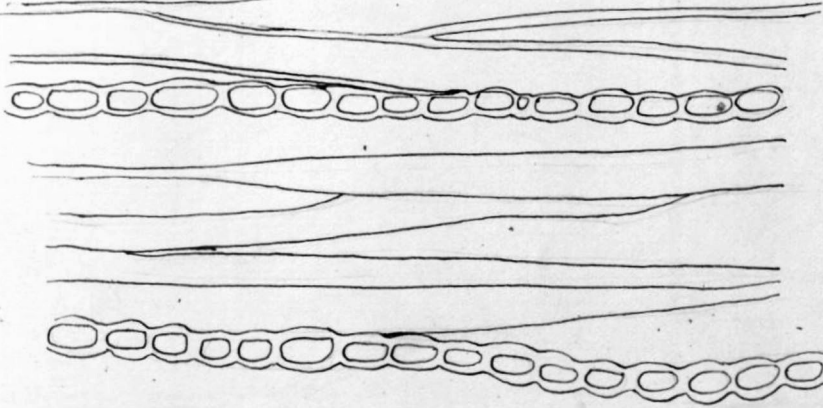
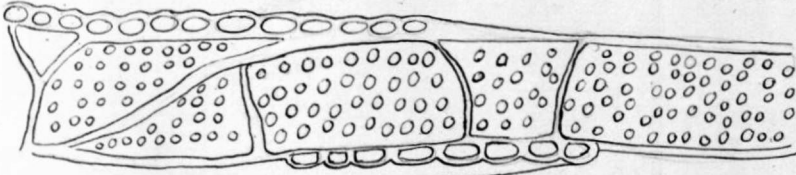


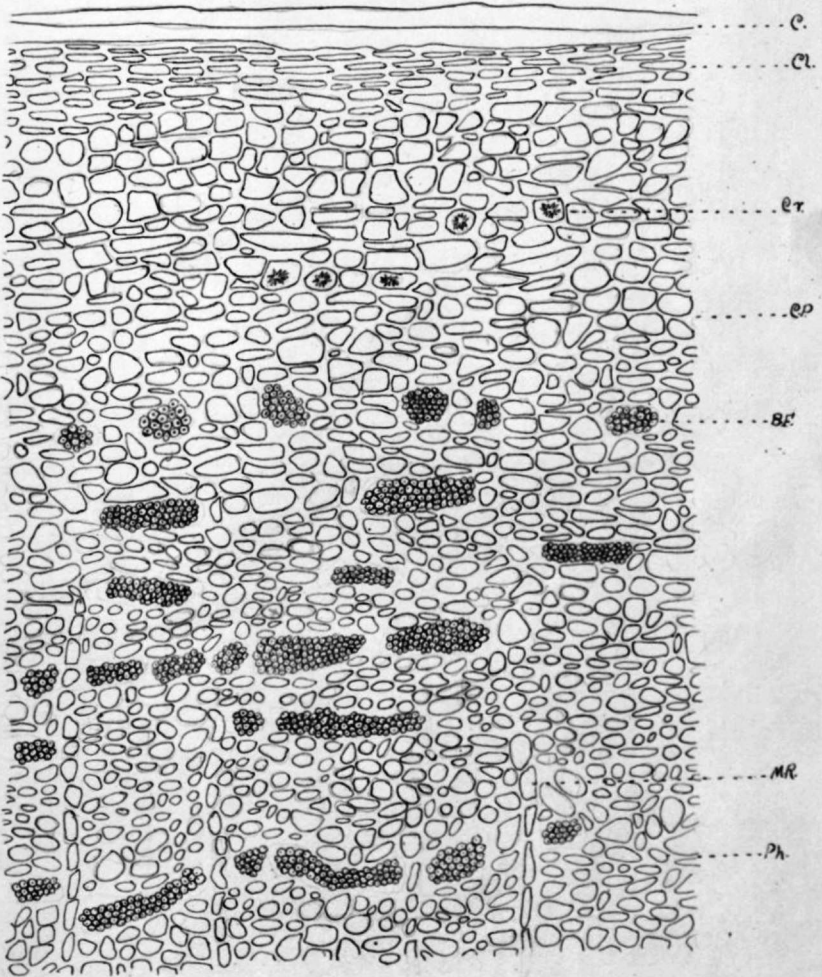


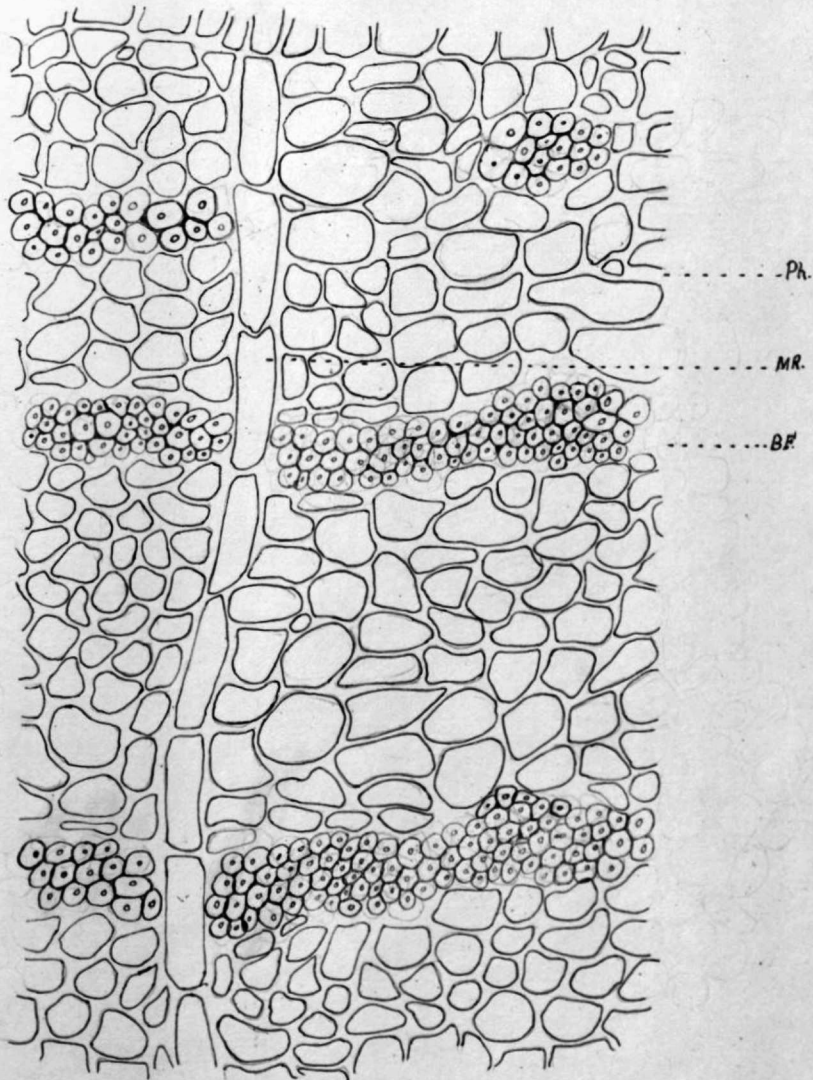












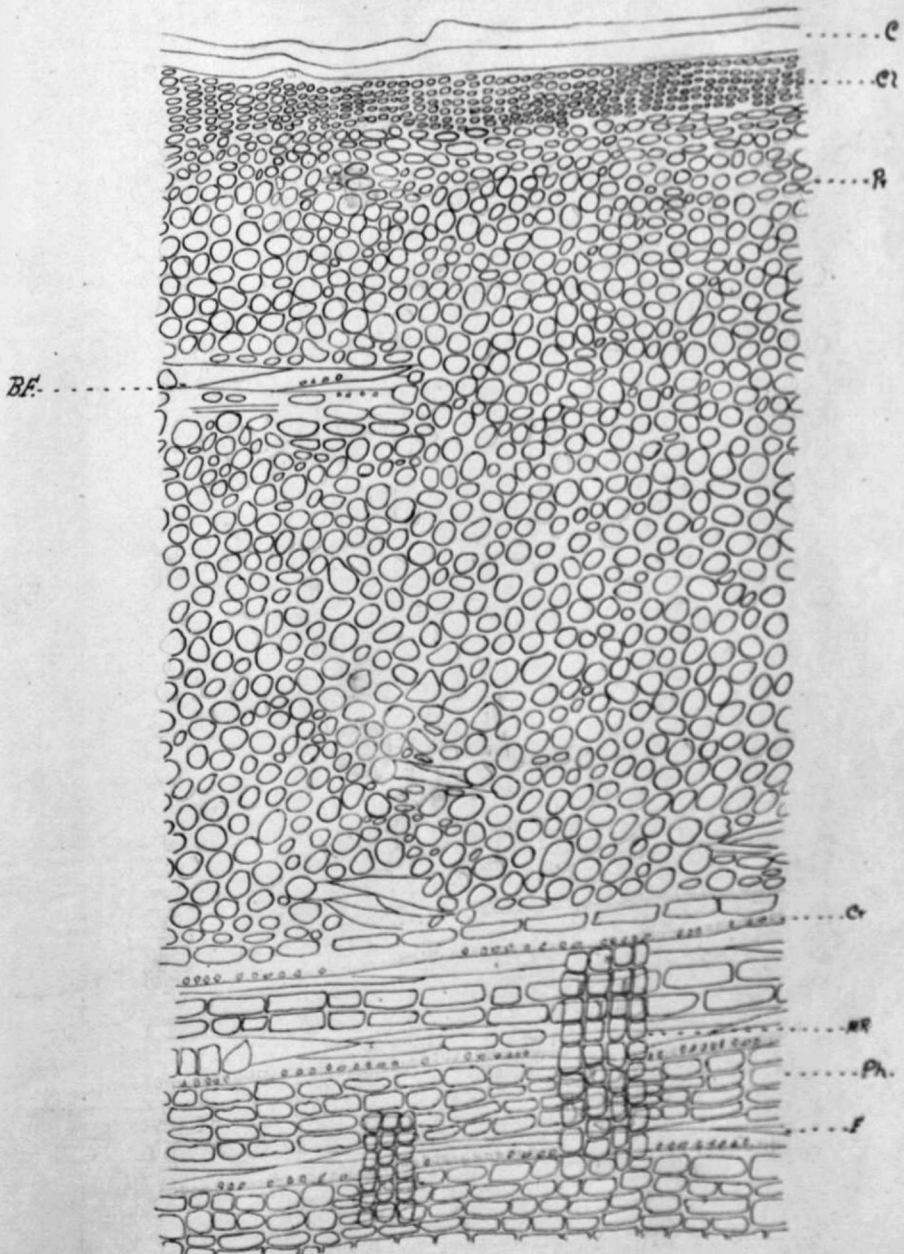
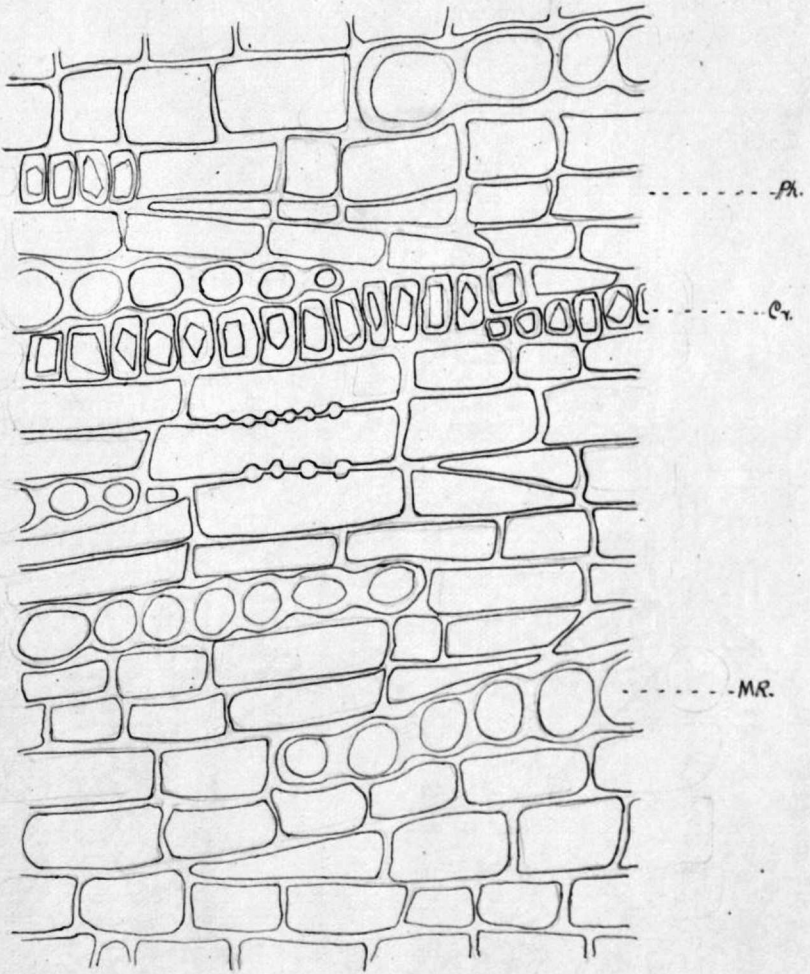
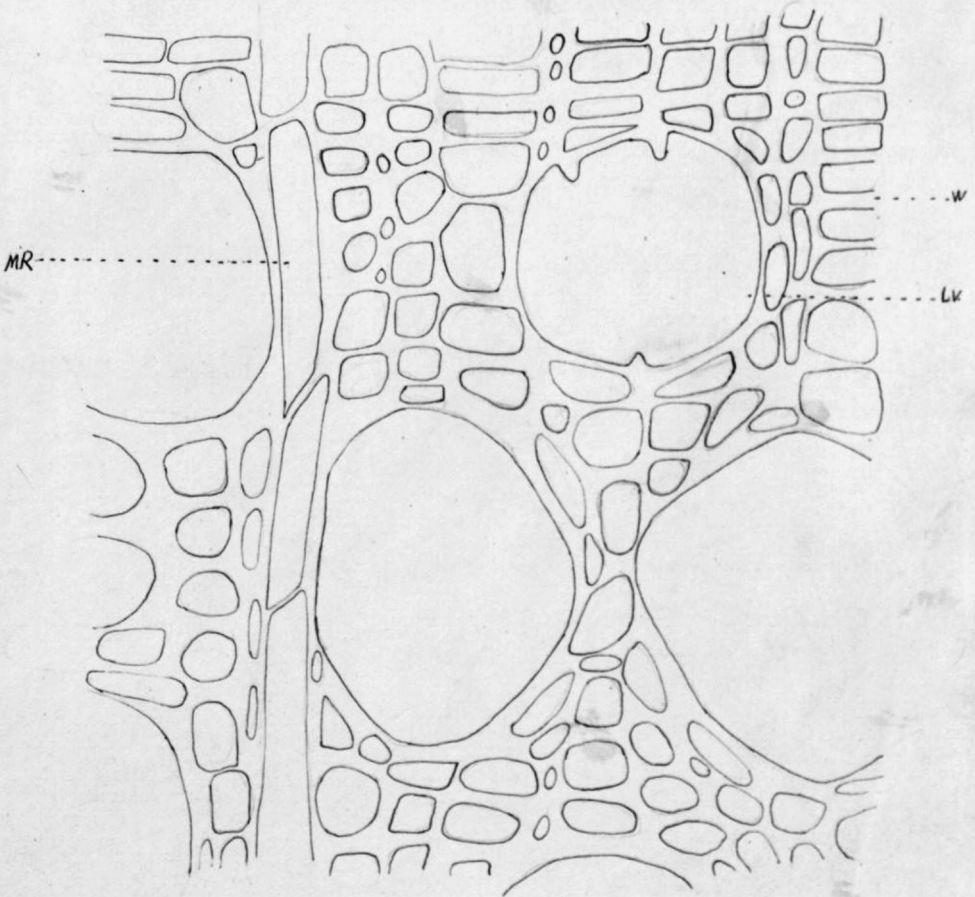


Plate I





APPROVED.....

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