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Sambucus Canadensis.

For

Department of Science

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Sambucus Canadensis L.

Sambucus Canadensis belongs to the family Caprifoliaceae. It is a somewhat woody shrub from five to ten feet high, with opposite, pinnate, deciduous leaves and compound cymes of small white, sweet-scented flowers. The flowers are said to have medicinal qualities.

The purple berry-like drupe is edible.

I. The Stem above Ground.

The Surface: The surface of the young stem is of a light green color, covered with a whitish bloom and dotted with little oblong spots (lenticels) which vary in color from a light brown to a light gray according to the age of shoot. The node the stem is surrounded by a deep purplering. The bark of the old stem appears to be of a bluish-gray color when seen from a short
distance, but upon close inspection, it is found to be of a grayish brown color. The smooth bark is roughened with little light brown warty spots. These are lenticels.

The lenticels appear on the stem as short longitudinal furrows surrounded by little brown pads. The brown color is due to coloring matter in the cells. On young stems the lenticels appear as oblong swollen places under the epidermis. The lenticels admit air and other gases to the interior of the stem. Aside from these openings, the stem is excluded from communication with the outside world, by the close-fitting bark.

The Nodes. — One is attracted at once by the two large leaf scars, and the end of several fibro-vascular bundles which served
to connect last year leaf to flower stem to the main stem. These fibers were easily traced into the wood of the stem by the use of a knife and pocket lens. This shows that the framework of the leaf is an outgrowth from the woody stem.

Longitudinal Section of Stem.

By cutting with a razor, a small longitudinal section (Fig. 2) from the outside of a young stem and magnifying it (x250) and examining the long cylindrical cells and their granular contents, I noticed the purple cells. Their color is due to the coloring matter in the granules.

The peculiar arrangement of this coloring matter suggested the following question which I could not satisfactorily answer. Why is the coloring matter in some cells and
not in others? 2) Why is this cell colored and the one below not? 3) Is the coloring matter brought up through the stem and stored in particular cells, or have only certain cells the power to secrete coloring matter? 4) What does protoplasm and what does light have to do with it?

The green pulpy mass just beneath the bark of the stem was examined. It is in layers, easily separated with forceps. It was readily seen by placing a portion under the microscope that it is composed of long string-like masses tightly laid side by side. Placed under a 6-inch objective, it showed those fibers to be composed of columnar cells squarely joined end to end. By drawing the tube and looking carefully at the cell contents I observed yellowish granules, also many little white
bodies darting and dancing about. This is the so-called Brownian movement, probably due to the molecular activities affecting the mass.

Fig. e. represents two of these columnar cells and contents. Between them are shown the pores that seem to hold the cells together. Side by side lie these cells with others that seem full of holes. They seem empty. Closer focusing revealed these same holes in many of the cells but they were not so numerous nor so large.

Cross-section of Stem.

A twig, 1/4 inch in diameter, from last year's growth was placed between pieces of cork in section cutter and thin sections made. A section was then stained, mounted in balsam, and allowed to harden. After a day it
was ready for permanent use. The section was first examined with a low power of the microscope (X50-100). The general arrangement, as shown by Fig. 1, plate 1, was observed from within outward. The inner mass is composed of pith cells, next are the wood cells proper. In the wood are many large ducts. Then come the white, thick-walled bast cells around the wood, then ten or fifteen layers of well-filled parenchymatous cells, then the thick-walled red cork surrounded by the outer, thick, almost shapeless epidermal cells. In the older tissues of the pith were found many-fibred cell walls.

The above section was then magnified five hundred diameters. Each kind of cell from pith outward to epidermis was measured and drawn. See Fig. 2, plate 1.
A cross section of a stem of this year's growth showed all the structures of last year's stem. Possibly, they were more clearly shown, except the reddish cork layer of older growth. The pith cells are more usually filled than in the cells of last year's growth. The intercellular spaces are much smaller than in the cells of the old stem. The parenchymatous layers are fewer in number between the last cells and the epidermis. The cells are more elongated as they approach the outside, being laterally compressed. At the base of young branches, the pith runs into the main stem, but in older limbs it is cut off and the junction much thickened with woody tissue.

The Growing Point of the Stem. A longitudinal section through the growing
point of the stem was made. The inner cone was closely examined and the general sameness of the tissues noticed. The primary meristem is not yet differentiated into other tissues. A short distance below one can trace these meristem cells changing into various forms. All the tissues of the plant are developed from the primary meristem. The spirals run almost to the tip of the growing point. Fig. 6 is a diagram of the growing point, \( aaa \) is the primary meristem. At the sides are shown the differentiating tissue, the young leaves and branches. These latter are arranged alternately in pairs, decussate, and are much more closely pressed together than can be shown by the diagram. The nodes are very closely approximated. When the stem elongates, the nodes separate and the long
II. The Leaves.

The leaves being outgrowths of the stem were next examined. The young leaves grow at the nodes, one on each side. The leaves, one and a half inches long, show that they are compound, while those only three eighths of an inch long, show no leaflets only lobes. The still younger leaves show no lobes. This seems to suggest that this plant—at one time in its development, had only simple leaves. The young leaflets are slightly covered with hairs which disappear as the leaves grow older. The unfolding leaflets have the blades rolled in from both sides.

Fig. 1, plate 2, is a diagram of a cross section of a leaf showing the midrib (a), hairs (x) and the
infoling blade.

The tips of the leaflets are purple. Examination with a higher power (x 250–500) shows that the cells of the tips of leaflets are filled with a purple coloring fluid. Leaflets not over an inch long show well the woody framework which runs through them. The framework looks like white rods running through the tissue of the leaf. By tearing a small bit of leaflet to pieces and examining it with the microscope (x 250–500), the cells, the stomata, the spirals and the cell contents were shown.

Cross-section of a Petiole.—In a leaf four inches long, a cross-section of the petiole shows with the use of a lens, the fibro-vascular bundles. Magnified fifty diameters it shows the general
structure but not distinctly. Diagrams a, show the position and form of the fibrovascular bundles. The epidermal cells (Fig. b) are white, orbicular and thick-walled. There are several layers of palisade cells (Fig. c) filled with green granules in the protoplasm. In the fibro-vascular bundles spoken above, there are many spirals. Some are much more closely wound than others. Possibly some of them were partially unwound in teasing. Some spirals are in pairs. By staining, the spirals were traced quite to the margin of the leaf. Stomata are found in the petiole and in the under surface of the blade. Stoma from the petiole is represented by Fig. d.

The Hairs of Leaflet. — Fig. 9, plate 1, represents a white, one-celled hair from a young leaflet.
The cell-contents are somewhat withdrawn from the cell-wall, y, shows where the base runs out into the epidermis and proves that the hair is only a large epidermal extension. Ached contracts its protoplasm.

The Colletes. — The minute bud-like appendages at the base and between the young leaves were next examined. There are two pairs of them on opposite sides of the stem. There are also two, one pair between the leaflets of the compound leaves. When young they are green in color but when more mature they are a rich purplish brown. Each one seems like a small sessile leaf folded inward from the outside forming a small double pouch. Their function seems to be that of supplying moisture for the young leaves. They are temporary structures and soon disappear.
III. The Flowers

A. Development. May 10th: pea-green anthers were observed at the ends of many young shoots. May 15th: These had grown so that they showed many minute rounded sub-divisions on as many very short stems. May 21st: The main flower-stem was a full inch in length. It was divided by two. The flower are terminal; the divided peduncles appear to be the transformed branches of a stem. May 24th: The flowers from an inflorescence two and a half inches long were examined. By magnifying two hundred and fifty diameters, all the parts of the flower were shown, rather rudimentary in the center. The calyx is of a yellowish green color with the sepals purple tipped. The calyx magnified two hundred and fifty diameters.
showe stornata. There are five stamens each two lobed.

B. The Full-blossom Flower. From my notes of July '80, I supply the following.

The inflorescence is a compound cyme of white, odorous, monopetalous flowers. The five white oval petals are united at the base. The upper side of the petal was magnified ninety diameters and examined for stomata. None were found.

Lower side was examined, stomata not well shown, until treated with a drop of alcohol which cleared and showed them quite plainly. When treated with iodine, the guard cells were colored brown, showing protoplasm. The petal magnified ninety diameters showed its cellular structure, also the spiral running almost to its border. Fig. 6, plate 2 showe
a stoma from the petal magnified five hundred diameters. Fig. e shows the distance between stoma.
The five yellow stamens are two-lobed. The filaments, anthers, and pollen are all present. The pollen is yellow-round to oblong, filled with yellow granules. Fig. d shows a pollen grain wet with water and magnified five hundred diameters. Fig. e, the same dry.

Fig f. The same from a specimen which has been in alcohol since July 88. Fig. g represents a fresh grain magnified one thousand and diameters and treated with alcohol to bring out the nucleus. It also shows the developing pollen tube. The pistile have three sessile stigmas. Fig. h, plate 2 represents the ovary, a little magnified, tipped with the sessile stigmas below is the calyx. The complete flower is shown.
IV. The Fruit.

I was unable to examine fully the fruit last year so cannot say but little about it.

The fruit is a purplish three-seeded drupe (Fig. a). Fig. b. represents a longitudinal section through the fruit, showing two seeds cut through.

IV. The Stem below Ground.

The underground stem does not taper to a point like the root. It tends to grow toward the surface, sprout up and become a new plant. It has many little branchlets, the same in appearance, but not in origin, as the rootlets of the root. It has nodes with rudimentary leaves. See Fig. a. In the axils of these rudimentary leaves are bud-like structures. Their position indicates that they are what a longitudinal...
section of one (Fig. 6) shows them to be, underdeveloped branches. They consist of a homogenous mass of meristem, etc., and an outside layer, xx.

The rudimentary leaf was carefully examined, a little of the epidermal tissue was peeled off from its underside and magnified (x100). Many stomata were observed. (Fig. 12) The guard cell (xx) are gorged with granules of chlorophyll and with starch.

The ascent of liquid in the underground stem was readily shown by placing a young shoot in green starch. The fibro-vascular were at once cloud green. The pith cells were but little colored. A longitudinal section magnified (x250) showed that the long cylindrical cells which make up the fibro-vascular bundle were filled with the coloring matter.
VI. The Root.

By digging about a young sprout, it was found to spring from an underground stem. From this stem run roots. The roots taper to a point, have no nodes and no leaves. A root grows downward and has many rootlets. The woody portion of a root was pulled out fully twelve inches in length. From the side of this woody portion run minute rootlets. On the rootlets were root hairs which were seen by carefully washing the rootlets and examining them with a lens.

A cross section of a root shows that its center is woody tissue instead of pith as in the stem. The large ducts may be seen with the unaided eye. Fig. a represents a cross section of the root. The dots represent the ducts. The radiating lines show the medullary rays. This is dia
gramatic to shon simply the general arrangement.

A cross-section of a root through the base of a
rootlet shows that the rootlet has its origin in
the cambium layer.

A small rootlet was placed under the microscope.
The root-hairs were observed also how closely the dirt
sticker to them. By putting a little water on the
rootlet it was observed how the root-hairs caused
the masses of dirt to move about. A small
rootlet was carefully washed by using a camel's
hair brush, and examined under the microscope
before and after staining. The root-hairs are tem-
porary surface structures and very numerous.
It is by means of them that the root are
capable of actually taking up the moisture and
nutritive matter from the soil.

The ascent of liquids through the center is
well shown in a root one fourth an inch in diameter. A portion one inch long dipped into the "new stain" was not over one second in being colored. The ascent was seen with the eye. See Fig. a. The center shows the woody portion which the coloring matter has ascended, also it has ascended into the branch which proves conclusively the deep origin of the rootlet. The shaded portion at the sides shows a much slower ascent of the coloring matter. A thin longitudinal section was placed under the microscope and a little of the "new stain" applied. Almost instantly it ran through the whole length. Fig. b. represents a cell, magnified two hundred diameters, with minute droplets ascending one after another in rapid succession. Care must be taken to distinguish between air bubbles and the coloring matter.
Plate 13 Explanation

Fig 1. Diagram to illustrate cross-section of Sambucus Canadensis.

a. The Epidermis
b. The Cork-cells
c. The parenchymatous cells 10-15 rows

This represents a plant-hair with the contents somewhat withdrawn from the cell-wall.
da. The woody tissue proper
e. The Bast-cells
f. The Medullary Rays
g. The Pith Cells

Fig 2. Cross-section of Sambucus Canadensis

a. The Epidermal cells
b. The Cork-cells
c. The parenchymatous cells
c'. Root & Bast cells
d. Woody Tissues
e. Large ducts in woody tissue
f. Pith Cells
g. Pith cell filled with guttation.
Fig 1. Cross-section of a young leaf, folded as in spring, showing the midrib at 4x, the hairs at 8x.

Fig 2. Flower of Sambucus canadensis.

Fig 3. Same as Fig 2, but showing the calyx around the ovary which is surmounted by the three sessile stigmas.

Fig 4. The fruit; Fig 5, long, seen fruit, showing two seeds cut through.

Fig 6. Stamens from petal of flower.

Fig 7. Pollen, dry; Fig 8, Pollen, wet; Fig 9, Pollen, soaked for months in Alcohol, showing how the contents are drawn toward the center.

Fig 10. Pollen grains treated with Alcohol, to bring out the nucleus; also at (y) is shown the pollen tube.