THE ADULTERATION OF COMMERCIAL CLOVES

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The clove tree is a beautiful evergreen tree, from thirty to forty feet high, and much branched. The leaves are smooth, glandular and about four inches long and two inches wide. The flowers are rose-colored, and form cymes which make the tree more beautiful when in full bloom.

The parts used, or the ones we see in commerce, are the unexpanded flowers, picked just before they are ripe. The unexpanded flowers consist of a long dark brown glandular calyx, terminated by four teeth, which clasp the bud containing the petals, stamens and pistil.

The clove tree begins yielding when it is about six years old, and reaches a stage of perfection when about twelve; after this age is reached it gradually declines until at about twenty the tree dies.1

The clove buds are first white, then green, and then a bright red, and at this stage they are picked.

The clove of commerce comes from the Molucca Islands, and is cultivated in the Indian Ocean Islands, Brazil, Zanzibar, and the West Indies.

The cloves were long known to the Chinese. Mayer says that an interesting fact is that cloves were mentioned

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1. Pharmacographia; Flükiger and Hanbury, p. 249.

by Chinese writers in 266 B. C. to 220 A. D. During this period it was customary for officers in court to hold a clove in their mouths to scent their breath.[1]

The first European author to mention cloves was Pliny.[1]

Little was known about cloves until the 15th century, when the Arabians and Venetians commenced bringing them into Europe; a little later the Portugese and Dutch monopolized the trade.

At the present time the clove trade lies in Zanzibar, which produces three-fourths of the entire crop. In 1872 Zanzibar produced ten and a half million pounds.[2]

In Zanzibar the seeds are planted in long trenches, and are kept well watered; great care must be taken especially after the shoots begin to appear. It takes about forty days for the shoots to appear, and after about two or three years the little shoots are transplanted in suitable places about thirty feet apart, and from this time on the trees require only ordinary care. The growth of the tree is very slow, and it takes from five to six years before the tree will bear.

As soon as the buds are full grown the harvesting

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1. Pharmacographia; Flückiger and Hanbury, p. 249.

2. Medicinal Plants; Robert Bentley and Henry Trimen; Vol.II, p. 1513.

commences. The cloves are picked by the use of peculiar four-sided ladders, or high step-ladders. Sometimes cloths are spread on the ground beneath the tree and the cloves knocked down by beating the trees with bamboo poles, but this is not a desirable way, as too many stems and ripe fruits are collected at the same time, causing much time to be lost in picking them over.

After the cloves are collected they are spread out each morning on cloths in the sun to dry, and are collected again each night. This is done so the cloves will not absorb moisture; the cloves are dried in this way until they are a dark brown color as we see them in the market. Sometimes the cloves are dried artificially in ovens, but this is not a desirable way, as they are liable to lose their volatile oil.[1] The methods of cultivation and collection in other places are the same as in Zanzibar.

The powdered cloves are of course the most adulterated, but in 1874 whole cloves were manufactured artificially by making a paste of ground-oak bark, ground cloves and wheat flour, and then molded in suitable molds. These are easily detected on close inspection of the cloves.[2]

In the powdered cloves the adulteration is more difficult to detect. They are adulterated with stems, fatty

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1. Proceedings Amer. Pharm. Ass'n, Vol. XXXVIII., p. 479.

2. Ibid., Vol. XXVIII., p. 177.

oil, starch, powdered acorns, ground cocoanut shells, and sometimes bread crumbs.

The stems are easily detected in powdered cloves where a microscopical examination of the powder is made.

The stem is made up of numerous stone cells, large bast fibers, and wood cells, which show plainly in the powder, as they are not easily separated in grinding.

When a powder darker in color is wanted, a fatty oil is used, but this is easily detected by the permanent grease stain it leaves on paper. There is always some other adulterant used with the fatty oil. The starch grains are easily seen under the microscope, and when treated with iodine solution take on a blue color.[1] Bread crumbs and powdered acorns contain starch in considerable quantity and are detected in the same manner as starch. These various adulterants are used in powders; but the general adulterant used is powdered clovestems, as will be seen by the table of samples examined. In examining different samples of powdered cloves a small amount of powder is mounted on a slide with chloral glycerine and then heated; this clears up the material so it is easier to distinguish the different tissue. From six to eight slides are made in the same manner so a more positive result can be obtained. Slides are

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1. Proceedings Amer. Pharm. Ass'n, Vol. XXII., p. 624.

also made with an aqueous solution of iodine; this colors the starch blue, if there is any present.

Then by comparing the slides of the powder with those of the sections of the clove tissue, one can tell if there is any foreign substance present. The samples examined were obtained from dealers in different cities in the state, and of nineteen samples examined only three were found not to be adulterated.

The clovestems seemed to be the most general adulterant. In all cases where adulteration was found, some stem tissue was invariably present.

Starch was also present in a number of cases, and some flower tissue was found, also tissue from cocoanut shells.

In 1898, A. L. Winton, of the Connecticut Experiment Station, reports[1] that from twenty samples examined, twelve were found not to be adulterated, and the rest were adulterated, principally with clovestems, starch, cocoanut shells, and coloring matter.

In 1901 the same author reports[2] that of four samples examined four were adulterated, two of which contained stem tissue and the other two starchy material and cocoanut

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1. 22nd Annual Report of the Connecticut Agricultural Station, p. 176.
2. Report of the Connecticut Agricultural Station, 1901, p.193.

shells.

In 1902 Winton reports[1] that out of six samples examined six were adulterated, principally with clovestems and in one case ground peas were found.

In some cases a ground substance is used, known as a clove filler, this is made up of various ground nut shells and contains a considerable amount of starch. The tissue is very easily distinguished from clove tissue, as a number of the cells are large and thin-walled and are filled with starch.

In studying the tissue of the clove it is necessary to observe it from every point of view; this is done by making cross and longitudinal sections through all the different parts.

The first sections were made through the base of the calyx tube, and through the ovary (plate I.); the first of these shows a region just beneath the epidermis in which numerous oil containers occur, followed towards the center by a circle of fibro-vascular bundles. The ground tissue filling in between the oil containers and fibro-vascular bundles is composed of thin-walled parenchyma. Interior to this region there are large intercellular spaces between the cells, and at the center a compact mass of cells, the colu-

1. Report of the Connecticut Agricultural Station, 1902, p.240.

mella. In the section through the ovary, (plate I), the oil containers and fibro-vascular bundles are in the same position, but instead of having a columella in the center a central cavity takes its place. This is the ovary, and attached to the center of the ovary are the ovules.

A cross section of a quarter of the calyx tube, (plate II), shows under higher magnification the finer structure of the cells. On the outside is a very thick cuticle, which is about .0089 mm. thick, next to the cuticle is a row of epidermal cells, and interior to this is the outer parenchyma. These are small thin-walled cells of various sizes ranging from .0089 mm. to .032 mm. in length; imbedded in the outer parenchyma are large containers of different sizes, from .0434 mm. to .0979 mm. in diameter, and from .1424 mm. to .1997 mm. in length. These oil containers have peculiar walls which are torn, showing their lysigenous origin. Also imbedded in the outer parenchyma, interior to the circle of oil glands, are the fibro-vascular bundles. These bundles are made of half xylem or wood tissue, and half phloem or sieve cells, the xylem being in the center, making a bicollateral bundle. Following the outer parenchyma toward the center is a region of net-like parenchyma; (plate IV), this is made up of thin-walled cells irregular in form, from .0089 mm. in width to .0356 mm. in length, with many large intercellular spaces.

In a longitudinal section of the pistil, (plate V), can be seen the thick cuticle on the outside, next the cuticle is a row of epidermal cells about .0089 mm. wide and .0142 mm. long. Interior to this is the parenchyma tissue and oil glands. The parenchyma cells are large, elongated, thin-walled cells, and scattered through the parenchyma are rosette crystals of calcium oxalate.

In the petal the cells are somewhat different in arrangement from those of the calyx; the thick cuticle on the outside, then a layer of outer epidermal cells. The oil glands are situated in the upper parenchyma next to the epidermis. The parenchyma cells in the outer half of the petal are large, about .0178 mm. in diameter and .0267 mm. in length, while the parenchyma in the inner half are smaller, from .0089 mm. to .0132 mm. in diameter. Imbedded in the inner parenchyma are the fibro-vascular bundles. The inner epidermal cells are half the size of the outer epidermal cells.

A cross section through the anther, (plate VII), shows the peculiar elongated, thick-walled epidermal cells. The walls of the epidermal cells are irregular in thickness. Interior to the epidermal cells is the anther sac which contains the pollen grains. The pollen grains are about .0142 mm. in diameter, and have a peculiar darkened angular center, and are easily distinguished.

DIMENSIONS OF CELLS IN CLOVE TISSUES.

Name of Tissue.	Diameter	Length.
Oil cell in pistil	.0523 mm.	.1424 mm.
Epidermal cell in pistil	.0089 mm.	.0142 mm.
Parenchyma cell in pistil	.0106 mm.	.0338 mm.
Inner parenchyma in calyx	.0089 mm.	.0801 mm.
Outer parenchyma in calyx	.0178 mm.	.0356 mm.
Oil cell in calyx	.0979 mm.	.1797 mm.
Oil cell in petal	.089 mm.	.1246 mm.
Parenchyma in petal	.0178 mm.	.0276 mm.
Surface cell of anther		.0142 mm.
Pollen grain	.0178 mm.	
Cell wall of petal parenchyma	.0053 mm.	

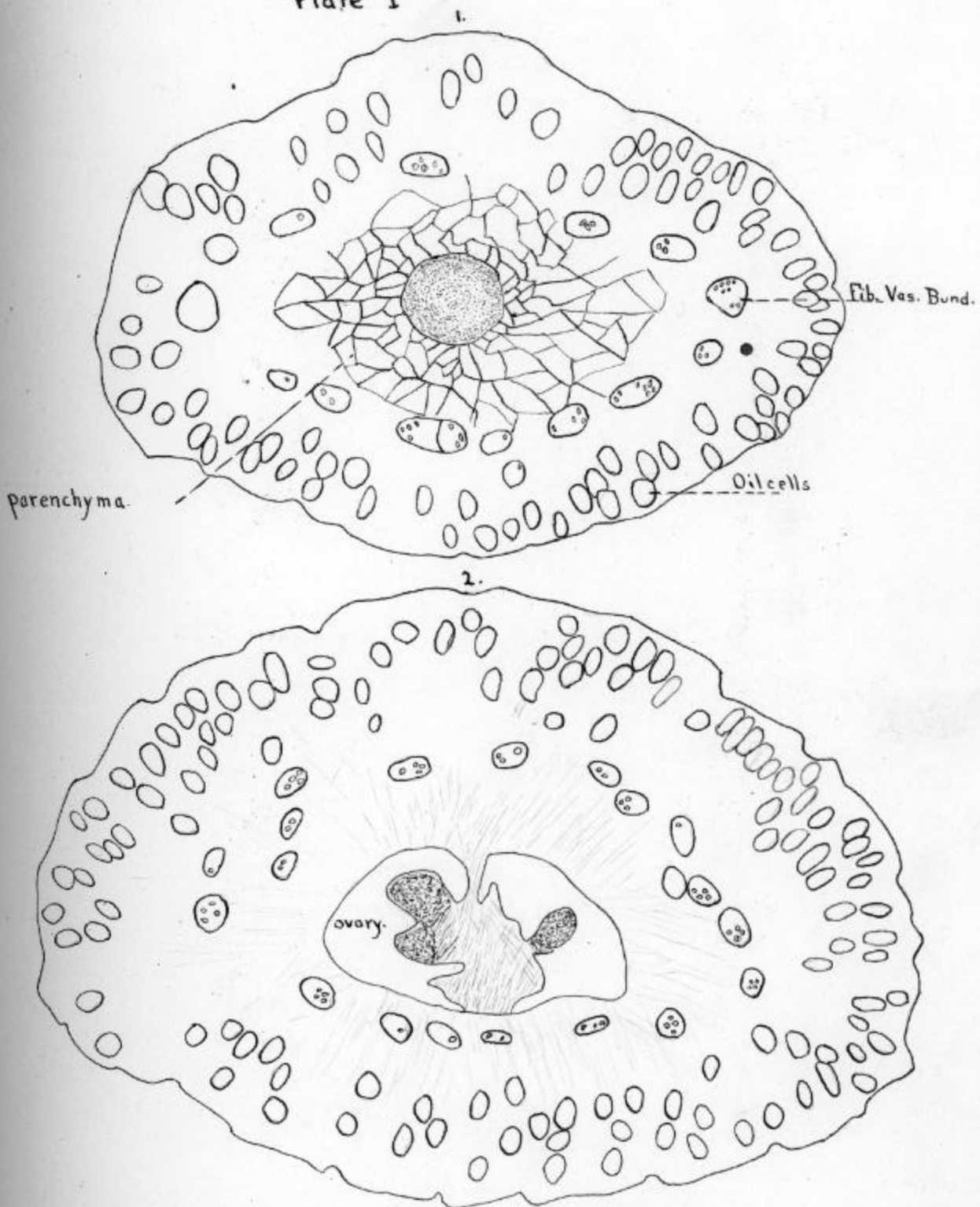
Dealer.	Place.	Color.	Stems.	Starch.	Other Tissue.
Ott's Pharmacy.	Madison, Wis.	Med. brown.	25-30%		
Gilpin, Langdon & Co.	Baltimore, Md.	"	no adulteration.		
Findlay & Co.	Madison, Wis.	Dark brown.	"	"	
Corbett & Ackerman,	Plymouth, Wis.	Light brown.	3-5%.		
Grocer,	Oshkosh, Wis.	Medium brown.	5-10%	5%	2%.
Pharmacist,	" "	Med. brown.	10%		1-20%
Empire Co.	Plymouth, Wis.	Dark brown.			15-20%
H. E. Genski,	" "	Lt. and dark brown.		2-5%	40-50%
H. J. Goelzer.	" "	Light brown.	5-10%		2%
A. Malandorf.	Sheboygan, "	Medium brown.	no adulteration.		
M. R. Zagal	" "	Light brown.	10-15%		10-15%
Huber Bro. Brester & Co.	Fond du Lac."	Medium brown.	5-10%		
Huber Bro.	" " " "	Medium brown.	2-5%		
-----	Brillion "	Medium brown.	5-10%		
Purcell,	Madison, Wis.	Medium brown.	15-20%	2-5%	
Lewis,	" "	Lt reddish brown.	5-10%		10%
Piper Bro.	" "	Light brown.	10%		
----	Appleton, "	Dark brown.	no adulteration.		
Connell,	Madison, "	Light brown.	10-15%	2%	

Approved R. N. Dennistom

Instructor in Pharmaceutical Botany

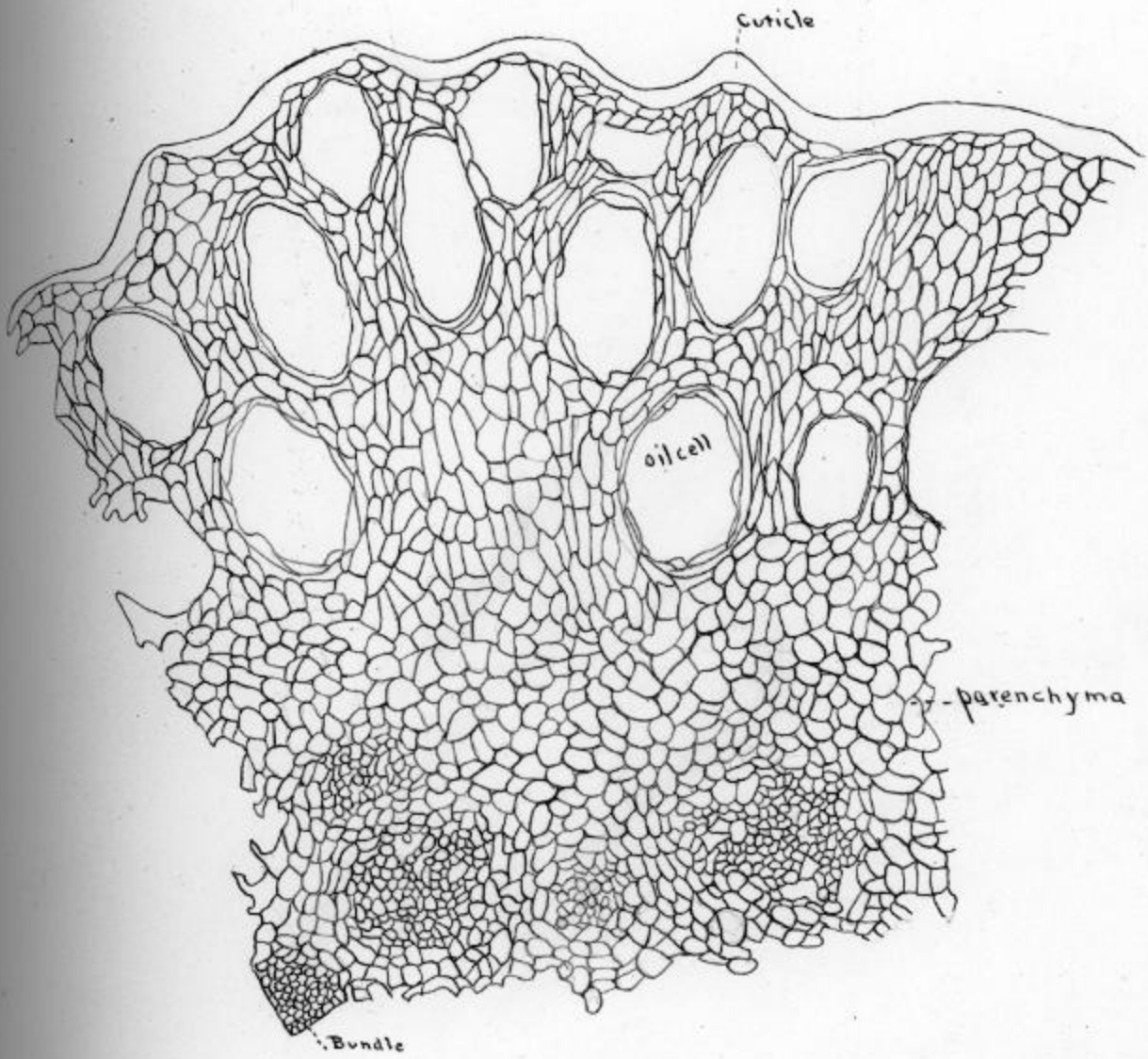
June 9, 1903.

Plate 1



1. Cross section through calyx tube 2. through ovary x. 20.

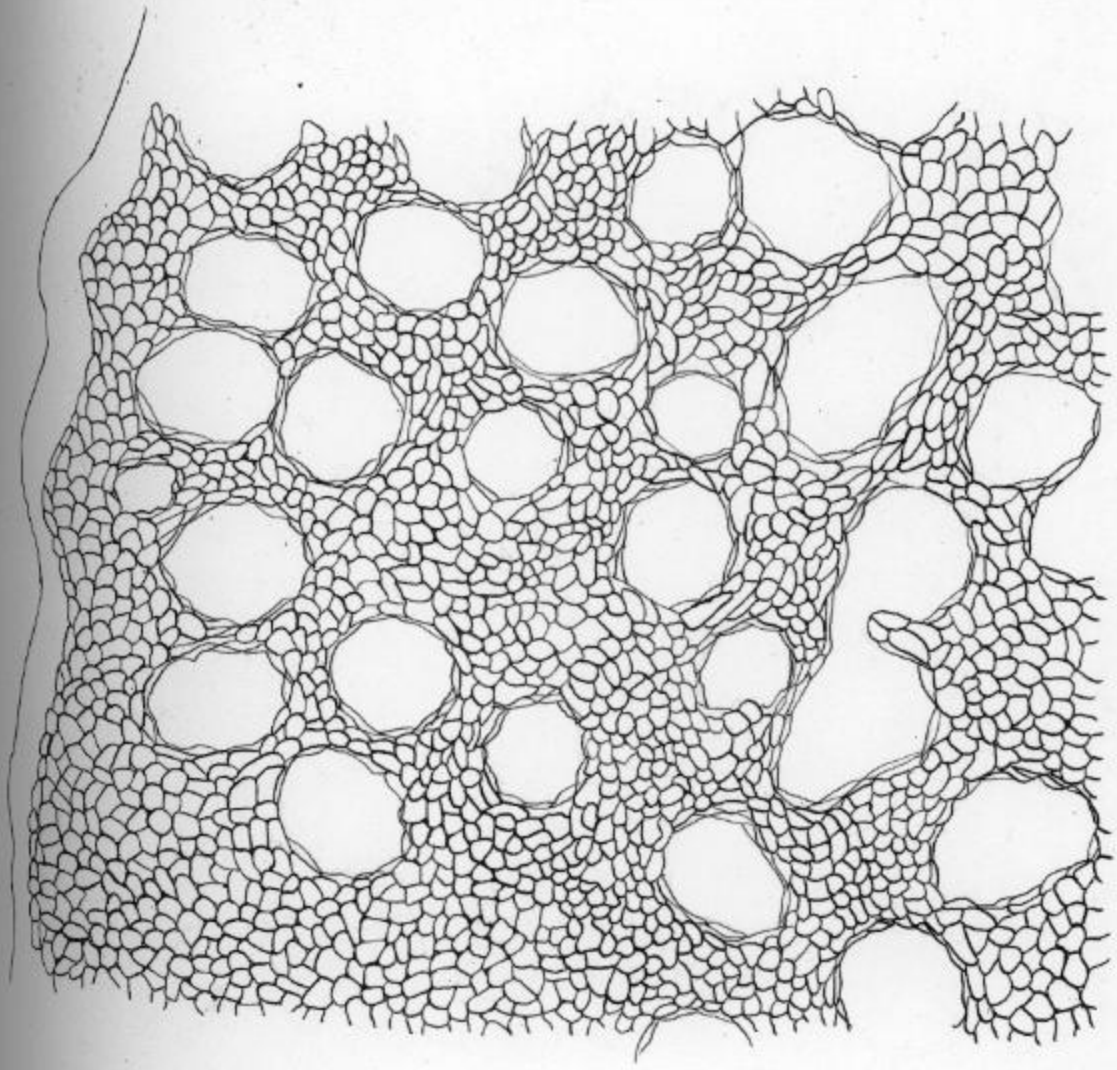
Plate II



Cross section of a ¼ of calyx

x132

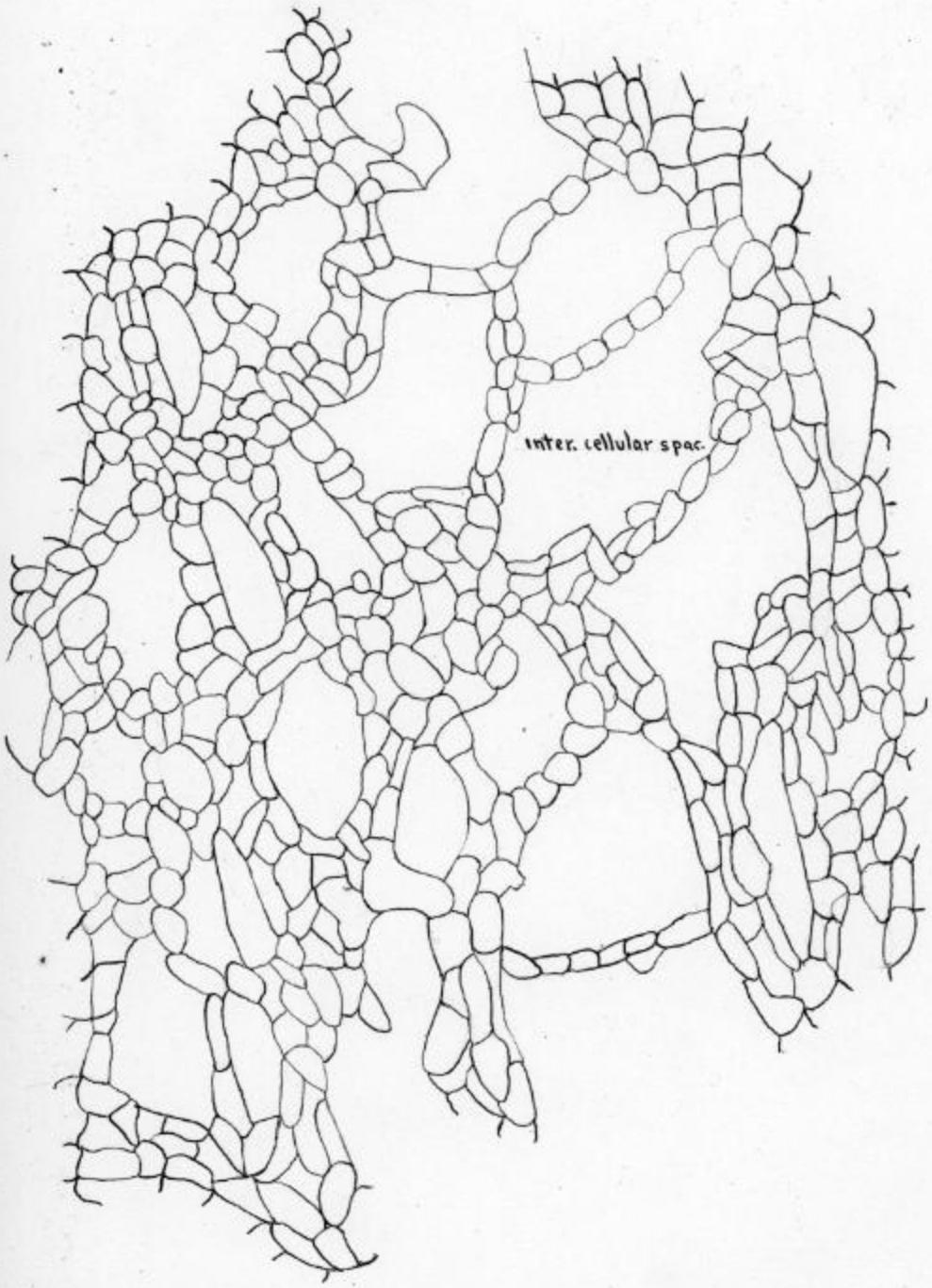
Plate III



Longitudinal section of calyx showing oil cells.

x 132.

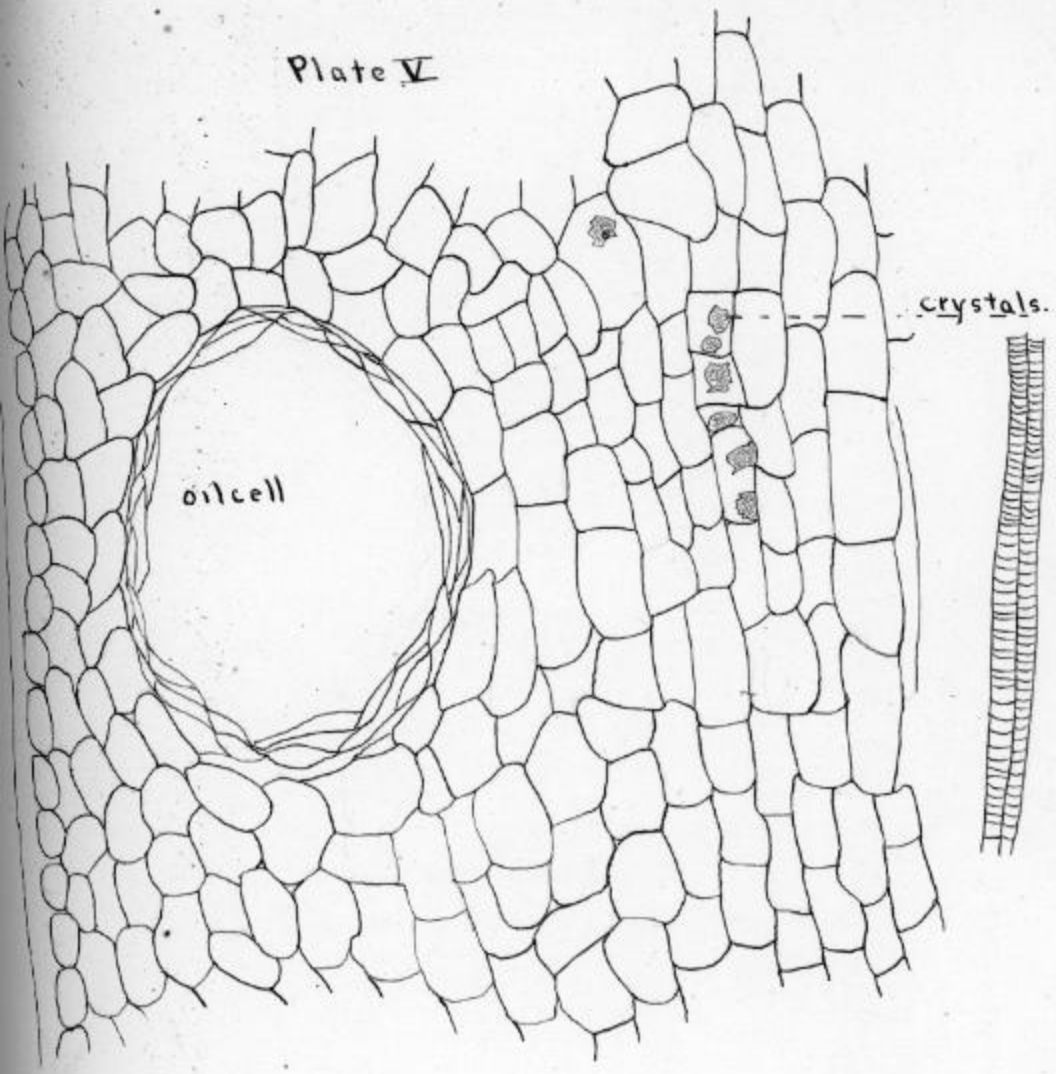
Plate IV



Longitudinal section of netlike parenchyma of calyx

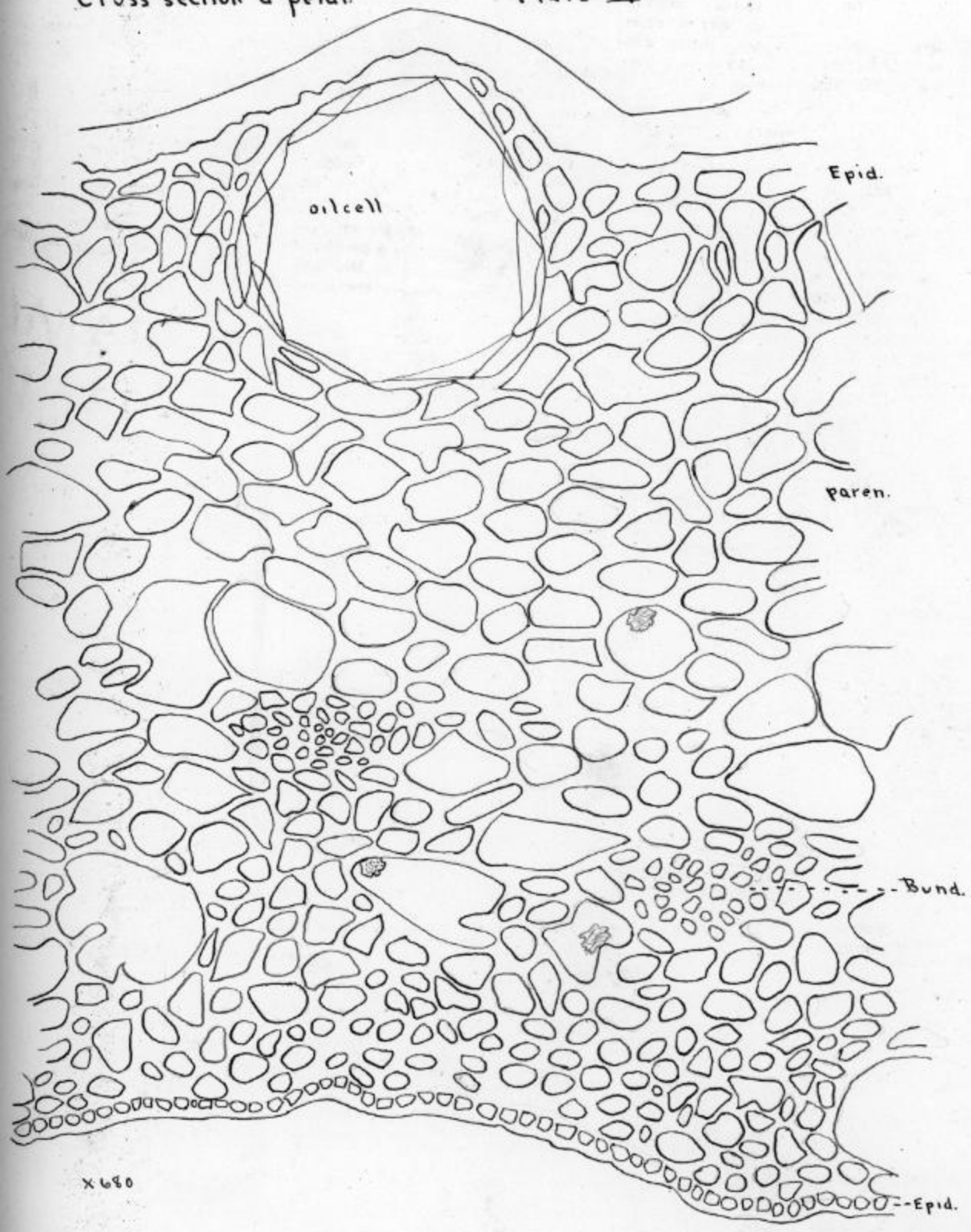
x 60.

Plate V



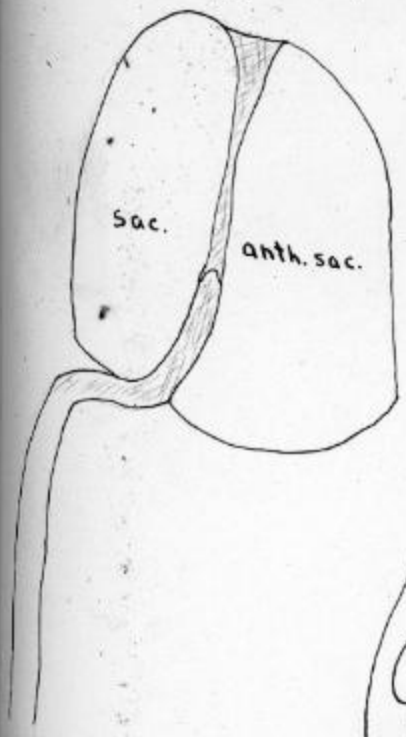
Longitudinal section of pistil. x 80.

Cross section a petal. Plate VI

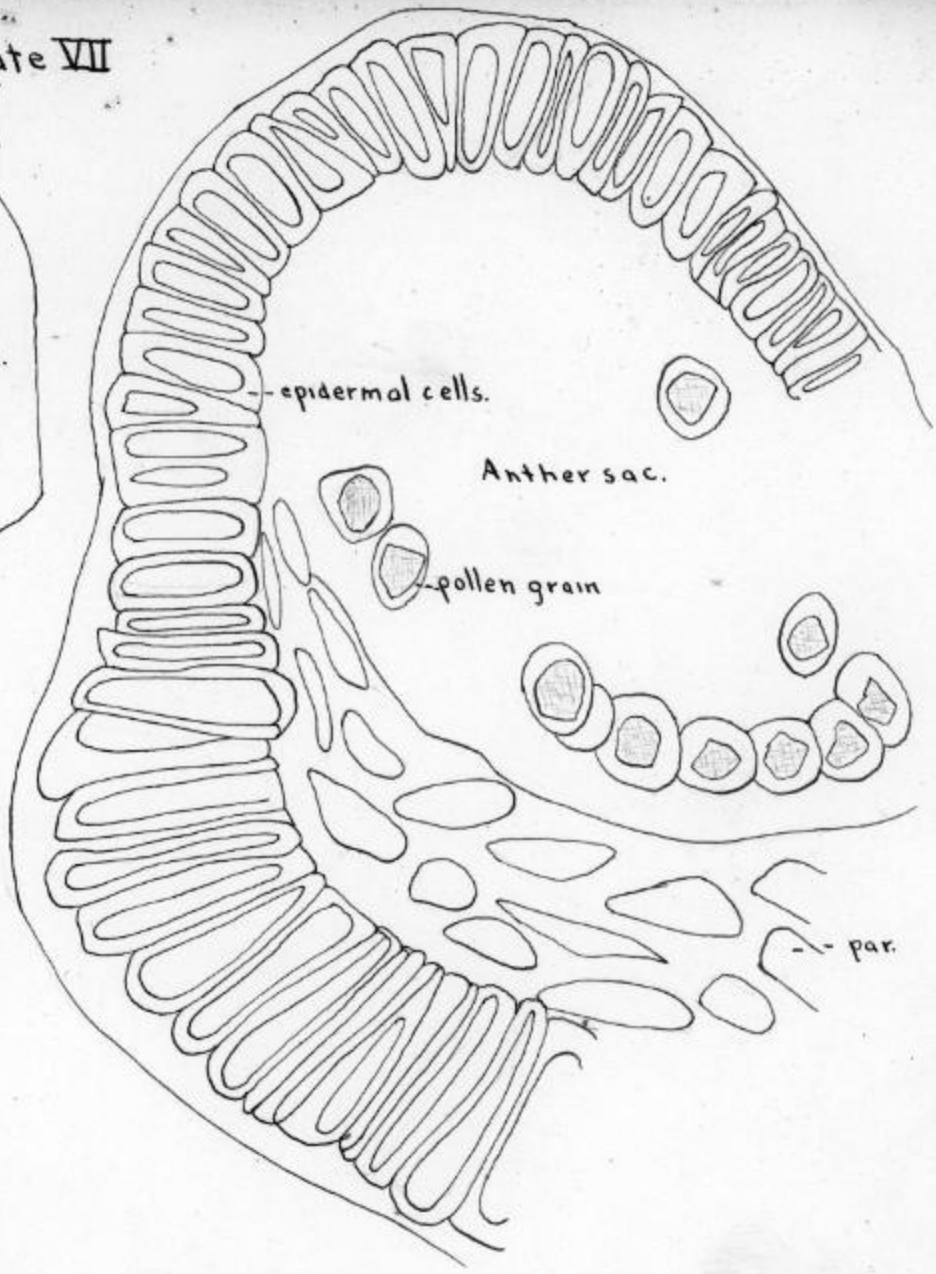


X 680

Plate VII



Stamen
x 85



Cross section of an anther
x 620