

## Effects of Sun-Blotch on the Anatomy of the Avocado Stem

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Because of the comparatively recent discovery of the avocado disease called sun-blotch, only a small amount of research has been done in determining the nature and effects of the disease.

It has been shown by Horne and Parker<sup>1</sup> that the disease is caused by a virus and can be transmitted from one plant to another only through living tissue by means of grafting or budding. The discovery of its mode of transmission is of utmost importance to the industry because only by careful bud selection can the disease be eliminated in future propagations.

The disease is limited in distribution almost entirely to California, being endemic here. It was first reported in California by Coit<sup>2</sup> in 1928 and has since been reported found on four trees in Palestine and on a tree in Florida, all of which trees were of California origin. No indications of sun-blotch have so far been found in the Hawaiian Islands or in Guatamala or Mexico, the native homes of this fruit. In California the disease is widely distributed throughout the commercial producing districts.

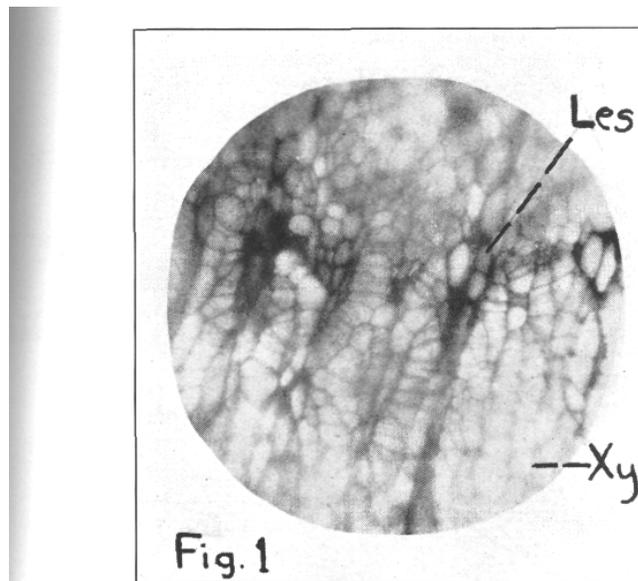
The external symptoms have been reported in detail by Horne<sup>3</sup>. Affected trees generally exhibit yellow or brown streaks on the younger growth which may or may not be associated with longitudinal grooves along the stem. The yellow or brown color may be localized or scattered irregularly along the stem, occasionally being more pronounced at the nodes. On older diseased stems the bark becomes roughened and necrotic lesions may appear. Leaf symptoms are variable and may exhibit different degrees of hyperplasia and variegation, the latter being restricted usually to the midrib or more prominent veins. In general, older affected trees have a tendency toward a drooping habit due to a weakening of the wood.

The present investigation was undertaken in order to study the effects of the virus upon the anatomical structure of the stem. Cross and longitudinal sections of prepared and fresh material were studied and microchemical tests were made to determine the presence of starch, fats, and other cell contents.

The normal stem anatomy of *Persea drymifolia* follows the plan of a typical dicotyledenous woody plant. The vascular tissue is made up of a ring of vascular bundles about the pith and is intersected by rays two or three cells wide. The epidermis is one cell in thickness in the young stem and contains stomata scattered irregularly along the axis.

The outer part of the cortex consists mainly of large groups of collenchyma cells with thickened walls and containing relatively few chloroplasts. Beneath the collenchyma and forming the inner cortex next to the starch sheath is a wide irregular band of typical thin-

walled chlorenchyma which may contain considerable amounts of starch. At many points along the stem this chlorenchyma tissue extends from the inner cortex to the epidermis, these extensions coinciding with the location of stomata on the surface of the stem.



Photomicrograph of phloem lesion showing groups of crushed phloem elements in cross-section.  
Les., phloem; Xy., xylem.

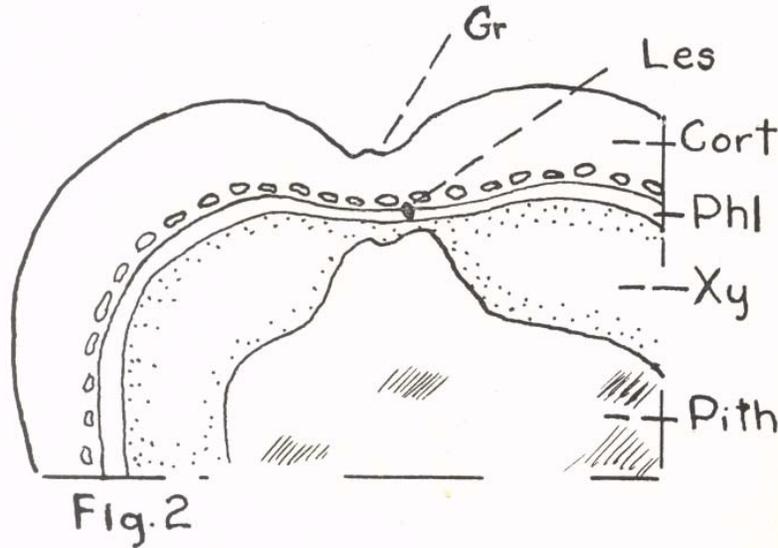
On the inner side of the cortex a colorless starch sheath surrounds the pericycle.

The pericycle consists of phloem fibers and modified stone cells. The fibers are grouped in small bundles and have simple pits. Between the groups of fibers and connecting them are one or two rows of modified stone cells which differ from ordinary stone cells in that the outer tangential wall is thin while the inner tangential wall is much thickened. These cells are roughly cubical to oblong in shape, simply pitted, and are heavily lignified.

The bulk of the xylem tissue is made up of xylem fibers and tracheal tubes that are simply pitted, the latter having elongated perforations in the endplates. Radially elongated cells make up the vascular ray tissue.

A large amount of pith is present in younger stems, this tissue being made up of thin-walled, lignified parenchyma cells.

Examination of diseased stems shows that considerable variation accompanies the external symptoms. In the cortex the cells are occasionally reduced in number and contain relatively fewer chloroplasts than normal cells.



Diagrammatic section through stem with groove. Note relative lack of xylem tissue and location of phloem lesion. Gr., groove; Les., phloem lesion; Cort., cortex; Ph., phloem; Xy., xylem.

In general the most prominent anatomical difference is seen in the vascular tissue of diseased stems. Associated with the symptomatic groove is the relative lack of development and differentiation of the xylem and phloem tissues. Immediately beneath the groove there is a variable reduction in the amount of vascular tissue from that of slightly below normal to that of a complete lack of production of xylem and phloem elements in the one-year-old stem. In this region the average diameter of the tracheal tubes may be more or less reduced. The arrangement of the vessels may also be irregular from the normal arrangement in definite sequence along the radii.

In a number of specimens observed the xylem elements below the groove were found to be replaced by modified parenchyma cells. The latter are distinguished from typical parenchyma by their somewhat thickened, lignified walls and by their relatively greater starch content. Similar parenchyma cells may be found embedded between two groups of normal xylem tissue in the older stem. The position of the modified cells indicates that a group of xylem cells was laid down followed first by a group of modified cells and later by a second group of normal xylem cells.

Occasionally in grooved stems and also in smooth, blotched stems as well, phloem lesions are found which result from a crushing of cells of the phloem and vascular ray tissue. These groups of crushed cells are generally radially arranged and may involve from one to many cells. The crushing of the tissue results from a loss of turgidity of the individual cells after being cut off from the cambium. Walls of the crushed cells are heavily impregnated with fatty substances, a condition reported to be of common occurrence in diseased phloem tissue of other plants affected by virus diseases.

From these observed conditions of stems affected by sun-blotch it appears that the virus is intermittent in its effect upon the differentiation of the cells as they are being cut off from the cambium. It may also be concluded that the virus is closely associated with the cambial activity of the plant stem and results in the abnormal production and

differentiation of vascular tissue.

At present this investigation is in its preliminary stages, this report being only a record of some early observations on a limited number of specimens. A more detailed study of both the anatomical and cytological condition of affected plants is warranted for a complete understanding of the effects of the virus.

<sup>1</sup>Horne, W. T. and Parker, E. R. The avocado sun-blotch disease. California Dept. Agri. Mo. Bul. No. 7, Vol. XX, pp. 447-454. July, 1931.

<sup>2</sup>Coit, J. E. Sunblotch of the avocado, a serious physiological disease. California Avocado Assoc. Yearbook, 1928, pp. 27-29. 1928.

<sup>3</sup>Horne, W. T. Avocado diseases in California. California Agr. Exp. Stat. Bul. 585. 1934.

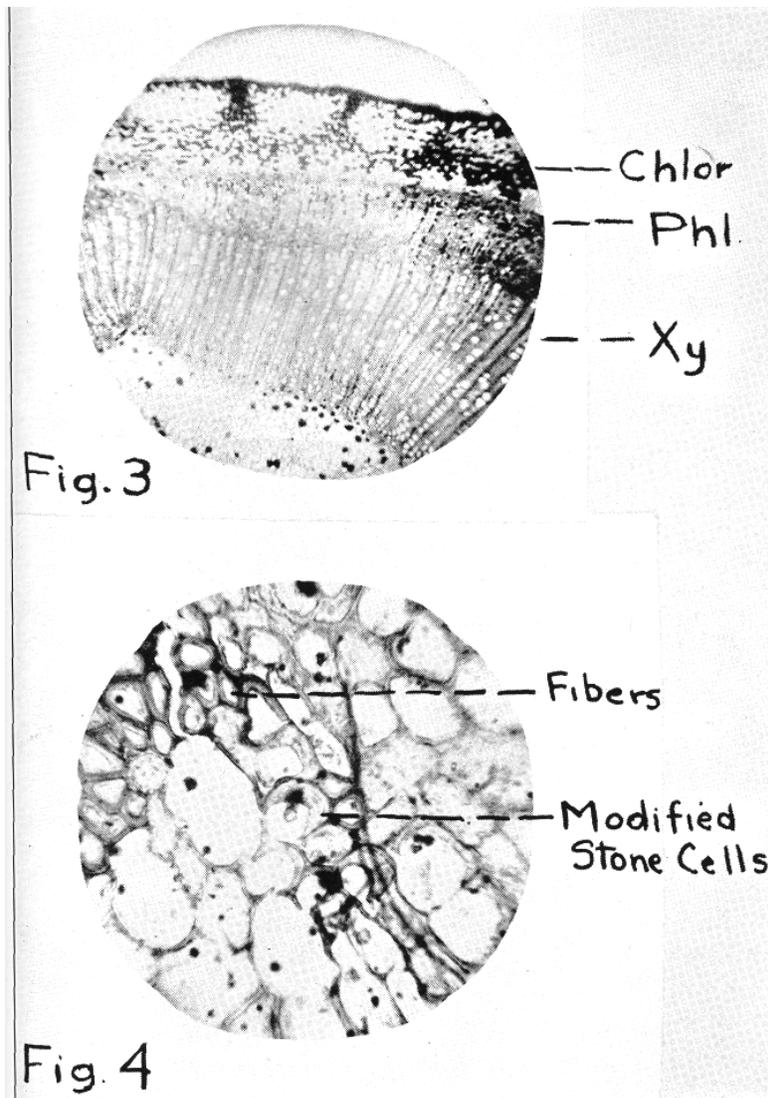


Fig. 3. Photomicrograph through normal stem showing chlorophyll tissue as darkened cells and normal development of xylem and phloem. Chlor., chlorenchyma; Phl., phloem; Xy., xylem.  
Fig. 4. Photograph of modified stone cell in cross-section. Note thickened inner tangential wall.

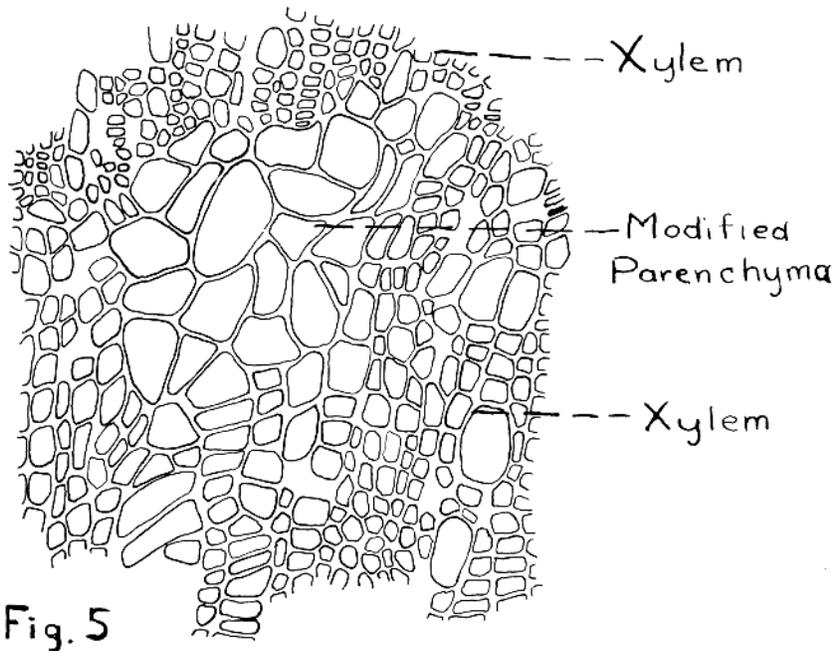


Fig. 5

Camera lucida drawing of modified parenchyma imbedded in normal xylem tissue of sun-blotched stem.

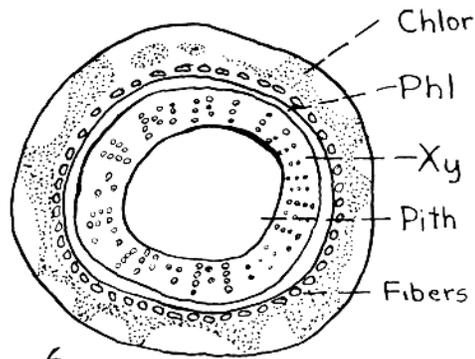


Fig. 6

Diagrammatic section of normal avocado stem showing distribution of various tissues. Chlor., chlorophyll bearing tissue; Phl., phloem; Xy., xylem.