

## INTERNAL DECLINE OF LEMONS

### I. DISTRIBUTION AND CHARACTERISTICS <sup>1</sup>

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#### INTRODUCTION

The term "internal decline" has been applied to a physiological abnormality causing the destruction of internal tissues in the lemon fruit, usually in the stylar end. The term as here used includes "blossom-end decay," "tip deterioration," "yellow tip," "dry tip," and other terms all applied locally by growers, packers, and shippers to the same trouble. When the study of this malady was first begun, the term was applied also to a browning of the "core" (placenta) and of the membranes (inner carpellary walls) covering the pulp segments of the lemon. Now it is applied only to the abnormality having the characteristics described in this paper.

Internal decline has been known by the lemon growers of California for at least 25 or 30 years, and the indications are that it is increasing in severity. Its seriousness fluctuates from year to year. For example, in 1920 in many of the groves as much as 10 to 60 percent of the fruit in an entire pick had to be culled out and discarded or sent to the by-products laboratory, while in the same groves in 1921 not more than 2 to 5 percent had to be discarded.

Experimental studies on internal decline were begun by the junior authors in 1915, and have been carried on intensively by the senior author since the summer of 1920. His discussion concerning one phase of his work on this problem will appear in an early number of this journal as the second paper in this series.

#### GENERAL DISCUSSION

*Distribution.* Internal decline may appear in the fruit of almost any lemon grove in southern California, except that it seldom, if ever, occurs in groves located within a few miles of the coast. Groves situated within the hot inland valleys are especially likely to show a large amount of the trouble. A great variation in distribution may occur not only in different groves but in different parts of a given grove.

*Varieties Affected.* The two principal varieties of lemons grown in California are the Eureka and the Lisbon. Besides these there are a few other varieties which are grown in comparatively small numbers. Any of

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these varieties may be affected with internal decline. Data thus far obtained do not indicate any marked difference in varietal susceptibility. In some localities the Eureka is reported to be more susceptible while in other localities the Lisbon is said to suffer most, but so far the data do not confirm these reports.

*Seasonal Appearance.* The trouble usually appears with the beginning of warm weather in June and continues during the summer and fall until November or December. However, some lemons that are slow in attaining a desirable picking size may be allowed to remain on the trees for a longer period than usual, and consequently a few lemons showing internal decline may appear in the packing houses at almost any time during the winter or even in the early spring months.

*Age of Trees.* Internal decline has been found on trees of all ages ranging from 3 or 4 years up to 50 years. It is often the case that the fruit on young, thrifty trees with heavy foliage is worse affected than that on older trees with less dense foliage.

*Age of Fruit.* The terms "tree-ripe," "silver," "light-green," and "dark-green" are used in the lemon industry to designate lemons in different stages of maturity as indicated by their color. Tree-ripe lemons are those which remain on the tree until they have attained their mature yellow color; silver lemons are those which are picked at a time when most of the chlorophyll has disappeared from the fruit, leaving it a very light greenish yellow; light-green and dark-green lemons are picked according to standardized sizes. They are younger than the preceding kinds but are sufficiently mature for picking. When lemons are picked while they are yet green, they are either allowed to color naturally while in storage or are artificially bleached before being placed on the market. The lemons that are picked while green possess the most desirable commercial qualities because they have a higher acid content and are less susceptible to the attacks of diseases.

In some cases internal decline is found only in the tree-ripe fruit, but it often appears also in the silver, light-green, and dark-green fruit from the same grove. The tree-ripe fruit usually shows the greatest percentage of the trouble, sometimes as much as 95 percent being affected. However, in "bad years" as much as 60 percent or more of the green fruit in a given pick may be affected.

#### SYMPTOMS

##### Green Fruit

*External Symptoms.* It is often impossible to determine without cutting the fruit whether or not it is affected. In some cases the trouble may be detected by a partial loss of luster at the styler end. Another indication is the development of a yellow or orange-yellow color on a quarter or more of the styler end while the remainder of the lemon is still green; even this appearance, however, is not a sure indication of internal decline.



*Internal Symptoms.* The first internal symptoms are usually found near the vascular bundles in the "nipple" of the peel at the styler end of the lemon. Small cylindrical openings are found arranged in a circle within the ring of vascular bundles. It is evident that these openings have been produced by the collapse of the parenchymatous cells. A little later in the development the vessels themselves appear to be clogged with a pinkish to rust-brown deposit of gum. At this stage the vessels and the surrounding tissues often begin to break down, and finally the central portion of the peel of the styler end of the lemon becomes a mass of gum having the characteristic pink to rust-brown color. In other cases the vessels are clogged with gum but there is very little indication of collapse in these or adjoining tissues. This is true for the examples shown in Plate VII. In conjunction with these conditions, pink to rust-brown splotches frequently appear at one or more places within the adjoining tissues (see *c*, Pl. VII). The tissues in these splotches, at this time, usually have a glossy appearance due to the formation of gum. At this stage the cells and the juice sacs of the pulp adjoining the peel at the styler end of the lemon become affected, lose water, and collapse (see *b*, Pl. VII). There is very little or no discoloration of these tissues at this time. In comparatively rare cases the vessels in the center of the lemon are discolored and filled with gum all the way through to the stem end. This is usually as far as the trouble has progressed in lemons that are picked while light or dark green in color.

### Silver Fruit

*External Symptoms.* Internal decline is not easily detected by external signs at this stage of development of the fruit. In many cases the more intensive coloring of the peel at the styler end of the lemon is an indication that the abnormal breaking down of the internal tissues has begun. However, as is true with the green fruits, this indication often may be misleading.

*Internal Symptoms.* The loss of water and the collapse of the pulp cells and juice sacs at the styler end continue. The progress is more rapid near the center of the lemon than out near the peel. It is especially rapid in the pithy core (placenta) that runs through the center of the lemon (see Pl. VII). As the fleshy pulp tissues dry out they may retain their normal color, but more often they assume a pinkish or light-brown color. In this stage of growth of the lemon it is found that, in those having internal decline, the breaking down of the tissue has progressed so far as to involve parts of the inner portion of the peel and perhaps a fifth of the adjoining pulp at the styler end.

### Yellow (Tree-ripe) Fruit

*External Symptoms.* Here again the signs are far from being infallible. The more intensive yellow or orange-yellow coloring of the styler end, which may occur while the remainder of the fruit is still green, persists



after the fruit has become ripe and serves in many instances as an indication of internal abnormality. If the peel of the lemon is comparatively thin, the breaking down of some of the internal tissues will cause the formation of a depression at the base of the nipple on the styler end of the lemon. In some cases the depression appears on one side only, thus causing the nipple to curve or bend over in that direction. These depressions are often, but not always, a sign that the lemon is affected and that it should be discarded.

In all the three classes of fruits the external signs are such that usually 50 to 90 percent of the lemons having internal decline may be detected and culled out.

*Internal Symptoms.* There is little or no indication of a further breaking down of the cells in the peel, but the pulp tissues continue to lose water and collapse as long as the fruits remain on the trees. When  $\frac{1}{3}$  to  $\frac{1}{2}$  of the styler end of the lemon has become affected (see *d*, Pl. VII), an abscission layer usually forms in the stem and the fruit drops.

After the trouble has progressed to a considerable extent, the styler end of the lemon becomes lighter in weight than the opposite end. On this account many of the badly affected lemons may be distinguished and culled out at the time of washing, because these lemons, unlike the sound ones, will float with the affected ends upward.

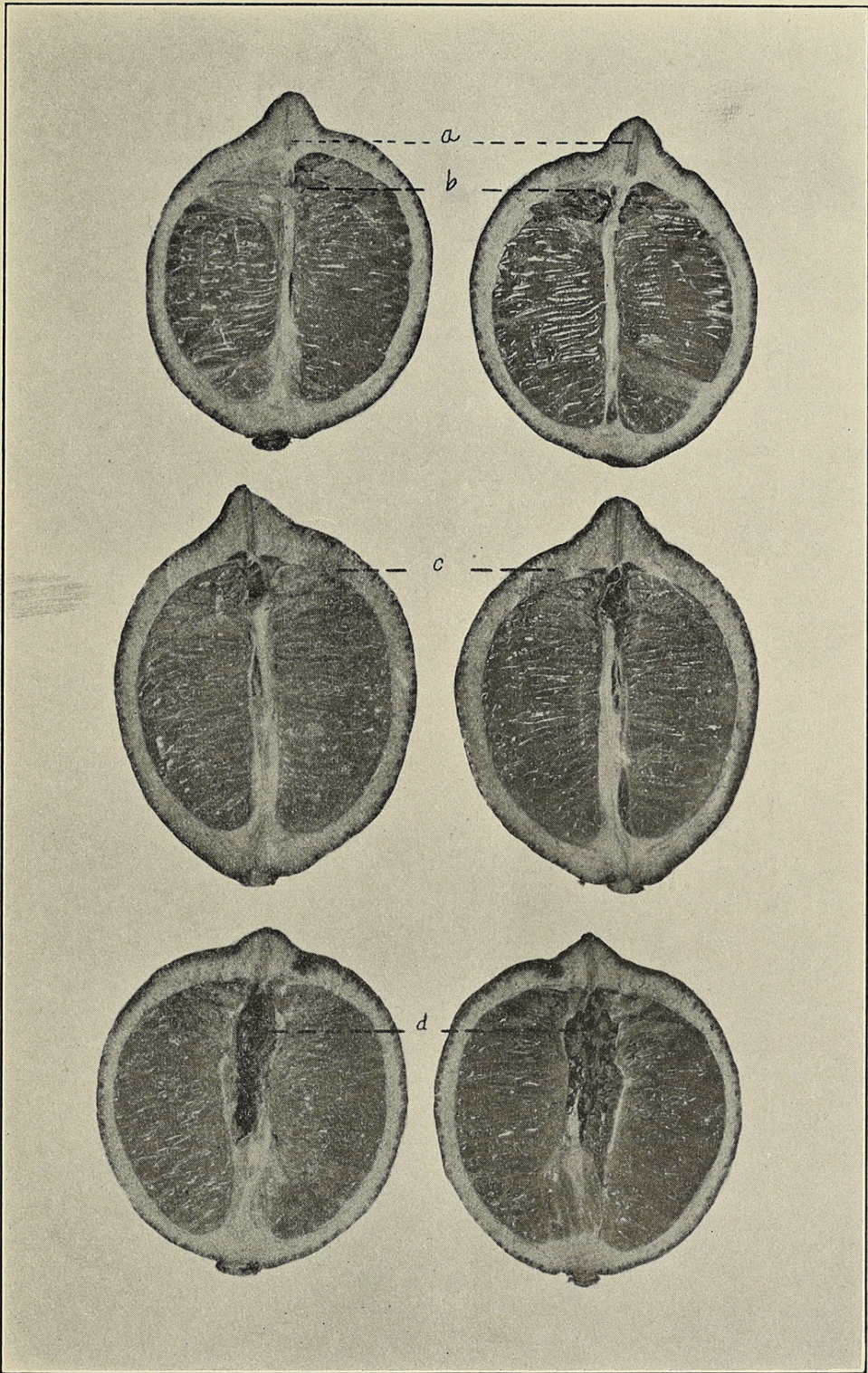
In the above description of the symptoms of internal decline, a typical example has been cited in which the collection of gum and the destruction of the tissues begin while the fruit is still green. As has already been stated, the malady may appear only in the silver or tree-ripe fruit. In such cases the course of development of the abnormal conditions is like that which begins while the fruit is still green, except that in some instances gum formation may be a little less abundant and discoloration of the tissues less pronounced.

#### EXPLANATION OF PLATE VII

- a.* Vascular bundles clogged with gum.
- b.* Initial collapse of pulp tissues.
- c.* Affected area in peel; vessels and adjoining cells becoming filled with gum.
- d.* Collapse of placental and adjoining tissues. The lemon usually falls from the tree at about this stage.

*Note:* The earlier stages of development of the malady cannot be satisfactorily shown in an ordinary photograph, and in fact none of the stages can be most advantageously shown without the use of a colored plate.





BARTHOLOMEW AND OTHERS: INTERNAL DECLINE





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