SOME NEW ASPECTS OF GUMMOSIS AND PSOROSIS OF CITRUS TREES IN FLORIDA

(With four plates)

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In connection with experiments of the past several years to determine the value of the bark-scraping method of treatment for the control of gummosis and psorosis of citrus trees, it has been observed repeatedly that grapefruit trees with advanced cases of gummosis and orange trees with advanced cases of psorosis usually have failed to respond satisfactorily to the treatment. In some instances these diseases have remained inactive or quiescent following the initial treatment, but became active again the following year, thus requiring retreatment. In those cases which continued to be more or less active year after year it was noted that, even where the development of gummosis or psorosis was checked fairly well at the places treated, judging by the cessation of gumming and the failure of the bark to die over areas of any great size, it was frequently found, at the inspection the following year, that they had broken out at points farther up and down on the attacked trunks or limbs. In some instances they might also break out anew in the old areas which had been treated two or three years previously and had apparently healed. Since the treatment each year extended well in advance of any gumming or discoloration in the inner bark, this continued progress of these bark diseases could not, in most cases, be attributed to inadequate scraping.

Even in those cases where the bark appeared to have healed without any killing sufficiently extensive to affect the life of the trees, they soon began to decline, often a limb at a time, until eventually the entire tree was involved in the decline. In most instances where other factors, particularly blight, were not involved, the decline extended over a period of several years, the trees becoming less vigorous and bearing less fruit each year until their retention was no longer profitable. The regularity with which many trees declined when these bark diseases, judging by external appearances, did not appear sufficiently active to account for this was quite puzzling. It appeared that, once these diseases progressed beyond a certain point, they frequently became systemic (Plate 1).

That this is true has been demonstrated conclusively by anatomical and cultural studies of the wood of the attached trunks and limbs of grapefruit trees declining from gummosis, and of orange trees declining from psorosis. The wood of such trees, instead of being pale yellowish white, as it should be normally, is frequently extensively discolored, with the central portion light brown. In cross and longitudinal sections of attacked trunks or limbs this brownish central wood is demarked from the external, more or less sound wood by one or more highly irregular, dark brown zones which appear as sinuous lines in sectional preparations.

(Plates 2 and 3.) The peripheral portion of the wood of such trunks or limbs usually is more or less irregularly discolored pale brown with grayish tinges in places, giving a somewhat mottled appearance in which small discolored areas may be demarked from the adjacent wood by dark brown zones. The discoloration of the outer wood is also frequently accompanied by dark brown flecks. In cross and longitudinal sections this marked discoloration frequently involves almost all the wood of a given trunk or limb, sometimes encroaching within an eighth of an inch of the living bark, or even extending out to the bark in areas where it may be gumming. Not only does this marked discoloration involve nearly all the cross section of attacked trunks or limbs, but it extends for considerable distances longitudinally, and often well in advance of the upper and lower limits of gumming on bark lesions. In trees where either gummosis or psorosis has been active for

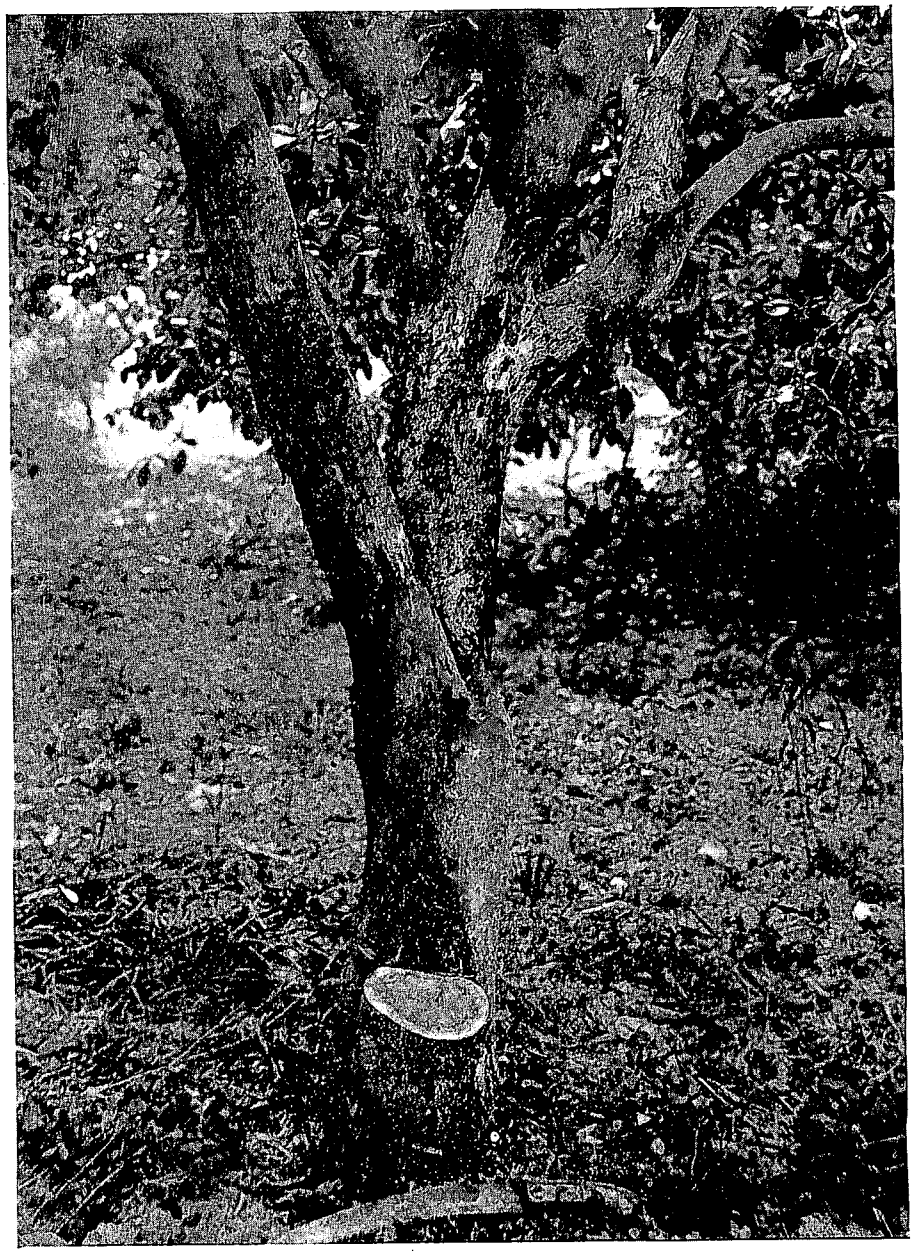

PLATE 1. Systemic case of gummosis in grapefruit tree in which the disease continued to progress despite treatment by the bark-scraping method each year from 1927 to 1936, inclusive. Note the discoloration of the wood where the front trunk was cut off just before photographing.

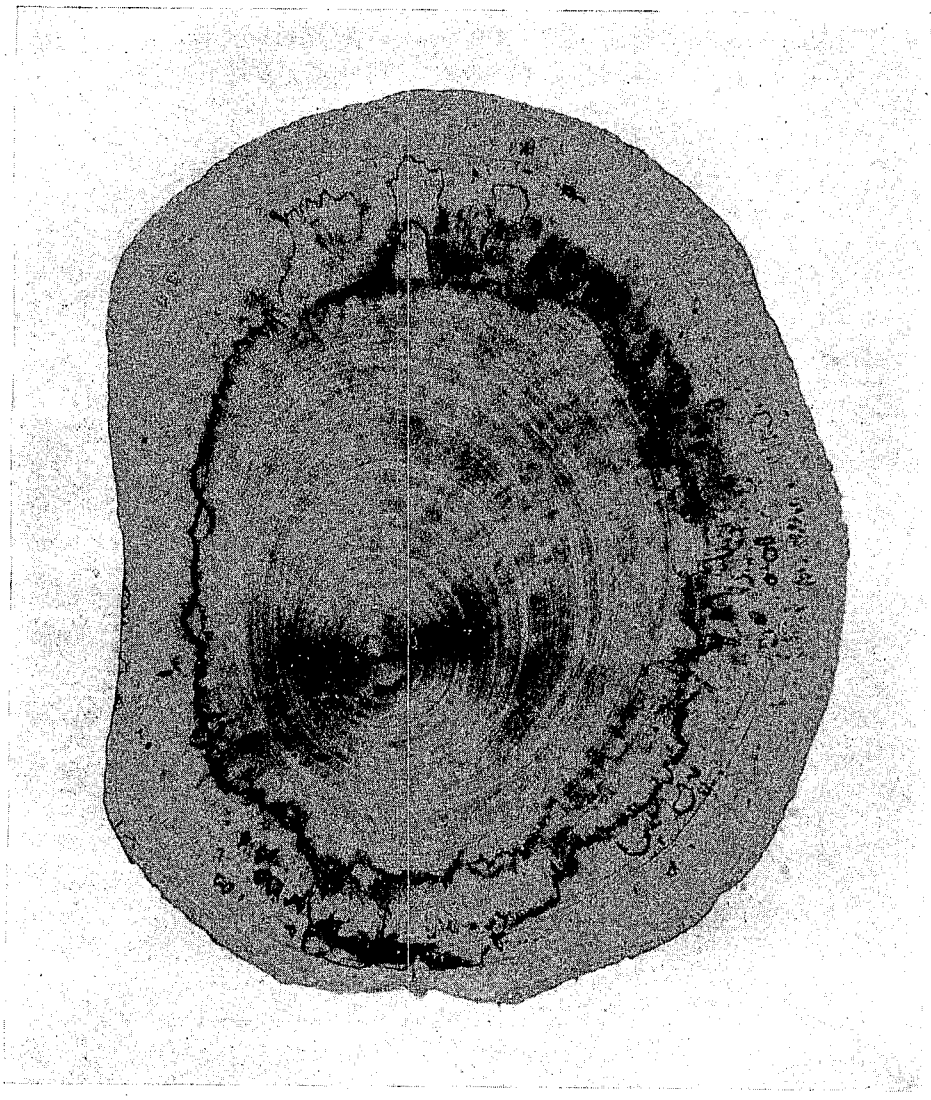

PLATE 2. Cross section of base of gumming grapefruit trunk cut from tree illustrated in Plate 1, showing the dark brown zones and flecks and the extensive discoloration involving nearly all the wood.

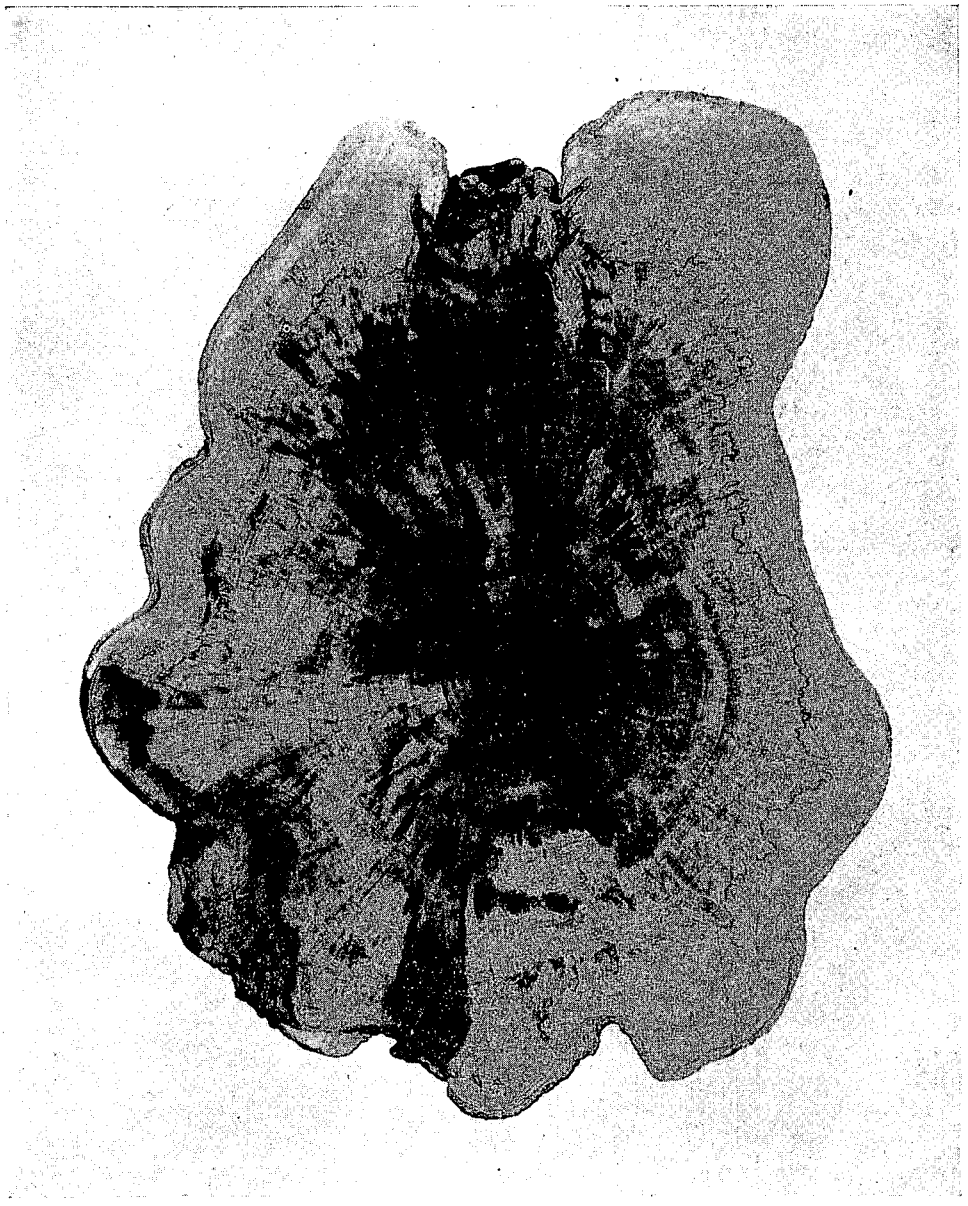

PLATE 3. Cross section, cut at bud union (ground line), of 14-year-old Valencia orange tree declining rapidly from psorosis. Note the dark brown zones and flecks and the extensive discoloration involving nearly all the wood.

PLATE 4. Longitudinal section of butt of Valencia orange tree illustrated in Plate 3, showing the extensive discoloration of the wood extending down into the root crown below the bud union

several years this discoloration of the wood frequently extends from the base of the tree up to a point 5 or 6, or even more, feet above, or well into the main limbs of the trees. Furthermore, this pronounced discoloration of the wood may even extend below the point of the bud union, involving more or less of the wood of the root crown (Plate 4), particularly in trees on rough lemon stock. In the vicinity where an area of bark has been killed by gummosis or psorosis, or a limb killed by either of these diseases has been cut off for some time, an exceptionally dark discoloration of the wood usually develops, which, no doubt, is due largely to oxidation.

There also occurs, intermittently throughout the outer layers of trunks and limbs attacked by both gummosis and psorosis, brown zones of closely crowded gum canals which appear as lines in sectional preparations. These may extend for but short distances or be more or less continuous around the wood layers. These zones of gum canals frequently are repeated in the successive growth layers and even 2, 3 or 4 zones may be repeated in quick succession within a single growth layer. Sections of the trunks or limbs involved in gummosis or psorosis show that these zones of gum canals commonly develop for considerable distances beyond the upper and lower limits of gumming in the bark lesions. Their formation begins with the inception of the disease and before there is any evidence of discoloration of the wood, and continues intermittently as long as the disease progresses and the part involved remains living.

The full significance of this extensive discoloration of the wood, of course, is not wholly apparent without cultural and microscopic investigations to determine whether or not any organisms are involved, and their effect upon the wood. From time to time over a period of several years either *Phomopsis citri* or *Diplodia natalensis* has been isolated from blocks of the discolored wood taken from sections of trunks or limbs of citrus trees with persistent cases of gummosis or psorosis. No other pathogenic organism has been isolated from the wood of such trees. These particular fungi are to be found throughout Florida wherever citrus groves occur, causing the two well-known stem-end rots of fruits; *Phomopsis* also causes melanose.

It is by no means necessary, however, to resort to pure culture technique in order to demonstrate the association of an organism with the discolored wood in the trunks of trees declining from gummosis or psorosis. Sections through trunks or limbs of such trees, when kept in moist atmosphere in culture dishes, commonly yield a profuse development of fungous mycelium from the discolored wood. Even on the cut ends of living trunks or large limbs left lying in the laboratory for a few days, sufficient outgrowth of the mycelium usually develops from the central discolored wood to be readily apparent. In the latter case, of course, the continued growth of the mycelium is soon arrested by the dessication of the wood.

Microscopic examination of the discolored wood reveals more or less evidence of fine thread-like fungous filaments ramifying through the cells in places. Accumulations of brown gum frequently occur near the pitted end walls of the segments of the vessels, or water-conducting elements, and a brownish gum-like substance is of frequent occurrence in the parenchyma cells of the medullary rays. Where the wood shows the dark brown zones or flecks the vessels are extensively occluded by gum and great masses of the cells of the bands of wood parenchyma and the parenchyma cells of the medullary rays are filled with a brown gum-like substance.

That the extensive invasion of the wood in the trunks and main limbs of citrus trees by such organisms as *Phomopsis citri* and *Diplodia natalensis* exerts a profound effect upon the water conduction and other vital processes of the tree will not be questioned. The discovery of this extensive invasion of the wood by these organisms explains why trees with advanced cases of gummosis and psorosis usually fail to show a marked improvement when treated by the bark-scraping method. While this method of treatment usually is very effective if administered during the early stages of these diseases, the findings here discussed demonstrate that it cannot be effective after the interior of the wood of the attacked trunks or

limbs has become extensively invaded and discolored by *Phomopsis* and *Diplodia.*

Observations and studies during the past several years do not indicate that these organisms, as a rule, are the primary causes of most of our gummosis in grapefruit and tangerine trees, and certainly they are not the primary cause of psorosis in orange trees. However, in the frequent instances where gummosis of grapefruit trees develops as a result of infection of the wood of untreated pruning wounds and other injuries by *Phomopsis* and *Diplodia,* these organisms must be regarded as the primary cause of gummosis. Infection of pruning and other wounds by these fungi takes place much more readily in Tahiti lime and Perrine lemon trees than in the case of grapefruit trees, occurring commonly even in very young trees. Tisdale* has recently reported the consistent association of these particular fungi with a dieback of young Tahiti lime and Perrine lemon trees, which occasionally assumes serious proportions in certain plantings. These organisms invade the wood of these young trees rapidly and the dying of the attacked parts is accompanied by more or less profuse gum formation. He was able to reproduce this trouble readily by inoculations with pure cultures of each of these fungi. It is of interest to note in this connection that, in grapefruit trees, serious cases of gummosis rarely occur in young trees.

In those cases where gummosis is initiated by purely physiological causes the gum exudes through cracks formed in the bark as a result of the internal pressure exerted when it accumulates in sufficient quantity between the wood and bark to rupture the latter. In such cases the gum flow ceases when the conditions stimulating its formation no longer prevail and the cracks frequently heal without infection taking place. Even when areas of bark are killed at points where the gum accumulates in pockets beneath it, infection of the underlying wood frequently does not take place and the wounds thus caused soon heal. Sections through such citrus trees show merely a very limited discoloration immediately back of the areas where the bark was killed, together with the usual lines of gum canals invariably present when gumming of the tissues from any cause is involved. Instances have been observed where grapefruit trees have developed severe outbreaks of gumming involving the trunks, main limbs, and even the small branches, and the trees recovered without any special measures other than the correction of the conditions that apparently induced this severe outbreak. Gumming of this type is alarming only in that it is indicative of a disturbance in the normal physiology of the tree and that the ruptures formed in the bark or local areas where the bark has been killed pave the way for the entrance of destructive organisms. When infection of these gumming cracks by *Phomopsis* and *Diplodia* take place, the bark immediately adjacent to these cracks soon develops a dark discoloration which is not evident until the dark outer surface is scraped or cut away. When infection of the bark by these fungi takes place new gumming starts and it is frequently only a matter of a short time until these organisms have invaded the underlying wood. In fact, such organisms as *Phomopsis* and *Diplodia* frequently develop faster in the wood than they do in the bark. The majority of the gummosis of grapefruit trees in Florida appears to develop in this manner.

In the case of psorosis on orange trees the wood usually remains free from discoloration, other than that caused by the gum canal formation, for a considerable length of time even after the disease has encircled the attacked trunks or limbs. Upon this disease becoming sufficiently severe to cause the killing of the bark in one or more areas, invasion and discoloration of the wood by such organisms as *Phomopsis* and *Diplodia* appears to have its inception. When the stage is reached at which the interior wood becomes discolored following invasion by these organisms, trees attacked by psorosis are doomed to a gradual decline. While the invasion of the wood by these organisms appears to be purely secondary in the case of psorosis, the havoc wrought by them appears to greatly exceed that occasioned by the disease in its initial form. In Florida, psorosis is particularly

*Tisdale, W. B. Diseases of Lime Trees. Florida State Hort. Soc. Proc. 47 (1934): 123-127. 1935. Bark Disease of Tahiti Lime and Perrine Lemon. Florida Agric. Exp. Sta. Press Bull., 481, 2 pp. 1935.

destructive to Valencia oranges, especially in the ridge section.

Observations made over a period of several years have shown quite conclusively that there is a direct relation between the occurrence of drought and the susceptibility of at least grapefruit trees to develop gummosis, and that the progress of the disease in grapefruit trees and their decline is most rapid in groves or situations that are subject to drought. These observations are supported by the experience of citrus growers who have been close observers of their grove conditions. The dieback of twigs and branches caused by attacks of *Diplodia,* which may or may not be accompanied by more or less gumming, was pointed out by Earle and Rogers* in 1915 to be a serious citrus trouble in Cuba and the Isle of Pines, especially on trees on unfavorable soils, and at the beginning of the dry season. Once the wood of citrus trees becomes invaded by *Phomopsis citri* or *Diplodia natalensis,* the weakening of the trees by prolonged periods of drought apparently furnishes conditions quite favorable to the rapid development of such wood-invading organisms within the trunks and limbs attacked by gummosis or psorosis. The ability of these two fungi to extensively invade and kill actively growing tissues which have considerable powers of resistance indicates that they are to be regarded as strong facultative parasites. It is, of course, highly desirable that extensive inoculations with pure cultures of these fungi be made in bearing citrus trees in order to determine the exact role they play in the production of gummosis.

Since the extensive invasion of citrus trunks and limbs by *Phomopsis* and *Diplodia* cannot be detected without cutting into the part involved, the importance of gummosis and psorosis is generally underestimated by growers. As a result, they rarely attempt to control these diseases until they have developed to the point where they encircle the attacked trunk or limb. As has been shown, it is then often entirely too late to combat these diseases by external treatment, as they may have become systemic by this time.

Unless attempted in the early stages, it is believed that the control of such diseases as gummosis and psorosis must be accomplished by preventive measures before they occur, rather than of remedial measures after they have been allowed to develop for a considerable length of time. It is believed that it is well worth while for a grower to devote the time and trouble necessary to make a periodic inspection of his trees for the development of bark diseases, so that outbreaks of them may be discovered early and timely treatment administered. Not infrequently the mere removal of a branch on which gummosis or psorosis has developed will prevent the organism likely to be already established in the wood from spreading downward into a larger limb or even the trunk. The admonition of the old motto, "A stitch in time saves nine," is truly applicable to the control of our citrus bark diseases. Growers are too frequently inclined to minimize the importance of these diseases until they threaten the life of the tree and it is much too late to effect their control. That is the time they usually call for assistance and one would have to perform miracles to render any material assistance at that late stage. The proper treatment of trees that have begun to decline from either gummosis or psorosis calls for the axe and the grubbing hoe rather than for the specialist.

On the basis of several years of experience with the bark disease problem of citrus trees it is quite apparent that growers are simply storing up trouble for themselves when they neglect to properly treat pruning and other wounds with some good durable dressing that is safe to use. Such treatment would not only obviate the development of many cases of gummosis that have their inception through these channels, but would at the same time prevent the entrance of organisms which cause wood decay, and which all too frequently cause the average length of life of trees to fall far short of that which might be expected when the trees are properly cared for in this respect.

*Earle, F. S., and Rogers, John M. San Pedro Isle of Pine Citrus Pathological Laboratory. First Annual Report. 41 pp., 19 figs. 1915.