# CHAPTER 9

# Virus-Like Disorders of Citrus

## Transmission Trials with Virus-Like Diseases of Citrus in Florida

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THE FOLLOWING REPORT summarizes transmission trials with virus-like diseases in Florida.

### *Wart*

This disorder was found affecting ten among 2,000 two and one-half-year-old Valencia sweet orange [*Citrus sinensis* (L.) Osb.] trees on Rough lemon [*C. limon* (L.) Burm. f.] rootstocks. All trees were examined and found normal at time of planting. The abnormality is limited to the Valencia portion of the tree; Rough lemon trunks and sprouts are not affected. Trunk symptoms consist of eruptive galls, ¼ to 1½ in. in diameter, that cover the bark from bud union to scaffold branches (Fig. 1,C). A necrotic cone-shaped peg underlies each gall, extending into the wood for a distance of ¼ to 1 in. (Fig. 1,B). When the bark is removed from an affected trunk, the woody cylinder shows a brown-colored cavity underneath each gall (Fig. 1,A). According to Dr. M. T. de Vasconellos (personal communication), the same trouble is common in the Dominican Republic on seedling orange trees.

Under greenhouse conditions in Florida, affected buds produce leaves that are twisted and show a large, faintly chlorotic area within the basal

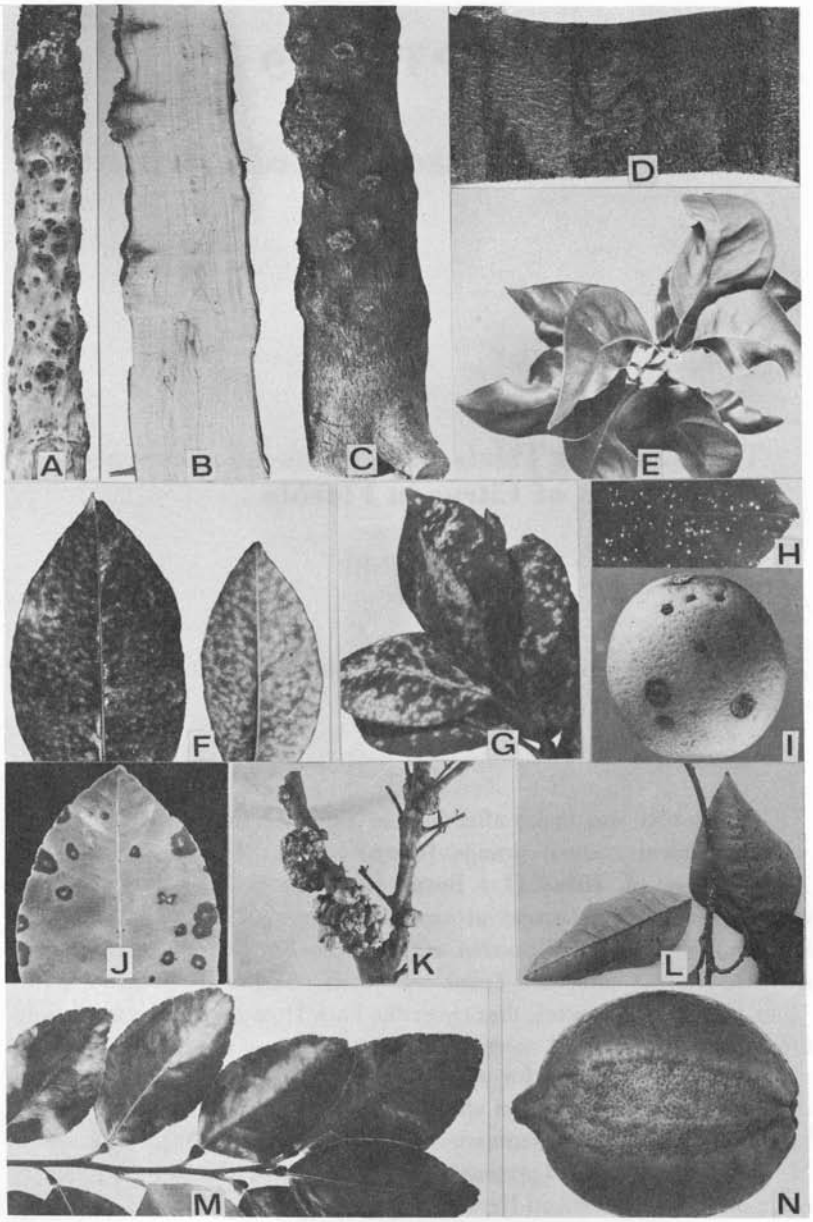


FIGURE 1. *A.,B.,C. Wart; D.,E. Crinkle-scurf; F.,G. Measles; H.,I. Cancroid spot; J. Juvenile spot; K. Sphaeropsoid knot; L. Popped bark; M.,N. Lime blotch.*

portion—symptoms that resemble the leaf distortion and chlorosis occurring in crinkle-scurf (Fig. 1,E) (3). Plants now 12 months old, grown from seed of fruits of affected trees, show neither of these abnormalities, but the leaves show strong undulations of the margins. In transmission tests, buds from affected trees were worked on 10 Valencia, 6 West Indian lime [*C. aurantifolia* (Christm.) Swing.], 6 Orlando tangelo (*C. reticulata* x *C. paradisi*), and 10 Rangpur lime (*C. reticulata* var. *austera* hyb.) seedlings. At the end of 18, 18, 18, and 4 months, respectively, none had shown any symptoms. However, symptoms were perpetuated in the growth of buds taken from affected trees.

### *Crinkle-scurf*

In this hyphenated name, *crinkle* refers to leaf twisting (Fig. 1,E) and *scurf* to a corky banding of the bark on trunks and main branches (Fig. 1,D). These symptoms occur together in 95 per cent of affected trees (3). Crinkle-scurf occurs almost exclusively in Valencia orange trees with up to 54 per cent of trees affected in certain orchards. It causes significant reductions in trunk diameter, fruit size, yield, and juice content, but the soluble solids of the juice are increased significantly. With respect to fruit size, yield, and juice content, the degree of deviation from the norm varies from year to year; some years, the differences are statistically significant at the 5 per cent level. However, the ratio of sugar to acid and the content of vitamin C are not noticeably affected.

Buds from affected trees were worked on 16 sweet orange, 5 sour orange (*C. aurantium* L.), 5 grapefruit (*C. paradisi* Macf.), 21 Rough lemon, 6 sweet lime [*C. aurantifolia* (Christm.) Swing.], 7 Cleopatra mandarin (*C. reticulata* Blanco), and 12 miscellaneous varieties. During observation periods ranging from 6 to 24 months, none of the test plants showed symptoms. Symptoms were perpetuated, however, in the growth of buds taken from affected trees.

### *Measles*

In Florida, trees are occasionally found with mature, more or less uniformly stippled leaves (Fig. 1,F). This disorder is referred to as measles, speckle (7), or pinpoint yellow spot. The spots measure approximately 2 mm in diameter and are separated from each other by an equal distance. On the adaxial leaf surface, spots are chlorotic; on the abaxial side they are dirty white to brown and slightly raised. Affected leaves are restricted generally to certain limbs, whereas the leaves on other

limbs of the same tree are normal. Measles is seen most frequently in the field, affecting sweet orange varieties, but occasionally it appears on grapefruit, Tahiti lime [*C. aurantifolia* (Christm.) Swing.], and sour orange. It has also been observed on seedlings of Washington navel and Orlando tangelo grown in vermiculite in the greenhouse.

The possibility that measles results from deficiencies of minor elements has been investigated by Dr. C. D. Leonard of the Florida Citrus Experiment Station. None of the minor elements tested corrected the condition. Claims put forward that measles is a symptom of slight boron toxicity are not supported by the fact that the symptoms appear year after year on the same tree, but only on the same branches.

A variant form, big measles, (Fig. 1,G) is apparently identical except that spots are larger, about 6 mm in diameter. This form has been found in budded Valencia sweet orange trees and in seedling navel orange trees. Spraying with sodium molybdate has not corrected the spotting, which indicates that big measles is not related to yellow spot (8).

Transmission trials over the past 13 years have failed to implicate a virus. Buds from affected sweet orange trees were worked on seedling plants as follows: 17 sweet orange, 20 West Indian lime, 3 Orlando tangelo, 3 grapefruit, 3 King orange (*C. reticulata* Blanco), and 3 miscellaneous varieties. During observation periods ranging from 11 to 40 months, measles symptoms failed to develop either in the test plans or on growth from the inoculation buds.

### *Cancroid Spot*

This abnormality, encountered only in Valencia sweet orange trees, produces lesions resembling those of bacterial canker (Fig. 1,I) on fruit, pinhead-sized spots in the foliage (Fig. 1,H), small leaves, defoliation, and dieback in the tops of trees.

Although cancroid-spotted fruit are unsaleable, the disease is of no commercial importance. The fruit of only 8 trees of a surrounding 70-tree sample in only one grove were found affected. Interest in cancroid spot rests more on such aspects as differentiation of cancroid spot from true canker, the relation between cancroid spot and certain symptoms in other parts of the tree, and the mechanism responsible for symptoms that resemble those caused by bacteria, viruses, nutritional deficiencies, and such physiological factors as drought and cold.

In spite of numerous attempts over several years, bacteria were never isolated from cancroid spot. This indicates that it is not a bacterial spot and is not related to citrus canker.

Associated with the fruit symptoms is an inconspicuous spotting of the foliage, designated glassy spot. Spots are small, from 0.3 to 1.0 mm in diameter, and bordered by a faint halo approximately 0.1 mm wide. By transmitted light, the spots appear translucent (Fig. 1,H). A few to several hundred of these spots may appear on a leaf, but not all leaves on a tree are affected. In addition, leaves are often reduced in size, especially the foliage of twigs bearing cancroid-spotted fruit. Dwarfed leaves resemble the little-leaf symptom of stubborn virus. Immature leaves affected by glassy spot frequently abscise between the petiole and blade, leading ultimately to sparse foliage and dieback of twigs. Glassy spot should not be confused with the necrotic dots of calcium deficiency nor with the punctiform, opaque spots of measles.

Buds from trees affected with cancroid spot were worked on the following seedlings: 24 sweet orange, 6 grapefruit, 6 Orlando tangelo, and 1 each of the following: Murcott (*C. reticulata* Blanco hyb.), West Indian lime, Cleopatra mandarin, and lemon [*C. limon* (L.) Burm. f.]. No symptoms were observed on the test plants in periods of from 17 to 24 months. However, the glassy spot symptom was perpetuated from buds taken near cancroid spotted fruit and in seedlings grown from seeds of such fruit. The observation suggests that cancroid spot is genetically or cytoplasmically inherited.

### *Juvenile Spot*

Juvenile spot is peculiar to grapefruit trees and is found only in trees less than 6 years old (4). The trouble has been observed by the author in Florida, Argentina, and Syria, and has been reported from Japan by S. Tanaka (personal communication). It is of no economic importance other than its often alarming resemblance to bacterial canker. Either surface of a leaf may develop spotting, depending on the side exposed to the sun. Spots are irregular, but roughly circular, from 1 to 8 mm in diameter, of chocolate-brown resinous appearance, with centers sometimes concentrically ringed (Fig. 1,J). Bright yellow halos 0.1 to 2.5 mm wide border the spots, and dome-shaped masses of hardened gum arise in the centers. Old spots are more or less sunken at the centers, suggesting insect punctures or cell collapse. Severe spotting is followed by defoliation.

Because no instance of juvenile spot has been seen in the past 12 years, the trouble has not been checked for transmissibility by grafting. However, the disease is tentatively considered to be non-viral since symptoms disappear as trees grow older.

### *Sphaeropsoid Knot*

Numerous types of galls on citrus are present in Florida (2) although one, woody gall, has not yet been reported (5). Galls, often resembling those of sphaeropsis knot, are occasionally observed on branches and twigs of Tahiti lime and sweet orange (Fig. 1,K) and have been the subject of transmission trials. However, none proved infectious. Galls often appear following grafting, but only in stems growing from buds taken from affected parts of parent trees. Formerly, sphaeropsis knot was believed to occur in Florida (8), but comparison of Florida material with authentic examples in Jamaica, together with failure of the Florida material to infect, led to the conclusion that the Florida knots tested are genetic in nature. Buds from trees affected with galls were worked on the following seedlings: 16 sweet orange, 14 West Indian lime, and 1 each of the following: sour orange, Orlando tangelo, trifoliate orange [*Poncirus trifoliata* (L.) Raf.], and grapefruit. Observations over 19 to 49 months showed no development of galls.

### *Popped Bark*

On occasion in Florida, twigs and leaves of sweet orange trees are seen that are peppered with pinhead-sized corky pustules (Fig. 1,L) resembling overdeveloped melanose lesions. Pustules on leaves cause growth distortions. Buds from twigs showing such pustules were worked on the following test plants: 2 sweet orange, 1 Cleopatra mandarin, and 1 sour orange. In 8 months no symptoms appeared on the test plants or on growth from the buds. However, seedlings from affected trees developed typical symptoms in the second year.

### *Lime Blotch*

Lime blotch closely resembles the symptoms described for wood pocket disease of lemon and seedless lime [*C. aurantifolia* (Christm.) Swing.] trees in California (1) and is presumed to be the same disease. In Florida, blotch is a serious disorder of the Tahiti or Persian lime, causing leaf blotch (Fig. 1,M), fruit sectoring (Fig. 1,N), and tree deterioration (6). Many lime plantings have been abandoned because of blotch, but recently where use has been made of blotch-free budwood as provided by the Florida Budwood Registration Program, the trouble has not reappeared.

Attempts to transmit blotch were begun in 1950. A total of 98 plants were worked with buds from affected trees as follows: 38 rooted cuttings of Tahiti lime, 44 West Indian lime, 4 sweet orange, 2 sour orange, 2

Rough lemon, 2 Cleopatra mandarin, 2 *Afraegle paniculata* (Schum.) Engl., and one each of the following: lemon, sweet lemon, limequat (*C. aurantifolia* x *Fortunella* sp.), and grapefruit. Observation periods ranged from 2 to 7 years, but no evidence of transmission occurred. However, leaf blotch appeared in leaves of sprouts from trees affected with blotch and on seedlings from such trees.

## *Conclusions and Summary*

Within limits of the techniques used, none of the eight virus-like disorders proved infectious. Five of these disorders, wart, crinkle-scurf, cancroid spot, sphaeropsoid knot, and lime blotch were perpetuated by buds from affected trees. Consequently, such trees should be as scrupulously avoided during the collection of budwood as though they were affected by virus diseases. To a grower, it is academic whether the trouble affecting his trees is bud transmitted or bud propagated.

The nature of juvenile spot and measles remains undetermined. Popped bark, cancroid spot, and lime blotch are seed transmitted and hence probably of genetic origin since no evidence was obtained of transmission as with virus diseases.

With further study involving extended host ranges, large numbers of plants, different grafting techniques, and prolonged periods of observations, it is possible that some of the trouble may yet prove transmissible.

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