CHAPTER 3

Cachexia-Xyloporosis and Related Diseases

A Review of the Cachexia-Xyloporosis Situation

J. F. L. CHILDS

THE CONFUSED NOMENCLATURE of the cachexia-xyloporosis situation makes the reviewer's role somewhat difficult. To avoid confusion as far as possible, the name cachexia will signify the symptoms of wood pitting and gum impregnated bark as originally described (4) on Orlando tangelo (*Citrus reticulata* x *C. paradisi*), certain mandarins (*C. reticulata*), and mandarin hybrids. The name xyloporosis will signify the wood pitting and brown discoloration of the bark as originally described by Reichert and Perlberger (23) on sweet lime (*C. aurantifolia*); it does not include little leaf or lopsided and malformed fruit symptoms that Reichert (25) later included in the xyloporosis syndrome.

The cachexia-xyloporosis situation was reviewed in detail at the Conference on Citrus Virus Diseases at Riverside, California in 1957 (5). To repeat that review seems unwarranted; the previous review will be mentioned only as a starting point and post-1957 developments will be emphasized.

Since the economic importance of cachexia and xyloporosis is well established and procedures for control are largely standardized, these aspects will be omitted.

LITTLE LEAF DISEASE.—Inclusion of little leaf disease symptoms in the xyloporosis syndrome by Reichert and his colleagues (23, 24, 26) seemed

unwarranted in 1957. It was noted then that the little leaf symptoms of malformed, lopsided, and acorn-shaped fruit are symptoms of another virus disorder, stubborn disease. No recent research is known which suggests that these symptoms should be considered part of the cachexia-xyloporosis syndrome.

RELATION TO TRISTEZA.—At one time McClean (13) suggested that tristeza and xyloporosis might be related because both cause wood pitting. By 1957 that hypothesis seemed groundless (5). On the basis of their own later work, McClean and Engelbrecht (14) agree.

SEED TRANSMISSION.—Circumstantial evidence of seed transmission has been reported several times (5, 14, 20). However, an early experiment designed for the purpose failed to demonstrate seed transmission of cachexia-xyloporosis in Orlando tangelo (5). In 1963, Olson (22) reported no seed transmission in a test in which 113 sweet lime seedlings of infected parent trees were indexed on Orlando tangelo. The author and coworkers (8) indexed 1,750 seedlings from infected trees of 6 species of citrus and 6 hybrids, on Orlando tangelo test plants; all were negative after 6 years.

Cachexia-Xyloporosis Since 1957

By 1957 certain conclusions seemed established, certain others were tentative, and several questions were still unresolved. In some cases additional evidence supports the original conclusions. In others, further work has altered our ideas and some problems have been solved.

RELATION OF CACHEXIA TO XYLOPOROSIS.—Probably the most controversial and long-lived question is the interrelation of cachexia and xyloporosis. On the basis of information available in 1957 (5), a single virus was judged to cause both diseases. Since 1957, Calavan (2), Calavan and Christiansen (3), Olson (20, 21), Moreira (15), Childs (7), Salibe and Moreira (29), and Salibe (28) agreed with this hypothesis on the basis of their own research.

In the same period, Grant *et al.* (10) and Reichert and Bental (27) reported conflicting opinions. Grant reported that bud inoculations from 7 sources caused cachexia symptoms on 24 out of 26 Orlando tangelo seedlings, but caused no symptoms on 25 seedlings of Columbia sweet lime. According to J. W. Jones (personal communication), Grant's former assistant, the sweet lime plants later developed xyloporosis symptoms, but those results were not reported.

Reichert and Bental's (27) dissenting opinion was based on observations on orchard trees of Clementine mandarin (*C. reticulata*), 15 years

old on sweet lime and on sour orange (*C. aurantium*) rootstocks, propagated from "sources that could not be traced." The virus status of the plants was unknown and the results should be considered as observations only and not as conclusions based on a controlled experiment. However, Reichert and Bental mentioned unpublished results of another experiment as follows: "In our small-scale preliminary experiments conducted under insect-proof conditions, sweet lime seedlings, graft inoculated with budwood from cachexia-infected Nocatee tangelo, produced typical xyloporotic pitting, confirming Childs' and Olson's results."

From time to time, Reichert *et al.* (24, 25, 26) observed wood pitting on sour orange, sweet orange, grapefruit, and other varieties of citrus tolerant to cachexia; they construed this as evidence that cachexia and xyloporosis are caused by different viruses. These observations were not confirmed by index tests. The results of other experiments (4, 29) indicated that cachexia-xyloporosis virus did not cause wood pitting on sour orange, sweet orange, or grapefruit.

The end of this matter is not yet in sight. In 1957 we indexed sweet lime seedlings obtained from a commercial nursery on the following plants: trifoliate orange (*Poncirus trifoliata*), kumquat (*Fortunella* hybrid), Orlando tangelo, and sweet lime. After 8 years, gum impregnation of the bark appeared on the sweet lime tops of 5 of 10 trees on trifoliata, on 5 of 10 trees on kumquat, and on 1 of 10 trees on Orlando rootstocks. None of the sweet lime tops on sweet lime rootstock developed symptoms and none of the rootstocks developed symptoms of any kind. Apparently, a virus-like entity was transmitted through the seed of trifoliata, kumquat, and Orlando tangelo. This can scarcely be a case of rootstock-to-top incompatibility because not all trees were affected. More probable is transmission of a virus through seed. The recent discovery of seed transmission of psorosis virus (9) suggests that seed transmission may occur in certain species or even varieties, but not in others.

INSECT TRANSMISSION.—Norman and Childs' (17) recent attempt to transmit cachexia with 5 species of insects failed, as have all previous attempts.

BUD-UNION CONSTRICTION.—In 1955, Grimm *et al.* (11) reported a bud-union constriction disorder of sweet orange [*C. sinensis* (L.) Osb.] on Rough lemon [*C. limon* (L.) Burm. f.] rootstock, and they suggested cachexia virus as a possible cause. Examination of many indexed trees in the Florida Citrus Budwood Program showed (5) that trees with bud-union constriction often did not carry cachexia virus and vice versa. The same results were obtained in South Africa (14) and in Brazil (15).

Bridges and Youtsey (1) examined this disorder in Florida recently and reached the same conclusion. No further information supporting the suggestion of Grimm *et al.* appeared after 1957.

GUMMY BARK DISEASE.—A cachexia-like disorder of sweet orange trees on sour orange rootstock (18) was reported from Egypt in 1957. According to F. Nour-Eldin (personal communication) this disorder and the bud-union constriction disorder of sweet orange trees on Rough lemon rootstock are related, and neither is caused by cachexia-xyloporosis virus. Further discussion is omitted because a manuscript concerning this disease is in preparation.

FOVEA DISEASE.—In 1959, Knorr (12) reported a disease on Murcott orange (*C. reticulata* hyb.) trees in Florida; he named the disorder fovea. According to Knorr, Murcott trees develop two types of wood pitting: a type that is typical of cachexia-xyloporosis and another type in which inverse pitting predominates. Knorr calls the latter fovea. Index tests of both types have not been completed.

Conclusions

In 1957, cachexia and xyloporosis were considered to be caused by the same virus. Since then eight research papers have presented evidence to support that theory. Two papers supported the opposite view. In one of them the final results of the experiment supported the theory. The other was based on observations of trees propagated from unknown bud sources and, consequently, falls short of the precision required. However, unpublished results of a controlled experiment discussed in the latter paper support the theory. Thus, convincing evidence that cachexia and xyloporosis are caused by different viruses is still lacking.

The little leaf symptoms of malformed, lopsided, and acorn-shaped fruits are recognized generally as symptoms of stubborn disease and not as symptoms of cachexia-xyloporosis.

That the cause of tristeza disease is not related to cachexia virus or xyloporosis appears established.

In the matter of seed transmisssion of cachexia-xyloporosis all experimental tests to date, comprising over 1,900 plants of six citrus species and six hybrids, were negative.

Experimental attempts to transmit cachexia with five species of insects failed.

Confusion of bud-union constriction of sweet orange on Rough lemon with cachexia is not warranted as noted in 1957. Recent experimental results confirm that view.

The cause of the cachexia-like disorder of sweet orange on sour orange rootstock has been determined, but a report of the work is not yet published. It is related to the bud-union constriction disorder of sweet orange on Rough lemon rootstock. It is not related to cachexia-xyloporosis.

Whether fovea is identical to cachexia-xyloporosis or is caused by another virus remains to be determined.

Previously, the author proposed that the name xyloporosis replace cachexia because it was used first and is more widely known. However, cachexia was shown to be a virus disease in 1952 (4), whereas experimental transmission of xyloporosis, as recognized by Reichert and Perlberger (23), was not reported, so far as can be determined, until 1961 (27). By the rules of nomenclature, cachexia becomes the preferred name provided that the two diseases are shown to be equivalent.

Literature Cited

1. Bridges, G. D., and Youtsey, C. O. 1968. Further studies on the bud-union abnormality of Rough lemon rootstocks with sweet orange scions, p. 236. *In* J. F. L. Childs [ed.], 4th Conf. Intern. Organization Citrus Virol. Univ. Florida Press, Gainesville.
2. Calavan, E. C., Christiansen, D. W., and Weathers, L. G. 1961. Comparative reactions of Orlando tangelo and Palestine sweet lime to cachexia and xyloporosis, p. 150-158. *In* W. C. Price [ed.], Proc. 2nd Conf. Intern. Organization Citrus Virol. Univ. Florida Press, Gainesville.
3. Calavan, E. C., and Christiansen, D. W. 1965. Variability of cachexia reactions among varieties of rootstocks within clonal propagations of citrus, p. 76-85. *In* W. C. Price [ed.], 3d Conf. Intern. Organization Citrus Virol. Univ. Florida Press, Gainesville.
4. Childs, J. F. L., 1952. Cachexia disease, its bud transmission and relation to xyloporosis and to tristeza. Phytopathology 42: 265-268.
5. Childs, J. F. L. 1959. Xyloporosis and cachexia—their status as citrus virus diseases, p. 119-124. *In* J. M. Wallace [ed.], Citrus Virus Diseases, Univ. Calif. Div. Agr. Sci., Berkeley.
6. Childs, J. F. L. 1956. Transmission experiments and xyloporosis-cachexia relations in Florida. Plant Disease Reptr. 40: 143-145.
7. Childs, J. F. L., Eichhorn, J. L., Kopp, L. E., and Johnson, R. E. 1965. Experimental evidence that cachexia and xyloporosis are caused by the same virus, p. 61-69. *In* W. C. Price [ed.], 3d Conf. Intern. Organization Citrus Virol. Univ. of Florida Press, Gainesville.
8. Childs, J. F. L., Johnson, R. E., and Eichhorn, J. L. 1965. The question of seed transmission of cachexia-xyloporosis virus, p. 90-94. *In* W. C. Price [ed.], 3d Conf. Intern. Organization Citrus Virol. Univ. Florida Press, Gainesville.
9. Childs, J. F. L. 1966. Preliminary report of seed transmission of psorosis virus. Plant Disease Reptr. 50: 81-83.
10. Grant, T. J., Grimm, G. R., and Norman, P. 1959. Symptoms of cachexia in Orlando tangelo, none in sweet lime and false symptoms associated with purple scale infestations. Plant Disease Reptr. 43: 1277-1279.

11. GRIMM, G. R., GRANT, T. J., and CHILDS, J. F. L. 1955. A bud-union abnormality of Rough lemon rootstock with sweet orange scions. Plant Disease Reptr. 39: 810-811.
12. KNORR, L. C. 1959. Fovea—a disease of concern to Murcott growers. Cit. Ind. 40(6): 5-7, 16.
13. MCCLEAN, A. P. D. 1950. Possible identity of three citrus diseases. Nature 165(42002): 767-768.
14. MCCLEAN, A. P. D., and ENGELBRECHT, A. H. P. 1958. Xyloporosis, cachexia and abnormal bud-unions in South African citrus trees. S. African J. Agr. Sci. 1(4): 389-405.
15. MOREIRA, S. 1965. Cachexia and xyloporosis: Are they caused by the same virus? p. 56-60. *In* W. C. Price [ed.], 3d Conf. Intern. Organization Citrus Virol. Univ. Florida Press, Gainesville.
16. NORMAN, G. G., NIXON, R. R., JR., HORNE, L., and GRANTHAM, J. T. 1959. Symptoms indicating xyloporosis in uninoculated Orlando tangelo seedlings. Plant Disease Reptr. 43: 1120-1121.
17. NORMAN, P. A., and CHILDS, J. F. L. 1963. Attempted transmission of xyloporosis of citrus with insects. Proc. Florida State Hort. Soc. 76: 48-50.
18. NOUR-ELDIN, F. 1956. Phloem discoloration of sweet orange. Phytopathology 46: 238-239.
19. OLSON, E. O. 1958. Bud union crease, a citrus disorder associated with kumquat-hybrid rootstocks and scions. J. Rio Grande Valley Hort. Inst. 12: 27-34.
20. OLSON, E. O., SLEETH, BAILEY, and SHULL, A. V. 1958. Prevalence of viruses causing xyloporosis (cachexia) and exocortis (Rangpur lime disease) in apparently healthy citrus trees in Texas. J. Rio Grande Valley Hort. Inst. 12: 35-43.
21. OLSON, E. O., SHULL, A., and BUFFINGTON, G. 1961. Evaluation of indicators for xyloporosis and exocortis in Texas, p. 159-165. *In* W. C. Price [ed.], 2nd Conf. Intern. Organization Citrus Virol. Univ. Florida Press, Gainesville.
22. OLSON, E. O. 1965. Evidence that xyloporosis virus does not pass through seeds of Palestine sweet lime, p. 86-89. *In* W. C. Price [ed.], 3d Conf. Intern. Organization Citrus Virol. Univ. Florida Press, Gainesville.
23. REICHERT, I., and PERLBERGER, J. 1934. Xyloporosis, the new citrus disease. Jewish Agency for Palestine, Agr. Exp. Sta. (Rehovot) Bull. 12: 1-50.
24. REICHERT, I., BENTAL, A., and YOFFE, I. 1956. On the problem of the identity of "little leaf" and "xyloporosis" diseases. Ktavim 6: 77-82.
25. REICHERT, I. 1953. Xyloporosis in citrus. Rept. 13th. Intern. Hort. Congr. (London) 2: 1275-1280.
26. REICHERT, I. 1959. A survey of citrus disorders in the Mediterranean area, p. 23-28. *In* J. M. Wallace [ed.], Citrus Virus Diseases, Univ. Calif. Div. Agr. Sci., Berkeley.
27. REICHERT, I., and BENTAL, A. 1961. On the problem of xyloporosis and cachexia diseases in mandarins. Plant Disease Reptr. 45: 356-361.
28. SALIBE, A. A. 1965. A quick field test for xyloporosis virus, p. 95-98. *In* W. C. Price [ed.], 3d Conf. Intern. Organization Citrus Virol. Univ. Florida Press, Gainesville.
29. SALIBE, A. A., and MOREIRA, S. 1965. Reaction of types of citrus as scion and as rootstock to xyloporosis virus, p. 70-75. *In* W. C. Price [ed.], 3d Conf. Intern. Organization Citrus Virol. Univ. Florida Press, Gainesville.