The Mystery of Florida's Citrus Canker

Scientists haven't seen this bacterial strain before, but it's already led to the destruction of millions of seedlings

Winter Haven, Florida. In late August, at Ward's Nursery located about 50 miles south of here, a foreman spotted diseased leaves on citrus seedlings. A state agricultural official concurred that the mottled brown lesions were worrisome and worth investigating. On 28 August, samples of the leaves were taken to Orlando to a meeting of senior state officials. Calvin Schoulties, the state's chief plant pathologist, and his colleague John W. Miller, peered through the double layers of plastic bag and examined the lesions. What they saw was unfamiliar.

The spots were smooth and dark brown surrounded by a narrow yellow halo, characteristics that are similar to fungal disease. But they also noticed that the lesions were "oozing," Schoulties says, which raised the possibility of canker, a bacterial disease that devastated the Florida citrus industry 70 years ago. But if it was canker, according to Miller, who is an expert on this plant disease, the lesions should have been "raised, rough, scabby, and light tan." The citrus leaves were rushed to the state laboratory in Gainesville for analysis. As a precaution, the state placed a quarantine on Ward's, one of the state's largest nurseries, barring shipment of any seedlings from the premises. Three days later at the state laboratory, bacterial colonies appeared on petri dishes—yellow ones that are typical of canker microbes. The bacteria were then inoculated onto grapefruit seedlings in the laboratory. By Labor Day, the worst fears of Ward's and state officials were realized. The unusual lesions appeared on the test seedlings, confirming that the bacterium was *Xanthomonas campestris* pv. *citrii* or the canker microbe.

Now, nearly 1 month later, six nurseries where canker was found have been completely torched. Federal and state officials and the citrus industry are feverishly working to track down the thousands of other seedlings sold from these six nurseries to Florida groves. All these seedlings and plants within a 125-foot radius will have to be burned.

Every morning at 8 o'clock, dozens of state and federal biologists gather at state headquarters here and then fan out across central Florida searching for canker. The disease can cause defoliation, premature fruit drop, disfigurement of fruit, and eventual death of the trees, but does not affect humans or animals. The only way to eradicate the disease is to burn the contaminated plants, the same method used in the 1920's epidemic that led to the destruction of 20 million seedlings and mature trees.

Although eradication is the primary and immediate goal of the citrus industry and government, the mystery about the Florida outbreak remains. According to federal and state plant pathologists, the Florida canker bacterium is very different from any other variety studied thus far. Furthermore, it is unclear how Ward's became contaminated with canker. The answers to these questions are important so that the authorities can assess whether present state and federal inspections at U.S. borders need to be tightened and how to prevent the contamination from occurring again. Florida state agriculture commissioner Doyle Conner blamed the canker problem on the transport of tainted plant material into the United States, but federal and state scientists say it is impossible at this point to pinpoint the origin of the epidemic.

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There are two things that Florida citrus growers dread most—cold and canker. For the past 3 out of 4 years, cold snaps have killed millions of trees here. Now the industry has been hit with canker as well. "They got the double whammy," said plant pathologist Dennis Mayhew, who is one of several California state scientists helping out in Florida.

So far, all 157 of the state's registered nurseries have been inspected and only six have shown contamination. The bacteria have not been found in any citrus groves. If no further contamination is found, the canker problem will probably not affect this season's shipments of citrus either to market or for processing into juice. (The canker outbreak has occurred early in the harvest season, which may minimize economic losses for the citrus growers. Fruit is now being shipped to other non–citrus-producing states after being dipped in a chlorine solution. Intrastate movement of fruit has been banned to prevent the spread of the canker.)

Canker, however, has exacerbated a long-term problem. Bobby McKown, executive vice president of the Florida Citrus Mutual, the growers' trade association, says that between now and next summer, grove owners need 10 million seedlings to begin rebuilding their stock killed by the cold. The discovery of canker has already led to the destruction of 2.5 million to 3 million seedlings, which represents about 21 percent of the total nursery stock in the state, according to Florida agriculture official Charles Youtsey. To compound the supply problem, federal officials have barred the nurseries that received stock from Ward's from shipping any seedlings or cuttings for a year and also ordered the land where seedlings were burned to lie fallow for 2 years. According to the U.S. Department of Agriculture (USDA), the bacteria may survive on branches and in the bark for at least 3 years.

Federal and state scientists are trying to characterize the Florida canker variety in order to trace its origins, but are having little luck. Several tests show that the Florida canker is unlike the four other known varieties of citrus canker organism, which have different virulence and host preferences. Citrus canker is endemic to Asia, particularly China and Japan, and South America, especially Brazil, Argentina, Paraguay, and Mexico. The A strain (A for Asiatic) is most virulent to grapefuit and causes defoliation; the B strain damages lemons; the C strain affects only Key limes and sour oranges; and the Mexican strain, which may be a B strain, causes disease in Key lime trees but does not affect the fruit.

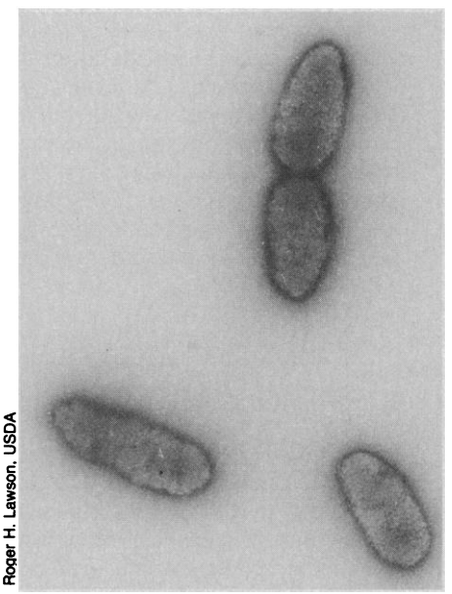
Four different tests have revealed that the Florida canker bacterium is a cousin, but not a twin to the other four varieties. According to Edwin Civerolo, a USDA research plant pathologist and a citrus canker expert, an antiserum test showed that the Florida isolate was a canker bacterium, but one unlike the other strains. According to a bacteriophage test, the Florida strain was not an A type. Civerolo analyzed the plasmids of two canker samples from Japan, one from Brazil, and one from Argentina. "The Florida strain was different," Civerolo said in an interview. "It doesn't even have any plasmids." An analysis of the fatty acid composition of the various strains also shows that the Florida strain is unique.

While other strains are choosy about host plants, the Florida bacterium has hit a wide range of citrus varieties, including grapefruit seedlings, at least four sweet orange varieties, and root stock. Scientists are not sure whether the bacterium can damage lemon and lime trees or whether it will damage fruit. The Florida strain may not damage fruit. On 6 September, various greenhouse trees with citrus fruit were inoculated with the bacteria, but to date, the fruit has not shown ill effects, according to state pathologist John Miller. The Florida strain appears to grow rapidly. Three days after the nursery foreman at Ward's discovered the diseased leaves, the bacteria had spread with remarkable speed to other parts of the nursery.

USDA investigators at first speculated that Ward's might have received diseased stock from another source, but they have now eliminated this possibility, according to federal official Theodore Boratynski, who is in charge of investigating Ward's Nursery. Nursery owner Franklyn Ward is known among Florida citrus growers as a "nurseyman's nurseyman." It was Ward's father, in fact, who established the use of pedigree trees to produce seedling stock after canker hit the Florida industry in 1913. That outbreak, which spread to other citrus-producing states, was traced to the importation of diseased plants from Japan. It took 14 years to eradicate the disease from Florida.

Boratynski says that Ward's has kept impeccably thorough records, which show that the nursery obtained certified budwood or cuttings from the Florida state agriculture department. Two seed sources were checked and given a clean bill of health. The pedigree trees at Ward's nursery were also canker-free. Boratynski is now concentrating on the possibility that nursery personnel may have somehow introduced the bacteria into the area and that nursery farming practices, such as cultivation or pruning, may have fostered the spread of the organism.

The elimination of citrus canker is a frustrating operation. Burning is the only sure method of eradication. Bactericides are limited in their effectiveness against canker as with other microbial plant diseases and are used in conjunction with other measures, including copper sprays. Antibiotics are of limited use because of their expense and the development of drug resistance by the bacteria.



Roger H. Lawson, USDA

Xanthomonas campestris *pv.* citri

Photomicrograph of the canker-causing bacterium isolated from Florida citrus seedlings.

The handful of American scientists who have studied canker have had to do so largely overseas. Florida citrus growers, mindful of the 1913 epidemic, have consistently protested proposals by scientists to study canker in Florida laboratories out of fear that the bacteria might inadvertently escape from the laboratory and into the groves. Civerolo has conducted tests on canker because his laboratory in Beltsville, Maryland, is located in a non–citrus-producing area.

He and several Florida scientists extensively studied canker in a cooperative program between USDA and Argentina for several years, beginning in 1978. (Argentina continues to battle citrus canker, despite efforts to control the bacteria.) Out of that experience, the federal government developed in 1982 a contingency plan in the event of a canker outbreak here. As a result, government officials were able to move swiftly last month after the appearance of canker was confirmed.

State and federal officials are now debating whether inspections at American borders are sufficient to prevent the entry of contaminated plants. The United States prohibits the import of growing stock except for the purposes of research. Even so, the plant material is quarantined and subjected to extensive testing before it is released to scientists for study. Nevertheless, the system was breached somehow, state agriculture commissioner Conner believes. At a special hearing on 1 October in Orlando, Conner told U.S. Senator Paula Hawkins (R–Fla.) with frustration, "Canker didn't just decide to pick up and fly here to Florida. It hitchhiked here. Somebody brought it here."

USDA officials testified that inspectors at major airports have repeatedly seized fruit and plants carried in by passengers but concede that the system is not foolproof. At the Los Angeles airport, USDA officials are now relying on beagles—described at the hearing as a "nonaggressive dog"—to sniff out plants and fruit packed in incoming baggage. (When the beagle smells success, it sits down.)

Conner wants more crackdowns. "We learned that we're vulnerable. We need to tighten up at the borders." This call for tighter controls may be sensible, but it may not be relevant to the current canker problem, says USDA's Civerolo. This canker strain is unlike anything else scientists have seen.

And questions about the future are unanswered. For instance, federal crop insurance does not cover the losses of the six nurseries. According to USDA officials, federal insurance only covers damage from "peril," such as hail or floods, but not losses from bacterial disease. At a time when the citrus industry is in dire need of more seedlings, Conner is urging USDA to compensate the nursery owners. He noted that the federal government helped to bail out poultry farmers when avian flu struck last winter. But federal officials noted that even if USDA declared canker to be an "extraordinary emergency," compensation would not be retroactive. Two Florida state legislators have introduced a bill that would place a special tax on citrus growers to compensate the nursery owners.

In the meantime, scientists say that tracing the origin of the canker will take a lot more work. Civerolo predicts that characterization of the bacteria may take up to 2 years and even then, he says, the ultimate source may never be known.

—MARJORIE SUN