Wineries in California have been under siege for decades. There’s finally hope that grapevines can be saved from bacterial disease

In 1961, Adam Tolmach planted a five-acre vineyard on land he had inherited from his grandfather in the wine-growing region of Ventura County, California, a few miles east of Santa Barbara. As an undergraduate, Tolmach had studied grape growing and winemaking (areas of study known as viticulture and enology, respectively) and then worked for a couple of years at a winery not far from his grandfather’s land. In 1983, he started producing his own wines, which he sells under the Ojai Vineyard label.

Over the years, Tolmach’s grapevines began to suffer. The plants lost vigor and the leaves dried. It turned out the vineyard was affected by Pierce’s disease, a sickness that had long plagued southern California, but had become more severe in the 1990s after the invasion of the glassy-winged sharpshooter, a large leafhopper insect that feeds on plant fluids and can spread a bacterium known as *Xylella fastidiosa*, usually just called *Xylella* (pronounced zy-LEL’-uh). This bacterium has existed in the United States since as far back as the 1880s, and over the years, it has destroyed at least 35,000 acres of the nation’s vineyards.


Adam Tolmach. Credit: Ojai Vinyard

Tolmach witnessed the slow but certain death of his grapevines. By 1995, there were just too many missing plants, he said. So he decided to pull out the infected vineyard. To continue making wine, he bought grapes from other producers. Tolmach became a winemaker with no vineyard of his own.

Every year, American winemakers lose about $56 million worth of vines, while government agencies, nurseries, and the University of California system invest another $48 million in prevention efforts, according to research published in the journal California Agriculture. At least 340 plant species serve as hosts to *Xylella*, though the bacteria only harm some of them. Across the globe, *Xylella* has devastated orange trees in Brazil and olive fields in southern Italy, and recently a newly identified species, *Xylella taiwanensis*, has been infecting pear trees in Taiwan. As of now, there is no permanent solution. Each time a *Xylella* species has invaded a new region, it has proved impossible to eradicate.

Countries have long fretted about the potential for infected plant imports to spread the bacteria, and more recently, climate change has been identified as an additional threat, pushing the disease vectors' habitat north, both in Europe and in the U.S. As winters become warmer, experts say, *Xylella* could enter new territories, upending their regional economies and landscapes.

Yet there might be some hope. After 40 years of crossbreeding European grape varieties with wild grapes, a plant geneticist recently patented five hybrid grapes that appear to be resistant to Pierce's disease. While scientists caution that it's not yet clear how long the resistance will endure, wine producers like Tolmach hope that these new grapes will allow their vineyards to flourish once again.

A variety of grape species are indigenous to America, and a recent study suggests that Native Americans might have used them to make alcoholic beverages more than 500 years ago. In North America, native varieties tend to have thick skin and an astringent, peppery, acidic taste that is quite different from the grapes used in most wines.

In the 1500s, Spanish settlers brought *Vitis vinifera*, the common European grapevine for winemaking, to Florida. Farmers never succeeded in cultivating European grapes in the new territory — after a few years, the plants would just die. Then, in the 1860s, the Los Angeles Vineyard Society led grape-planting efforts in the Santa Ana Valley. By 1883, there were a total of 50 wineries and 10,000 acres of grapevines. Then, just a couple of years later, the grapevines had all died inexplicably.

In 1889, the U.S. Department of Agriculture instructed one of the first formally trained American plant pathologists, Newton Pierce, to figure out what was killing the European grapevines. Pierce studied the disease, eventually speculating that it was caused by a microorganism, but he never identified one. Still, in recognition of his effort, the disease was eventually named after him.

In the 1970s, a University of California, Berkeley entomologist named Alexander Purcell helped solve the mystery. At the time, researchers were beginning to think Pierce's disease was caused by bacteria but had yet to pin down a culprit. Purcell and his colleagues proved the then-unnamed *Xylella* was responsible by growing the bacterium from samples taken from plants infected by blue-green sharpshooters, and then directly infecting healthy plants with the lab-grown pathogen. Over time, a more complete picture of disease transmission emerged.

The glassy-winged sharpshooter feeds on the green stems and leaves of grapevine plants, which contain water and dissolved nutrients, Purcell told Undark. If the plant is infected with *Xylella,* some of the bacteria linger in the insect's needle-like mouthparts. The next time the glassy-winged sharpshooter feeds upon a grapevine, the insect can transfer the *Xylella* to the new plant. Inside the plant's vascular tissues, the bacteria multiply, obstructing the normal flow of water and nutrients and interfering with the plant's metabolism and physiology — a process that ultimately kills the plant.

In the late 1980s, Purcell mapped swaths of the U.S. and Europe by how conducive they are to disease spread. Knowing that *Xylella* do not thrive in regions with cold winters, that are far from large bodies of water, and that lack a disease-carrying vector such as the glassy-winged sharpshooter, Purcell drew out maps by hand. He then marked the regions with the right combination of geographic and climatic conditions to allow for Pierce's disease to spread, noticing a pattern emerge.

At the time, the European Union was not very concerned about *Xylella*, though Purcell contends that the bacteria had almost certainly arrived in the region. In talks and at conferences, he warned that European countries were facing a great danger. He urged the E.U. to increase its regulations of plant imports. Those warnings went unheeded, Purcell said, and in 2017, Pierce's disease was first detected on the grapevines of the Spanish island of Mallorca, jeopardizing the future of winemaking there. Today, *Xylella* is spreading through the Mediterranean region and other parts of Europe — just as Purcell predicted.

The glassy-winged sharpshooter spreads Xylella bacteria when it feeds on the vascular tissues of plants. Credit: Courtesy of University of California, Riverside

Alberto Fereres, a Spanish entomologist and researcher at the Spanish National Research Council, is concerned about the devastating effects of the European outbreaks, including one in southern Italy that has infected and killed 20 million olive trees, more than a third of the region's population. "[*Xylella*] is present in many more countries than we indeed thought," Fereres said, adding that his research group recently discovered that the bacteria have been present in Spain for more than 20 years, but for much of that time it only lived in plants that don't show symptoms of the disease.

Fereres hopes at least some plants will adapt to the presence of the bacteria and that farmers will be able to control the indigenous European vector, the meadow spittlebug, by tilling the land to kill the bug's juveniles and placing barriers or nets to separate the insects from susceptible plants.

So far, the U.S. has largely used insecticides to get rid of infected insects. The Temecula Valley in California, for example, experienced a severe outbreak of Pierce’s disease in the late 1990s. Back then, stakeholders managed to defeat the disease in less than two years by introducing specific pesticides into the farming of grapevines.

Matt Daugherty, an entomologist at the University of California, Riverside, studied the resulting decline in Temecula’s glassy-winged sharpshooter population. He said the insect’s numbers remained low until around 2017, when the population exploded for a second time.

“Now the bad news is this,” Purcell said: “After about 18 years, the insect is now resistant to the insecticide.” In entomology, Purcell added, such resistance is common if the same insecticide is used year after year. He and Fereres maintain that pesticides are not a viable long-term solution to the problem. In some countries, this approach has also run up against public opinion. In Italy, for example, consumers have strongly opposed the use of pesticides on olive trees threatened by *Xylella*.

Rodrigo Almeida, a plant pathologist at the University of California, Berkeley, warns that climate change might worsen the situation: While low winter temperatures in many grape-growing regions have traditionally limited the spread of Pierce’s disease, the past few years have brought warmer winters, allowing *Xylella* to spread.

“With warming temperatures and warmer winters, you’re going to have sort of more disease where you already have it, and you’re probably going to see the range expand north as well,” Almeida said. Warmer temperatures favor greater survival of the insects and increase the likelihood that an infection will persist through the winter. Almeida added that it’s difficult to predict precisely how much the disease will increase and how it will impact the new territories, but that there is the possibility that the disease will find a home in areas where a dry climate combines with warmer winters.

“We’re expecting things to get worse and worse,” Daugherty said.

Yet, in territories where European grapes die because of *Xylella*, wild indigenous grape varieties that are not a good fit for winemaking thrive. Those plants bear a unique gene that prevents them from succumbing to the disease, and that specific gene could be a counteroffensive to the bacteria and might well change the future of winemaking.

In 1989, University of California, Davis plant geneticist and viticulturist Andrew Walker inherited grapevine seeds that he was told were produced from crossbreeding two known *Vitis* species. But as the plants grew, he soon noticed they were behaving weirdly. For one thing, their vines had sprouted fine hairs along the stems. More importantly, the plants proved resistant to Pierce’s disease. Walker decided to investigate. Perhaps, he speculated, the parent plants, which were still flourishing in an abandoned vineyard owned by his university, had accidentally crossbred with the native grapevines that were growing wild nearby.

Indeed, this turned out to be the case. *Vitis arizonica* grows wild in the southwest U.S. and Mexico, and Walker matched the genetic fingerprint of the male *V. arizonica* in his own plants. The wild plant carries a dominant gene that passes along Pierce’s disease resistant traits to its offspring.

Sensing that this could lead to breakthrough for new varieties of grapevine, Walker began the slow process of crossbreeding. This technique goes back about 10,000 years and involves selectively breeding plants and animals with desired traits. In this case, Walker wanted to cross disease-resistant *V. arizonica* with winemaking varieties like cabernet sauvignon.

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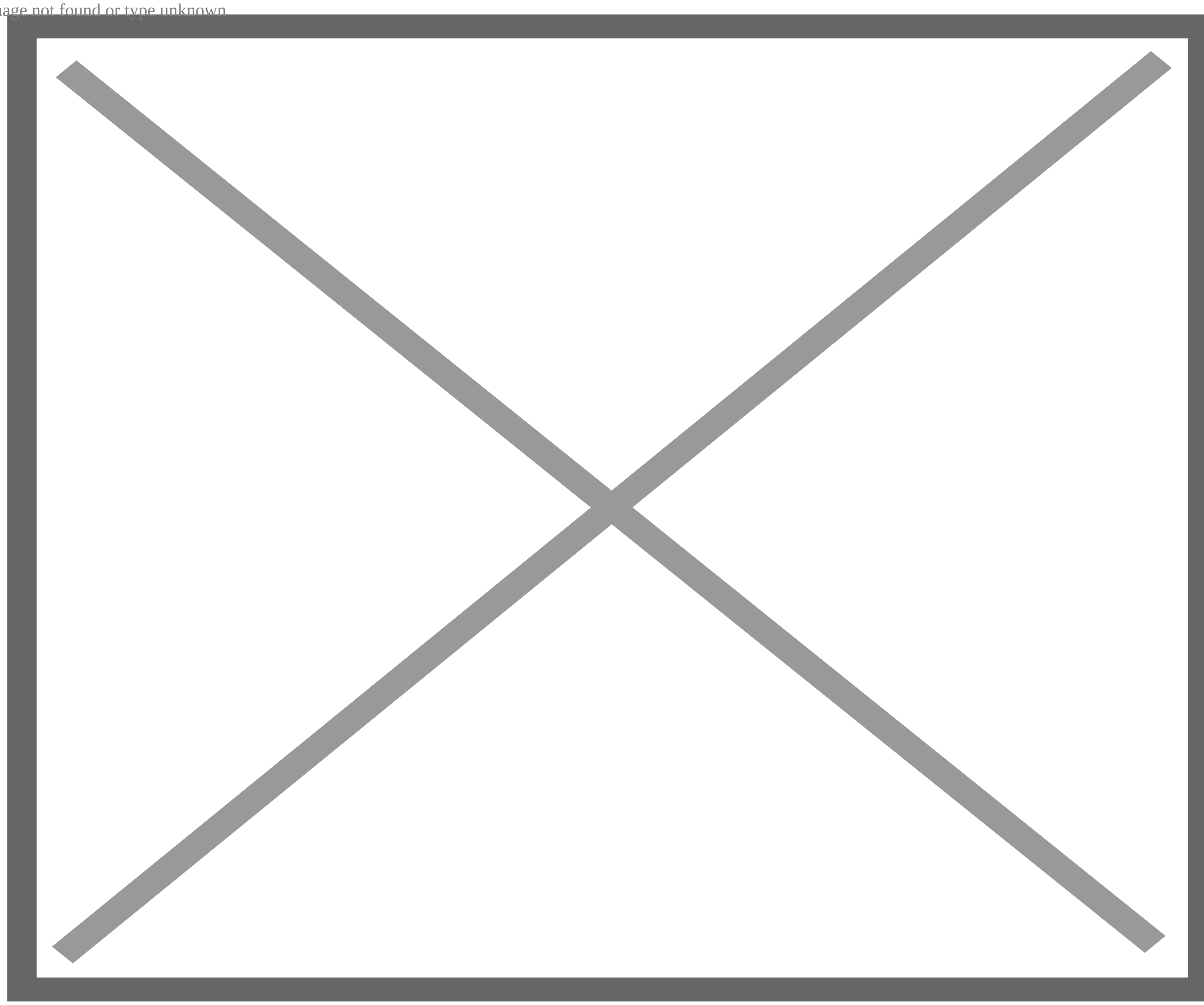

A grapevine leaf affected by Pierce's disease. As the plant's vascular structure is obstructed by bacteria, the flow of water and nutrients is impeded, and the leaves become brown and dry. Credit: Agricultural Research Service/USDA

The first generation's seedlings all carried the gene for disease resistance. Walker selected the highest quality among them, and when the plants flowered, he crossed them again with various *V. vinifera* varieties. He did this for four to five generations, reaching a point where 97 percent of the plant's genome came from *V. vinifera* and 3 percent came from *V. arizonica*. It took Walker about 20 years to develop these new plants, five varieties of which have been patented and given out to a few producers, and sold through a handful of nurseries. Tolmach, the winemaker from Ojai, was one of the few lucky ones to receive them.

“I guess what's shocking to me is that the quality is there — these can be standalone wines by themselves,” said Tolmach. In 2017, he planted about 1,800 plants on 1.2 acres with four of Walker's varieties, and he recently bottled the 2019 vintages. (These vintages won't be available until this fall, when they will be priced between $30 and $40 per bottle, which is comparable to his vintages that use traditional grapes.) Tolmach said that his new plants are healthy and thriving with no sign of the disease, and he's now thinking of planting more on a 10-acre vineyard that he purchased in northern Santa Barbara County.

Matt Kettmann, a California writer and wine critic who has been following Tolmach's work for years, tasted Tolmach's wines produced with resistant grape varieties. He said they are unique and interesting wines with characteristics reminiscent of wines of European heritage. He described Tolmach's 2019 wine using Walker's paseante noir grape as tasting of “black cherry, mocha, clove, baking spice,” while praising its “smooth texture and rich mouthfeel.” “That one,” said Kettmann, “was really kind of impressive to me.”

Kettmann anticipates that the new wines will be appreciated by connoisseurs, but he wonders how the larger American market will respond. Europeans emphasize the value of terroir — the taste imparted to a wine by a particular region's soil, topography, and climate. Americans, on the other hand, tend to care more about the variety of the grape, like pinot gris, cabernet sauvignon, or zinfandel — and Walker's varieties are entirely new.

“Tradition is a huge consideration in choosing wine varieties for winemaking. Can you name any new grape varieties introduced during the last 50 years that are now widely used for wine?” wrote Purcell in an email.

It's also not clear whether new genotypes of *Xylella* might evolve to infect the hybrid grapes, Purcell and Fereres wrote to Undark. Currently, only a single gene confers the resistance. For this reason, it might be necessary to incorporate new resistance genes by crossbreeding additional varieties of grapevine, said Purcell.

Still, growers like Tolmach are excited by Walker's resistant varieties, and some are planting them in areas that have been impacted by *Xylella,* Walker said. Though Tolmach has made wines with the new grapes exclusively, he suggests many wineries may opt to blend the grapes with other mainstream varieties.

For his part, Walker believes that any skepticism about his grapes' novelty will fade in the face of climate change. "It is going to force people to reevaluate how we improve grapevines," he said.

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