Invasive forest insects and pathogens: Past, Present, and Future

BY ELLEN MICHAELS GOHEEN

In 2010, forest pathologists will ***NOT*** be celebrating the 100th anniversary of the arrival in western North America of *Cronartium ribicola*, the invasive fungus that causes white pine blister rust. Instead we will only be reminded of the continuing destruction and damage that invasive species have on our environment and economy.

An invasive species is federally defined as a "species that is non-native (or alien) to the ecosystem under consideration and whose introduction causes or is likely to cause economic or environmental harm or harm to human health." Invasive species have been characterized as "catastrophic wildfires in slow motion" because of the massive disruptions in ecosystem function, reduced biodiversity and the degradation of urban landscapes, forests, prairies, wetlands, rivers, and oceans that they cause.

Private landowners and small communities are often some of the hardest hit by invasive species. Most people think that invasive species must come from a foreign country or different continent, yet organisms "arriving and settling in" from other parts of the U.S. can be just as devastating as those coming from across the ocean. The pitch canker fungus, which threatens California's small and isolated populations of Monterey pine, came to the west from the southeastern U.S. Evidence is suggesting that a new-to-California (2004) woodboring beetle, the golden spotted oak borer, which is currently causing substantial mortality of California black oak, canyon live oak, and coast live oak in forest and woodland settings in San Diego County, arrived in California on firewood from Arizona, where this beetle is native.

Southwestern Oregonians are no strangers to dealing with invasive species in the form of vascular plants; we've fought and will continue to fight the good fight against yellow star thistle, puncture vine, and many other noxious invasive plants. What is not well publicized though, is the substantial impact that non-native forest insects and pathogens have had, are having, and will certainly continue to have in southwest Oregon's forests.

The impact of native bark beetles is also a very important issue here. Native pathogens such as dwarf mistletoes and several fungi that cause root diseases can severely impact species composition, stand structure, and ecological function over time in our forests. This is especially true in light of human-influenced changes in ecosystem processes, such as reduced stand diversity through single-species planting or the impacts of fire exclusion. Yet the staff at the Southwest Oregon Forest Insect and Disease Service Center, which has served all federal land managers since 1994, has spent roughly 80 percent of staff time on three invasive pathogens: *Cronartium ribicola* (the cause of white pine blister rust), *Phytophthora lateralis* (the cause of Port-Orford-cedar root disease), and *Phytophthora ramorum* (the cause of sudden oak death) and only 20 percent on the natives.

Why are invasive insects and pathogens so bad? Their small or microscopic nature makes them difficult to detect and they often reside deep in wood. Damage may not be noticed until populations are established. Symptoms of infection may be masked by use of chemicals; "healthy-appearing" plants that are infected may pass visual inspections. Insect and pathogen biology may not be well known in their country of origin, making successful treatments subject to trial and error. Natural controlling processes and limiting factors that keep them in check may not be present in their new environment. Native organisms may serve as efficient vectors of non-native ones. And, the short generation time of many invasives may facilitate processes such as genetic mutation and hybridization.

THE LEGENDS

Chestnut Blight. Few people interested in forests and forestry issues have not heard about how the fungus causing chestnut blight, arriving from Asia into New York in 1904 via one shipment of chestnut nursery stock, changed forever the hardwood forests of the east coast and was the force behind the Plant Quarantine Act of 1912. It took 15,000 years for American chestnut to attain its post-glacial range from Georgia to Maine; it took only fifty years for chestnut blight to spread through the same area. What many people are not aware of is that another invasive root rot pathogen, *Phytophthora cinnamomi*, arrived in the southeastern U.S. in 1824 and had already killed chestnut at a landscape scale in the moist lowland forests of the south before the chestnut blight even started. The two invasive pathogens together virtually wiped out American chestnuts.

Dutch Elm Disease. Seventy million American elm trees died between the 1920s and the 1970s, when the pathogen causing Dutch elm disease arrived on elm logs. Urban, suburban, and rural landscapes were significantly altered. Dutch elm disease was first reported in Oregon in 1973; more recently it has caused the removal of numerous elms from urban parks and streets in the Rogue Valley. In a twist of nature, the Dutch elm disease fungus mutated on American trees and a new, much more damaging strain was accidently sent back to Europe, causing another extensive wave of mortality there.

European Gypsy Moth. Perhaps most famous in the history of invasives is the story of European gypsy moth, brought by design to Massachusetts in 1869 to start up an American silk industry which didn't quite work out. The moths were freed and began defoliating eastern forests at a great rate. Hundreds of millions of dollars have been spent to slow the spread of gypsy moth from east to west and to eradicate isolated gypsy moth populations, particularly those that show up in western states. The gypsy moth is an extremely successful hitchhiker. Its egg masses are frequently moved long distances on vehicles or household articles. Thanks to an elegant trapping and survey system used diligently by western state Departments of Agriculture, new arrivals of moths can often be pinpointed down to the offending wheel well or recently-transported backyard birdbath, and eradication efforts can be kept to very small areas. In 2006, as an example, 66 gypsy moths were caught in Oregon, most of them in Bend. As they investigated further, Oregon Department of Agriculture personnel found out that the Bend infestation had arrived from Connecticut in a 1967 Chevy purchased through an internet auction site! Despite several introductions in recent years (Central Point, Ashland, Shady Cove), European gypsy moth has not become established here thanks to timely detection and treatment.

THE PRESENT

White Pine Blister Rust. White pine blister rust is now a well-established disease in southwestern Oregon, and has killed and continues to threaten five-needle pines (western white pine, sugar pine, and whitebark pine) growing on moist, high hazard sites. The fungus causing the disease was introduced to the west coast on one shipment of eastern white pine seedlings from France offloaded in Vancouver, British Columbia in 1910. It quickly spread throughout the western range of western white pine and was first described on sugar pine in Oregon in 1936. Although evidence was that the pathogen had been there on that host for several years previously it is a more recent invader of our high-elevation whitebark pines. It is difficult to quantify the damage that blister rust has caused in our area because of lack of background information on historic population levels of five-needle pines. However, we know that impacts have been and continue to be huge. Current surveys show that in southwest Oregon, 20 percent of our sugar pines, 30 percent of our western white pines, and 52 percent of our white bark pines are infected by the blister rust fungus. Only active management will protect and restore five-needle pines in southwest Oregon. A program was begun in the 1950s to identify potentially disease-resistant five needle pines. Planting resistant stock mixed with other species on appropriate sites in concert with management activities such as pruning is now the foundation for the restoration strategy for five-needle pines.

Whitebark pine killed by white pine blister rust.

Port-Orford-cedar Root Disease. Port-Orford-cedar is an extremely valuable tree both from an economic and ecological perspective. Not only has it commanded some of the highest prices ever paid for the wood of a conifer, its role as a riparian species that provides stream shade and large wood structure and its unique ability to grow and attain large size on ultramafic soils make it a critical ecological resource. Port-Orford-cedar's native range is limited to a relatively small area in southwest Oregon and northwest California. What is now known as Port-Orford-cedar root disease was first described on ornamental Port-Orford-cedar nursery stock being grown near Seattle in 1923. The causal pathogen, *Phytophthora lateralis*, was described on ornamental Port-Orford-cedars in the Willamette Valley in 1948. It was first found in the native range of Port-Orford-cedar near Coos Bay in 1952. Where it originally came from and how it got to Seattle and then Oregon is unknown. Although interest in Port-Orford-cedar and its Asian cousins as valuable nursery stock was high in those early years, the nursery trade is a likely pathway. Unfortunately, the pathogen virtually eliminated Port-Orford-cedar as a nursery commodity. Moved by water and in soil organic matter, the pathogen quickly spread in the wild and now occurs on about 25 percent of high-risk sites (low-lying areas, streams, wet drainages) through most of Port-Orford-cedar's native range in Oregon. On such sites, the disease causes extensive mortality, especially of the larger host trees. In the 1990s a breeding program was begun to identify naturally resistant Port-Orford-cedars. 12,500 apparently resistant trees have been tested and about two percent have been proven to have usable resistance to the disease. Planting resistant trees on appropriate sites, combined with such management techniques as preventing or regulating access into uninfested areas, careful scheduling of activities in Port-Orford-cedar areas, vehicle washing, and favoring Port-Orford-cedar on low-risk sites (areas away from roads and streams, upland sites, well-drained areas) are key to maintaining the species.

Symptoms of P. ramorum infection on tan oak leaves.

Sudden Oak Death. An unprecedented level of mortality in tanoaks and coast live oaks was first described in Marin County, California in the mid 1990s and coined "sudden oak death" because of the apparently rapid death of affected trees. The causal pathogen, *Phytophthora ramorum*, was identified in 2000. *Phytophthora ramorum* has since spread into 14 coastal California counties from Monterey to Humboldt. Millions of oaks and tanoaks have been killed in California. In some watersheds, 90 percent of the tanoaks are dead. Sudden oak death was confirmed in Oregon, just outside of Brookings in Curry County in 2001, where its main host is tanoak. It is also present in nurseries throughout Europe and in nurseries and some woodlands in the United Kingdom.

New to science and of unknown origin, *P. ramorum* causes mortality of oaks in the red oak group, mortality of tanoaks, and branch and twig dieback and leaf blights on more than 100 other plant species. Its hosts include many common woodland understory species and several extremely popular nursery-grown landscape plants. Unlike *P. lateralis, P. ramorum* is an above-ground pathogen infecting leaves, twigs and stems. While it can survive in organic matter in the soil for at least several years and has been shown to be moved in soil, its spread is predominantly aerial. Favored by moist conditions, spores are moved from canopy to understory by rainfall and rain drip, can be picked up in wind-driven rain and clouds, and can occasionally move as far as three miles. Very long distance spread via nursery plants has occurred across the US and across countries in Europe.

Phytophthora ramorum is subject to both federal and state regulations. Nurseries in Washington, Oregon, and California must be inspected for the presence of the pathogen. Those that ship out-of-state are inspected more

See INSECTS, page 19