FOREST PEST SPECIES PROFILE

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Phytophthora ramorum S. Werres, A.W.A.M. de Cock & W.A. Man in't Veld

Other scientific names:
Phylum, Order, Family: Oomycota: Pythiales: Pythiaceae
Common names: sudden oak death (SOD); sudden oak death syndrome (SODS); ramorum blight; ramorum dieback; ramorum leaf blight; ramorum shoot blight

Phytophthora ramorum causes a very serious disease called sudden oak death which causes extensive mortality of tanoak and oaks. It is also associated with disease on ornamental plants and other broadleaf and conifer trees. This pathogen has been a significant problem in North American and European forests and nurseries.

Cankers and bleeding on coast live oak (*Quercus agrifolia*) resulting from *Phytophthora ramorum* infection (Photos: Joseph O'Brien, USDA Forest Service, Bugwood.org)

DISTRIBUTION

The geographic origin of *P. ramorum* is unknown; it is believed that it has been introduced independently to Europe and North America from an unidentified third country.

North America: Canada (nursery report now eradicated); USA (14 counties in coastal California, one county in southwest Oregon)

Europe: Nursery reports only from Belgium, Denmark, France, Germany, Ireland, Italy, Norway, Poland, Slovenia, Spain, Switzerland, and Sweden. Nursery as well as wildland reports from the Netherlands and the United Kingdom.

IDENTIFICATION

In culture, *P. ramorum* hyphae are highly branched, contorted and dendritic (GISD, 2007). Chlamydospores are mostly terminal occurring on hyphal tips, 22 to 72 µm in length and at first are translucent but darken to a cinnamon brown colour (Kliejunas, 2001; GISD, 2007). Sporangia are oval-shaped, semi-papillate, deciduous and 30-90 µm in length (Kliejunas, 2001; GISD, 2007).

HOSTS

In the US, *Phytophthora ramorum* attacks a variety of tree species including coast live oak (*Quercus agrifolia*), California black oak (*Q. kelloggii*), shreve oak (*Q. parvula* var. *shrevei*), canyon live oak (*Q. chrysolepis*) and tanoaks (*Lithocarpus densiflorus*) (Thomas, 2005). It is also known to infect several other plant and tree species such as Pacific madrone (*Arbutus menziesii*), poison oak (*Toxicodendron diversilobatum*), big leaf maple (*Acer macrophyllum*), coast redwood (*Sequoia sempervirens*), Douglas fir (*Pseudotsuga menziesii*), grand fir (*Abies grandis*), rhododendron and azalea species (*Rhododendron*), Pacific huckleberry/evergreen huckleberry (*Vaccinium ovatum*), lingonberry (*V. vitis-idaea*), strawberry tree (*Arbutus unedo*), mountain laurel (*Kalmia latifolia*), manzanita (*Arctostaphylos manzanita*), English yew (*Taxus baccata*), dwarf rose (*Rosa gymnocarpa*), salmonberry (*Rubus spectabilis*), California coffeeberry (*Rhamnus californica*), cascara buckthorn (*Rhamnus purshiana*), beaked hazelnut (*Corylus cornuta*), Victorian box (*Pittosporum undulatum*), California buckeye (*Aesculus californica*), California bay laurel (*Umbellularia californica*), California honeysuckle (*Lonicera hispidula*), toyon/Christmasberry (*Heteromeles arbutifolia*), western starflower (*Trientalis latifolia*), *Syringa* spp., *Viburnum* spp., *Pieris* spp. and *Camellia* spp. (Kliejunas, 2001; EPPO, 2006).

In Europe, *P. ramorum* is mainly found on *Rhododendron* and *Viburnum* species, but has also been isolated from *Arbutus, Camellia, Hamamelis, Kalmia, Leucothoe, Pieris* and *Syringa* species (EPPO, 2006). In the UK, an isolated finding was reported on one *Quercus falcata* tree and on a few trees of *Fagus sylvatica, Quercus ilex*, *Q.cerris, Castanea sativa* and *Aesculus hippocastanum* (EPPO, 2006). In the Netherlands, infections on one *Q. rubra* and two *Fagus sylvatica* have been reported; all were located near infected *Rhododendron* (EPPO, 2006).

An updated list of *P. ramorum* hosts can be found on the USDA's Animal and Plant Health Inspection Service (APHIS) Web site at: www.aphis.usda.gov/plant_health/plant_pest_info/pram/index.shtml

BIOLOGY

Phytophthora ramorum exists as two separate mating types – the A1 mating type (found primarily in Europe) and the A2 type (found primarily in North America) (Kliejunas, 2001). Sexual reproduction can only occur if these two types come together.

Two types of asexual fruiting structures – sporangia and chlamydospores – are produced on the foliage of non-oak hosts (Kliejunas, 2005; DEFRA, 2005a). Infected oak produce few spores while other hosts such as bay laurel and tanoak produce prolific sporulation, and are believed important in the epidemiology of the disease. The sporangia hold and produce zoospores which can swim by means of flagellae. Warm temperatures of approximately 18-20°C and/or a water film facilitate infection. Leaves and twigs then develop black lesions where, in conditions of very high humidity and moderate temperature, new sporangia and chlamydospores are produced typically within two days (GISD, 2007). Chlamydospores form inside the leaf tissue, and provide a resting/survival structure that remains viable in the organic material or soil for over one year. Infectious propagules accumulate in water bodies in the soil beneath the host (GISD, 2007). Infection of the main stems of tanoaks and oaks generally occurs only under high spore pressure, usually provided by nearby sporulation hosts, such as rhododendron or bay laurel (GISD, 2007).

SYMPTOMS AND DAMAGE

Symptoms vary depending on host type. On oaks and tanoak, infection results in stem bark lesions, basal cankers which produce reddish, black or dark brown sappy exudates ('bleeding'), and crown dieback (Kliejunas, 2001; Thomas, 2005). Cankers are typically found on the lower trunk, although they may occur up to 20 m above the ground; they do not extend into the roots below the soil line (Kliejunas, 2001). Branch cankers also occur, especially on tanoak. On tanoak, infection of terminal twigs can lead to tip dieback, leaf flagging or the formation of shepherd's crooks (Kliejunas, 2001). Exudations do not always develop on tanoak, especially on smaller diameter branches. Infected host trees die relatively quickly once crown

symptoms develop although the severity of damage varies considerably between sites. On other hosts, infection typically results in leaf lesions, small branch cankers, and stem and branch dieback (Kliejunas, 2001).

Symptoms of *Phytophthora ramorum* infection on tanoak (*Lithocarpus densiflorus*) and coast live oak (*Quercus agrifolia*) (Photos: Joseph O'Brien, USDA Forest Service, Bugwood.org)

DISPERSAL AND INTRODUCTION PATHWAYS

Phytophthora ramorum is dispersed locally by rain splash, wind-driven rain, irrigation or ground water, soil and soil litter (Kliejunas, 2001; DEFRA, 2005a). The deciduous nature of the sporangia opens the possibility for air dispersal. Bark and ambrosia beetles are commonly found on infected trees but their potential role of vectors has not yet been investigated (EPPO, 2006).

Spread over longer distances occurs through the movement of contaminated plant material, growing media and nursery stock as well as in soil carried on vehicles, machinery, footwear or animals (Kliejunas, 2001; DEFRA, 2005a).

CONTROL MEASURES

Trunk painting with Agri-Fos, a systemic fungicide, has effectively prevented infection on high value trees. This material provides some curative action, if the infection is not too far advanced. An active eradication program, requiring the removal of all host material with a buffer strip of 30 m has greatly reduced the spread of the pathogen in Oregon. In California, and in nurseries, the focus is on preventing the further spread through careful monitoring and detection methods and quarantine procedures.

In natural areas heavily infested with *P. ramorum* eradication is not feasible. Small infestations can be eradicated if the pathogen is detected early enough, by removing all infected or suspect host material, with a large buffer zone, treating stumps to prevent resprouting, and broadcast burning to kill inoculum in the plant debris and leaf litter (COMTF, 2008). In nurseries, the application of fungicides, the planting of host resistant plants and cultural control methods such as pruning, destruction of affected plants, avoiding standing water and careful examination of plants can help to decrease the incidence of *P. ramorum* (DEFRA, 2005b; Benson, 2003).

References

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