



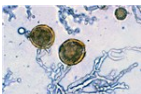


Invasive Species Compendium

Datasheet report for *Phytophthora ramorum* (Sudden Oak Death (SOD))

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Pictures

Picture	Title	Caption	Copyright
	Symptoms	<i>Phytophthora ramorum</i> (sudden oak death (SOD)); aerial stem canker on a tan-oak (<i>Notholithocarpus densiflorus</i>).	©Matteo Garbelotto/U.C. Berkeley, USA
	Symptoms	<i>Phytophthora ramorum</i> (sudden oak death (SOD)); bark seeping on an infected coast live oak (<i>Quercus agrifolia</i>).	©Matteo Garbelotto/U.C. Berkeley, USA
	Symptoms	<i>Phytophthora ramorum</i> (sudden oak death (SOD)); lesions on infected leaves of <i>Umbellularia californica</i> (Oregon myrtle, California bay laurel).	©Matteo Garbelotto/U.C. Berkeley, USA
	Sporangia	<i>Phytophthora ramorum</i> (sudden oak death (SOD)); sporangia releasing zoospores.	©David Rizzo/U.C. Davis, USA
	Chlamydospores	<i>Phytophthora ramorum</i> (sudden oak death (SOD)); chlamydospores..	©David Rizzo/U.C. Davis, USA

Identity

Preferred Scientific Name

Phytophthora ramorum Werres, De Cock & Man in't Veld

Preferred Common Name

Sudden Oak Death (SOD)

International Common Names

English: ramorum blight

Spanish: muerte repentina de los robles

English acronym

SOD

EPPO code

PHYTRA

Summary of Invasiveness

Phytophthora ramorum is considered an invasive species due to its ability to spread, persist, and reproduce in new environments. Its rapid life-cycle, propensity to reproduce asexually and splash dispersal via windblown rain, plus its ability to survive through harsh climatic conditions, are elements favouring this species' potential invasiveness. Spread potential in forests has been elucidated by several studies in California and Oregon employing population genetics approaches. Results have consistently shown that scale of spread of naturalized endemic pathogen populations in natural ecosystems is limited to a few hundred metres and, occasionally, during extremely wet years, spread may reach a few (3-5) km (Mascheretti et al., 2008; Mascheretti et al., 2009; Eyre et al., 2013). Spread events at scales larger than those reported above appear to be associated either with the movement of infected plant parts, normally from large wild infestations, or with the introduction of infected plants, normally from infested ornamental nursery plant stock (Croucher et al., 2013). Spread scales from the hundreds of metres to the few kilometres apply to pathways that involve only foliar hosts, in particular California bay laurels and tanoaks, and are clearly positively correlated with rainfall (Eyre et al., 2013). However, spread from foliar hosts such as California bay laurels, tanoaks and ornamental rhododendrons to stem hosts such as oaks and tanoaks occur at the much lower scale of 10 to 20 metres and are strongly associated with the occurrence of episodic and above average rainy years (Cobb et al., 2012; Garbelotto et al., 2017). Given the limited spatial scale of dispersal of *P. ramorum*, its spread is strongly driven by structure and composition of individual forest stands and is projected to increase as the density of infectious foliar hosts increases (Cobb et al., 2010; Meentemeyer et al., 2015). Monocultures of Japanese larch in the UK, stands with high proportion of tanoaks in Oregon and California, and oak woodlands with an abundance of California bay laurels have all been the hardest hit systems. Presence of contiguous forests (Condeso and Meentemeyer, 2007), genetics of host populations (Dodd et al., 2005; Hayden et al., 2011), microclimate (Anacker et al., 2008; DiLeo et al., 2014) and climate (Meentemeyer et al., 2004; Venette and Cohen, 2006; Ireland et al., 2013; Meentemeyer et al., 2015) are all known to drive the spread in ecosystems invaded by *P. ramorum*. In spite of the theoretical tolerance of the pathogen to both high and low temperatures, models validated by extensive field sampling in regions infested by NA1 populations indicate high maximum temperatures strongly limit the spread of the pathogen (Meentemeyer et al., 2015) and may even cause significant reversion from positive to negative infection status in foliar hosts (Lione et al., 2017). High temperatures have also been shown to make water populations of the pathogen not viable (Eyre et al., 2015). In the lab, exposure of Petri dishes to 55°C for 1 hour, to 45°C for 4 hours or to 40°C for 24 hours has blocked pathogen growth (Swain et al., 2006), but survival of the pathogen has been reported up to 1 week at 55°C for infected California bay laurel leaves (Harnik et al., 2004), and in other trials the pathogen has been shown to survive in plant tissue between 40°C (2 days) and -20°C (4 days) (Tooley et al., 2008). Finally, the pathogen's broad host range on popular, nursery grown, ornamental plants, and the non-lethal, nondescript nature of the disease on most of the foliar hosts allows for long-term dispersal.

Disease epidemiology in nursery settings has not been extensively studied, however it has been reported that disease cycles are strongly influenced by seasonality and year-to-year climatic variations (Tjosvold et al., 2008). Propagules have been shown to survive in potting mix for over a year but infested mix only caused infection if leaves were in contact with it (Tjosvold et al., 2009), this is in contrast with shorter survival in natural ecosystems (Fichtner et al., 2007; Eyre et al., 2013). Infection does not seem to be strongly associated with irrigation water, but sprinkler irrigation did favour disease development (Tjosvold et al., 2008). Serrano et al. (2020) have provided a first in depth analysis of an outbreak in a mock nursery setting and have identified leaf to leaf, followed by leaf to soil as the two main pathogen dispersal mechanisms in the absence of flooding. In the same study, dispersal from individual infected potted rhododendrons was always less than 2 metres in a single growing season. Anecdotal evidence suggests outbreaks in nursery settings may be associated with flooding of growing beds (see Serrano et al., 2020). Thus, both in natural ecosystems and in nurseries, foliar infections appear to be driving disease outbreaks and the microevolution (i.e. generation of novel genotypes) of the pathogen (Eyre et al., 2013; Serrano et al., 2020). Soil and water are infested but may often be dead ends, epidemiologically speaking, although water populations have been shown to foster microevolution of the pathogen which could lead to the emergence of adaptive traits (Eyre et al., 2015).

Genetic analysis shows *P. ramorum* infection initially reported only in Europe and parts of North America is also present in northern Vietnam, at the border with China (Jung et al., 2020); three clonal lineages were originally identified: EU1 (Europe and North America, nurseries and forests), NA1 (North America, nurseries and forests) and NA2 (North American nurseries) (Ivors et al., 2006). Information to date indicates that divergence of these lineages occurred ages ago, *P. ramorum* originated from isolated populations and has migrated at least four times to North America and Europe (Grünwald et al., 2011). In 2012, Van Poucke et al. (2012) identified a fourth lineage, named EU2, in the UK, and additional lineages may be present in Vietnam (Jung et al., 2020). Whole genome resequencing has identified genomic differences among the lineages (Dale et al., 2019), but lineages also differ phenotypically from one another both *in vitro* and *in planta*, although estimates of their relative invasiveness may often be biased by the choice of hosts tested (Elliott et al., 2011; Eyre et al., 2014; Franceschini et al., 2014; O'Hanlon et al., 2017). One mating type only is found in each of the four widely studied lineages: EU1 and EU2 are A1 and NA1 and NA2 are A2 (Grünwald et al., 2019). Lineages with different mating types are co-mingled in some North American nurseries (Grünwald et al., 2012) and in a few forest stands of southwestern Oregon (Grünwald et al., 2016) raising the issue of potential sexual reproduction between lineages carrying different mating types. *In vitro* tests have indicated mating is possible (Boutet et al., 2010), however 'hybrid' progeny appears to be unstable possibly due to aberrant aneuploid genome size (Vercauteren et al., 2011). In spite of the clonal nature of populations within lineages, significant intralinesage phenotypic variation has been observed; such variation is mostly due to the presence of non-wild types (*nwt*) that are often less virulent and are caused by genomic alterations, including locus copy number variation and

chromosomal rearrangements (Kasuga et al., 2012; Kasuga et al., 2016). The emergence of *nwt* is strongly associated with host species (stem hosts) or habitat (plants grown in nursery settings) (Elliott et al., 2018) and may be a trait identifying pathogen populations from 'dead end' hosts.

Taxonomic Tree

Domain: Eukaryota
Kingdom: Chromista
Phylum: Oomycota
Class: Oomycetes
Order: Peronosporales
Family: Peronosporaceae
Genus: *Phytophthora*
Species: *Phytophthora ramorum*

Notes on Taxonomy and Nomenclature

On the basis of DNA data and morphological traits such as sporangia and chlamydospores, *P. ramorum* belongs to clade 8c, closely related to *Phytophthora lateralis*, a pathogen of *Chamaecyparis lawsoniana* (Port Orford cedar) and *Phytophthora hibernalis*, a pathogen of many orchard tree species. This clade is more distantly related to a group of species including *Phytophthora syringae*, *P. cryptogea*, *P. trifolii* and *P. drechsleri*, among others. Draft whole-genome (Tyler et al., 2006; Malar et al., 2019) and mitochondrial (Martin et al., 2007) sequences of *P. ramorum* are available.

Description

Sporangia are hyaline, ellipsoid or elongated-ovoid (length x width = 25-97 x 14-34 μm , mean 46-65 x 21-28 μm), sympodial, semipapillate, and deciduous, carried on a short stalk. They are produced readily on most media if plant material is included. They are also produced on V8 agar plates, although not consistently. Chlamydospores are large, round, hyaline or yellow-cinnamon depending on substrate. They can be terminal and intercalary or more rarely lateral, and are a good diagnostic feature, especially because of their size (20-91 μm , mean 46-60 μm). *P. ramorum* is a heterothallic, amphigynous species, and both mating types are known in nature but do not readily form sexual spores when artificially crossed. Measurements of mature gametangia are as follows: oogonial diameter, mean 30.5 μm , range 25-35 μm ; oospore diameter, mean 25.5 μm , range 22.5-27.5 μm ; antheridial width, mean 17.3 μm ; antheridial length, mean 15.0 μm . Growth is optimal at 18-20°C: a relatively slow grower. Hyphae are often extremely knobbly, although they lack swellings, and abundant septation can be observed, especially when producing chlamydospores. Mycelium is appressed, forming concentric growth rings more or less pronounced based on the type of media (Werres et al., 2001).

Distribution

In Europe, *P. ramorum* has been reported in commercial nurseries in over 20 countries, and is under regulatory control (Sansford et al., 2009). Outside of nurseries, in the UK infection appeared to be at first limited to ornamental plants in gardens and scattered woodland trees and shrubs until 2009 (Grünwald et al., 2012), when extensive mortality and infection erupted in the UK, on Japanese larch (*Larix kaempferi*) in timber plantations (Brasier and Webber, 2010). Limited outbreaks have been reported in France (Schenck et al., 2018) and the Netherlands (De Gruyter et al., 2006).

P. ramorum was first identified in 2001 in the USA in the California coastal forests around Marin County (Kliejunas, 2010; COMTF, 2017b; COMTF, 2017c). When *P. ramorum* was subsequently found infecting woody ornamentals in a California nursery surrounded by *P. ramorum*-infected *Umbellularia californica* trees, federal regulations were imposed on the US nursery industry to prevent the spread of the pathogen. In 2004, two large wholesale nurseries in California and Oregon mistakenly sent *P. ramorum*-infested host plant material to numerous states across the USA. As a result, multiple surveys conducted in all affected states in 2004 detected *P. ramorum* in nurseries in 41 states (R Bulluck, National Science Director, USDA-APHIS-PPQ, personal correspondence, 2018). These detections were considered episodic and the infested plants were destroyed. *P. ramorum* has been detected on infected plants outside of nursery or managed landscape perimeters in only two states, California and Oregon. *P. ramorum* remains under official control in the USA (NAPPO, 2016) and surveys continue on an annual basis in forest habitats, regulated nurseries and nearby areas (USDA-APHIS, 2016).

In California and Oregon, *P. ramorum* has killed over 50 million trees in coastal regions (Meentemeyer et al., 2011; Frankel and Palmieri, 2014; Cunniffe et al., 2016, Suddenakdeath.org). Tanoak (*Notholithocarpus densiflorus*) is the most susceptible species in California and Oregon (Frankel and Palmieri, 2014; Swiecki and Bernhardt, 2017). Sudden oak death was first reported in California on the coast near San Francisco (Rizzo et al., 2002b) and it spread along the coast into northern counties. In California, *P. ramorum* is quarantined in 15 counties, Humboldt, Mendocino, Napa, Lake, Sonoma, Solano, Contra Costa, Alameda, Marin, San Mateo, Santa Clara, Santa Cruz, San Francisco, Monterey and Trinity (USDA-APHIS-PPQ, 2016). The infestation is patchy and limited to areas within 80 km of the Pacific Ocean (Frankel and Palmieri, 2014).

In 2001, sudden oak disease was discovered in Oregon, in the south-western part of the state, Curry County (Goheen et al., 2002). Mitigation efforts in Curry Co. were implemented soon after detection, continued for many years and then discontinued in 2015 when it was apparent that although measures slowed down the spread of disease, they did not eliminate it (Frankel and Palmieri, 2014; Goheen et al., 2017). After treatments were used in the cooperative programme, the pathogen could no longer be detected in 39% of the treated forest plots (Goheen et al., 2013). *P. ramorum* is quarantined in a forested area of Curry Co., Oregon (NAPPO, 2016).

In Washington State, *P. ramorum* has been found infecting individual plants along streams passing through plant nurseries and significant outbreaks on planted ornamentals have been identified in a preserve (Strenge et al., 2017).

Distribution Table

The distribution in this summary table is based on all the information available. When several references are cited, they may give conflicting information on the status. Further details may be available for individual references in the Distribution Table Details section which can be selected by going to Generate Report.

Last updated: 21 Jul 2022

Continent/Country/Region	Distribution	Last Reported	Origin	First Reported	Invasive	Reference	Notes
Asia							
India	Absent, Invalid presence record(s)					EPPO (2022); CABI/EPPO (2013)	
-Kerala	Absent, Invalid presence record(s)					EPPO (2022); CABI/EPPO (2013)	
Japan	Present					EPPO (2022)	
-Kyushu	Present		Native			EPPO (2022)	
-Shikoku	Present		Native			EPPO (2022)	
Vietnam	Present					EPPO (2022); Jung et al. (2020)	
Europe							
Austria	Absent, Confirmed absent by survey					EPPO (2022)	
Belgium	Present, Localized					Werres et al. (2001); Merlier et al. (2003); Werres and Merlier (2003); CABI/EPPO (2013); EPPO (2022)	
Croatia	Present, Localized					EPPO (2022); CABI/EPPO (2013)	
Czechia	Absent, Eradicated					EPPO (2022); CABI/EPPO (2013)	
Denmark	Present, Few occurrences					CABI/EPPO (2013); EPPO (2022)	

Continent/Country/Region	Distribution	Last Reported	Origin	First Reported	Invasive	Reference	Notes
Estonia	Absent, Confirmed absent by survey					EPPO (2022)	
Finland	Present, Transient under eradication					EPPO (2022); Lilja et al. (2007); Rytkönen et al. (2012); CABI/EPPO (2013); Seebens et al. (2017)	
France	Present, Localized					EPPO (2022); Husson et al. (2007); CABI/EPPO (2013); Schenck et al. (2018)	
Germany	Present, Few occurrences					Werres and Marwitz (1997); CABI/EPPO (2013); EPPO (2022)	
Greece	Present, Few occurrences					EPPO (2022); Tsopeles et al. (2011); CABI/EPPO (2013)	
Ireland	Present, Localized					CABI/EPPO (2013); O'Hanlon et al. (2016); Seebens et al. (2017); EPPO (2022)	
Italy	Absent, Eradicated					EPPO (2022); CABI/EPPO (2013); Ginetti et al. (2014)	
Latvia	Absent, Intercepted only					EPPO (2022)	

Continent/Country/Region	Distribution	Last Reported	Origin	First Reported	Invasive	Reference	Notes
Lithuania	Absent, Intercepted only					EPPO (2022); CABI/EPPO (2013); IPPC (2016); Seebens et al. (2017)	
Luxembourg	Present					EPPO (2022)	
Netherlands	Present, Localized					EPPO (2022); IPPC (2006); CABI/EPPO (2013); NPPO of the Netherlands (2013)	
Norway	Present		Introduced	1989		Seebens et al. (2017); Herrero et al. (2006); Herrero et al. (2011); Rytkönen et al. (2012); CABI/EPPO (2013); EPPO (2022)	
Poland	Present		Introduced	2000		Seebens et al. (2017); Orlikowski and Szkuta (2002); CABI/EPPO (2013); EPPO (2022)	
Portugal	Present, Few occurrences					EPPO (2022); Gomes and Amaro (2008); CABI/EPPO (2013)	
Serbia	Present, Few occurrences					EPPO (2022); Bulajić et al. (2009); Bulajić et al. (2010); CABI/EPPO (2013); Seebens et al. (2017)	
Slovakia	Absent, Eradicated					EPPO (2022)	

Continent/Country/Region	Distribution	Last Reported	Origin	First Reported	Invasive	Reference	Notes
Slovenia	Present, Localized					Žerjav et al. (2004); CABI/EPPO (2013); IPPC (2018); EPPO (2022)	
Spain	Absent, Eradicated					EPPO (2022); Moralejo and Werres (2002); Pintos Varela et al. (2003); Moralejo et al. (2009); CABI/EPPO (2013)	
-Balearic Islands	Absent, Eradicated					EPPO (2022); Moralejo et al. (2009); CABI/EPPO (2013)	
Sweden	Absent, Eradicated					EPPO (2022); CABI/EPPO (2013); Seebens et al. (2017)	
Switzerland	Present, Few occurrences					CABI/EPPO (2013); EPPO (2022)	

Continent/Country/Region	Distribution	Last Reported	Origin	First Reported	Invasive	Reference	Notes
United Kingdom	Present, Localized					Inman et al. (2003); Lane et al. (2003); Beales et al. (2004); Beales et al. (2004a); Brasier et al. (2004); Giltrap et al. (2004); Denman et al. (2005); Denman et al. (2005a); Giltrap et al. (2006); Hughes et al. (2006); Giltrap et al. (2007); Denman et al. (2009); Clark (2011); Brasier and Webber (2012); CABI/EPPO (2013); King et al. (2015); Schlenzig et al. (2016); EPPO (2022)	
-Channel Islands	Present, Few occurrences					CABI/EPPO (2013); EPPO (2022)	
-England	Present, Localized					EPPO (2022); Inman et al. (2003); Lane et al. (2003); Beales et al. (2004); Brasier et al. (2004); Lane et al. (2004); Denman et al. (2009)	
-Scotland	Present, Localized					Brasier and Webber (2012); CABI/EPPO (2013); King et al. (2015); Schlenzig et al. (2016); EPPO (2022)	
-Wales	Present					EPPO (2022)	
North America							

Continent/Country/Region	Distribution	Last Reported	Origin	First Reported	Invasive	Reference	Notes
Canada	Present, Transient under eradication					CABI/EPPO (2013); IPPC (2009); EPPO (2022)	
-British Columbia	Present, Transient under eradication					CABI/EPPO (2013); EPPO (2022); CABI (Undated)	Personal communication to CABI from CFIA, 2 February 2022.

Continent/Country/Region	Distribution	Last Reported	Origin	First Reported	Invasive	Reference	Notes
United States	Present, Localized					Hicks (2018); Davidson et al. (2002); Goheen et al. (2002); Maloney et al. (2002); Hansen et al. (2003); Hüberli et al. (2003); Murphy and Rizzo (2003); Hüberli et al. (2004); Hüberli et al. (2005); Hwang et al. (2006); Vettrains et al. (2006); Vettrains et al. (2006a); Grünwald et al. (2008); Sutton et al. (2009); Yakabe and MacDonald (2010); Riley and Chastagner (2011); Riley et al. (2011); Alexander (2012); CABI/EPPO (2013); Garbelotto et al. (2014); Osterbauer et al. (2014); Grünwald et al. (2016); NAPPO (2016); NAPPO (2016a); Rooney-Latham et al. (2017); Seebens et al. (2017); Leboldus et al. (2018); Rooney-Latham et al. (2020); Elliott et al. (2021); Elliott et al. (2021a); EPPO (2022); CABI (Undated)	Present in some areas, under official control
-Alabama	Present, Transient under surveillance					Hicks (2018); Chastagner et al. (2010); EPPO (2022); CABI (Undated)	

Continent/Country/Region	Distribution	Last Reported	Origin	First Reported	Invasive	Reference	Notes
-Arizona	Absent, Confirmed absent by survey					Arizona Department of Agriculture (2022); EPPO (2022)	
-Arkansas	Absent, Eradicated					Arkansas Department of Agriculture (2022); EPPO (2022)	In 2021, 3 P. ramorum- positive plants were found at 2 nurseries. All infected plants were destroyed. ADA considers P. ramorum eradicated from these sites. Statewide surveys for P. ramorum in 2022 have found no positive samples. P. ramorum has never been found in production nurseries nor in the environment in the state of Arkansas.

Continent/Country/Region	Distribution	Last Reported	Origin	First Reported	Invasive	Reference	Notes
-California	Present, Localized					Hicks (2018); Davidson et al. (2002); Maloney et al. (2002); Hüberli et al. (2003); Hüberli et al. (2004); Hüberli et al. (2005); Vettraino et al. (2006); Vettraino et al. (2006a); Grünwald et al. (2008); Tjosvold et al. (2008); Vettraino et al. (2008); Chastagner and Riley (2010); Chastagner et al. (2010); Yakabe and MacDonald (2010); Riley and Chastagner (2011); Riley et al. (2011); Blomquist et al. (2012); Hüberli et al. (2012); CABI/EPPO (2013); Garbelotto et al. (2014); NAPPO (2016a); USDA-APHIS (2016); Rooney-Latham et al. (2017); Rooney-Latham et al. (2020); UC Berkeley Forest Pathology and Mycology Lab (2020); EPPO (2022); CABI (Undated)	
-Colorado	Present, Few occurrences					EPPO (2022)	

Continent/Country/Region	Distribution	Last Reported	Origin	First Reported	Invasive	Reference	Notes
-Connecticut	Absent, Eradicated					Connecticut Agricultural Experiment Station (2022); EPPO (2022)	P. ramorum has not been found in Connecticut outside of prior regulatory instances.
-Florida	Absent, Confirmed absent by survey					Hicks (2018); Jeffers et al. (2009); Chastagner et al. (2010); CABI/EPPO (2013); Patel et al. (2016); EPPO (2022)	
-Georgia	Absent, Confirmed absent by survey					Hicks (2018); US Forest Service/Animal Plant Health Inspection Service/National Association of State Foresters/National Plant Board (2011); CABI/EPPO (2013); EPPO (2022); CABI (Undated)	
-Illinois	Present, Few occurrences					EPPO (2022)	
-Indiana	Present, Few occurrences					EPPO (2022); Press et al. (2020)	
-Iowa	Present, Few occurrences					EPPO (2022)	
-Kansas	Present, Few occurrences					EPPO (2022)	

Continent/Country/Region	Distribution	Last Reported	Origin	First Reported	Invasive	Reference	Notes
-Louisiana	Present, Transient under surveillance					Hicks (2018); Preuett et al. (2012); CABI/EPPO (2013); EPPO (2022); CABI (Undated)	
-Maryland	Absent, Eradicated					Maryland Department of Agriculture (2022); MDA (2009); Maryland Department of Agriculture (2017); Hicks (2018); EPPO (2022); CABI (Undated)	In 2019, <i>P. ramorum</i> was detected in Rhododendron plants from one nursery. All infected plants were destroyed. Annual surveys conducted by the Maryland Department of Agriculture targeting <i>P. ramorum</i> in state forests, streams and nurseries did not detect the pathogen in 2019, 2020 and 2021.
-Massachusetts	Absent, Confirmed absent by survey					Hicks (2018); Gillman (2011); Brazeel et al. (2016)	
-Mississippi	Absent, Eradicated					Mississippi Department of Agriculture and Commerce (2022); Jeffers et al. (2009); Hicks (2018); EPPO (2022)	There is currently no evidence of <i>P. ramorum</i> in Mississippi based on the results of an active surveillance programme consisting of inspections at every plant nursery in the state.

Continent/Country/Region	Distribution	Last Reported	Origin	First Reported	Invasive	Reference	Notes
-Missouri	Absent, Confirmed absent by survey					Missouri Department of Agriculture (2022); EPPO (2022)	P. ramorum has never been detected in Missouri in the environment or in planted plants.
-Nebraska	Present, Few occurrences					EPPO (2022)	
-New Jersey	Absent, Eradicated					New Jersey Department of Agriculture, Division of Plant Industry (2022); EPPO (2022)	P. ramorum has not been found in New Jersey outside of prior regulatory instances.
-New Mexico	Present, Few occurrences					EPPO (2022)	
-New York	Absent, Eradicated					New York State Department of Agriculture & Markets (2022); EPPO (2022)	New York State Department of Agriculture & Markets has actively been surveying for P. ramorum since 2004 and has been unable to detect P. ramorum established in the natural habitats of New York State.
-North Carolina	Present, Transient under surveillance					Hicks (2018); Hwang et al. (2006); North Carolina Forest Service (2017); EPPO (2022); CABI (Undated)	

Continent/Country/Region	Distribution	Last Reported	Origin	First Reported	Invasive	Reference	Notes
-Oklahoma	Present, Few occurrences					EPPO (2022); Hicks (2018)	
-Oregon	Present, Localized					Hicks (2018); Goheen et al. (2002); Hansen et al. (2003); Grünwald et al. (2008a); Reeser et al. (2008); Sutton et al. (2009); CABI/EPPO (2013); Osterbauer et al. (2014); Kamvar et al. (2015); Grünwald et al. (2016); NAPPO (2016a); Kanaskie et al. (2017); Leboldus et al. (2018); UC Berkeley Forest Pathology and Mycology Lab (2020); Søndreli et al. (2021); EPPO (2022); CABI (Undated)	
-Pennsylvania	Absent, Eradicated					Pennsylvania Department of Agriculture (2022); US Forest Service Northeastern Area (2016); Hicks (2018); EPPO (2022)	Annual specific surveys conducted by the Pennsylvania Department of Agriculture have shown that <i>P. ramorum</i> is not present in the natural environment of Pennsylvania. Any shipments received into Pennsylvania which test positive for <i>P. ramorum</i> are always subject to eradication measures.

Continent/Country/Region	Distribution	Last Reported	Origin	First Reported	Invasive	Reference	Notes
-South Carolina	Absent, Confirmed absent by survey					Hicks (2018); Jeffers et al. (2009); South Carolina Forestry Commission/USDA Forest Service (2010); CABI/EPPO (2013); EPPO (2022)	
-Tennessee	Absent, Confirmed absent by survey					Hicks (2018); Hulvey et al. (2010); CABI/EPPO (2013); Shrestha et al. (2013); EPPO (2022)	
-Texas	Absent, Confirmed absent by survey					Hicks (2018); Kurdyla et al. (2014); EPPO (2022)	
-Virginia	Absent, Eradicated					Virginia Department of Agriculture and Consumer Services (2022); CABI/EPPO (2013); Hicks (2018); EPPO (2022)	No positive sites were found during the statewide survey in 2019, 2020 and 2021.

Continent/Country/Region	Distribution	Last Reported	Origin	First Reported	Invasive	Reference	Notes
-Washington	Absent, Eradicated					Washington State Department of Agriculture (2022); Dart et al. (2007); Chastagner et al. (2012); CABI/EPPO (2013); WSDA (2016); WDNR/USFS (2017); Hicks (2018); Elliott et al. (2021); Elliott et al. (2021a); EPPO (2022)	<i>P. ramorum</i> has not been detected in the native environment in Washington State since surveys began in 2003. All detections of this pathogen have occurred at nurseries, or closely allied settings, and in each case, a mandatory eradication has taken place to USDA standards.
South America							
Argentina	Present					Vélez et al. (2020)	

Risk of Introduction

P. ramorum is a quarantined pest in California and southern Oregon, USA (other than nurseries, the rest of Oregon is not quarantined due to wildland eradication and containment efforts). All host plants are regulated in nurseries shipping out of state in Washington, Oregon and California.

The USA, the EU, Canada, New Zealand, Australia, the Czech Republic, Mexico, Taiwan, South Korea and other countries have identified *P. ramorum* as a quarantine pest (Frankel, 2008). The European Union Pest Risk Analysis for *P. ramorum* (Sansford et al., 2009) lists 68 countries that mention *P. ramorum* in their regulations (Kliejunas, 2010). The European Plant Protection Organization (EPPO) includes *P. ramorum* in the A2 list of quarantined organisms (www.eppo.int/ACTIVITIES/plant_quarantine/A2_list).

Habitat

Natural habitats that have become endemic for the pathogen include a few types of coastal California forests. The first is the mixed evergreen forest characterized by coast live oak (*Quercus agrifolia*), California bay laurel (*Umbellularia californica*) and Pacific madrone (*Arbutus menziesii*). The second is the tanoak-redwood forest, characterized by redwood (*Sequoia sempervirens*) dominance, with a significant tanoak (*Notholithocarpus densiflorus*), California bay laurel and Douglas fir (*Pseudotsuga menziesii*) component (Rizzo et al., 2002a; Rizzo et al., 2002b; Garbelotto et al., 2003). In 2009, the pathogen was found infecting tanoak in a bishop pine (*Pinus muricata*) forest along the Mendocino Coast (Frankel and Hansen, 2011). In Oregon impacted forests are dominated by tanoak and Douglas fir with red alder (*Alnus rubra*) and Oregon myrtlewood (California bay laurel) (*Umbellularia californica*) (Hansen et al., 2008).

In Europe, and particularly in the UK, the pathogen is present in woodlands characterized by the presence of hosts such as native beech (*Fagus sylvatica*), *Quercus cerris* and *Q. falcata*, horse chestnut (*Aesculus hippocastanum*) and naturalized *Rhododendron ponticum*, all hosts on which infection of the stem and branches can be observed. In these environments, it may also infect the leaves of holm oak (*Quercus ilex*), sweet chestnuts (*Castanea sativa*) and ash (*Fraxinus excelsior*) (Slawson et al., 2006).

It is also established and an aggressive lethal pathogen of Japanese larch in plantations of the UK (Webber et al., 2010), Ireland (McCracken, 2013) and northern France (Schenck et al., 2018).

In northern Vietnam, *P. ramorum* has been found in subalpine and montane *Rhododendron* scrub and forests, and in montane broadleaved forests.

Habitat List

Category	Sub-Category	Habitat	Presence	Status
Terrestrial				

Hosts/Species Affected

Quercus rubra, *Q. palustris*, *Pittosporum undulatum* and many other species are regarded as potential hosts: for these species, inoculation experiments have been completed, confirming susceptibility, but no natural infection has been recorded to date (2003). A database of species tested for susceptibility is available at the Risk Analysis for *Phytophthora ramorum* website (<http://rapra.csl.gov.uk/>). More information on host range is given in the following references: Werres et al. (2001); Davidson et al. (2002a); Hansen and Sutton (2002); Linderman et al. (2002); Maloney et al. (2002); Parke et al. (2002); Rizzo et al. (2002a); Rizzo et al. (2002b); Tooley and Englander (2002); Garbelotto et al. (2003); Hüberli et al. (2003) and Kliejunas (2010). A host list is maintained by the USDA Animal and Plant Health Inspection Service (http://www.aphis.usda.gov/plant_health/plant_pest_info/pram/downloads/pdf_files/usdaprlst.pdf). To date (2012) there are over 120 species listed. The California Oak Mortality Task Force (www.suddenoakdeath.org) also maintains a host list with photos of symptoms. In 2017 the abundant rainfall associated with el nino, combined with the extensive distribution of the disease in the San Francisco Bay Area, resulted in the infection of eight *Arctostaphylos* species commonly known as Manzanita spp., of which at least six are considered rare or endangered (Rooney-Latham et al., 2017; Garbelotto et al., 2020).

In 2009, *P. ramorum* was confirmed as the cause of extensive dieback and mortality in mature and juvenile Japanese larch (*Larix kaempferi*) at a number of sites in south-west England. In 2010, *P. ramorum* was isolated from larch plantations displaying similar symptoms in south Wales. Overall, 2400 ha or ca. 0.6 million mature larch were affected (Webber et al., 2010) in addition to a large area of juvenile larch. This is the first widespread and lethal damage caused by *P. ramorum* to a commercially important conifer species anywhere in the world. In 2013, it was reported in Japanese larch plantations of Ireland (McCracken, 2013) and in 2018 in France (Schenck et al., 2018). Secondary infection of *Fagus sylvatica*, *Nothofagus obliqua*, *Castanea sativa*, *Betula pendula*, *Rhododendron ponticum*, *Tsuga heterophylla* and *Pseudotsuga menziesii* was found adjacent to some affected larch sites in south-west England.

Yaupon (*Ilex vomitoria*), sweetbay magnolia (*Magnolia virginiana*) and baldcypress (*Taxodium distichum*) were reported as hosts of *P. ramorum* when several plant species native to the Gulf Coast and south-eastern US forests were tested for reaction to *P. ramorum* (Preuett et al., 2013).

Host Plants and Other Plants Affected

Plant name	Family	Context	References
<i>Abies alba</i> (silver fir)	Pinaceae	Unknown	O'Hanlon et al. (2016)
<i>Abies concolor</i> (Rocky Mountain white fir)	Pinaceae	Unknown	Riley and Chastagner (2011)
<i>Abies grandis</i> (grand fir)	Pinaceae	Other	Elliott et al. (2018); King et al. (2015); Leboldus et al. (2018); Riley et al. (2011)
<i>Abies magnifica</i> (red fir)	Pinaceae	Other	Chastagner and Riley (2010)
<i>Abies procera</i> (noble fir)	Pinaceae	Unknown	O'Hanlon et al. (2017); King et al. (2015); O'Hanlon et al. (2016)
<i>Acer circinatum</i>	Aceraceae	Other	DiLeo et al. (2008)
<i>Acer laevigatum</i>	Aceraceae	Unknown	King et al. (2015)
<i>Acer macrophyllum</i> (broadleaf maple)	Aceraceae	Other	Hayden et al. (2004); Rizzo et al. (2002); Vettrano et al. (2010)
<i>Acer pseudoplatanus</i> (sycamore)	Aceraceae	Other	Brown and Brasier (2007); King et al. (2015)
<i>Adiantum aleuticum</i>	Pteridaceae	Other	Vettrano et al. (2006); Vettrano et al. (2006)
<i>Adiantum jordanii</i> (California maidenhair fern)	Pteridaceae	Other	Elliott et al. (2018); Vettrano et al. (2006); Vettrano et al. (2010); Vettrano et al. (2006)
<i>Aesculus californica</i> (California buckeye)	Hippocastanaceae	Other	Hayden et al. (2004); Rizzo et al. (2002); Vettrano et al. (2010)
<i>Aesculus hippocastanum</i> (horse chestnut)	Hippocastanaceae	Other	King et al. (2015)
<i>Alnus cordata</i> (Italian alder)	Betulaceae	Unknown	O'Hanlon et al. (2016)
<i>Alnus glutinosa</i> (European alder)	Betulaceae	Unknown	Lilja et al. (2007)

Plant name	Family	Context	References
Alnus incana (grey alder)	Betulaceae	Unknown	Lilja et al. (2007)
Arbutus	Ericaceae	Unknown	O'Hanlon et al. (2016)
Arbutus menziesii (Pacific madrone)	Ericaceae	Main	DiLeo et al. (2008); Elliott et al. (2018); Garbelotto et al. (2003); Hayden et al. (2004); Ivors et al. (2004); Rizzo et al. (2002); Vettraino et al. (2010)
Arbutus unedo (arbutus)	Ericaceae	Unknown	Elliott et al. (2018); Moralejo et al. (2009)
Arctostaphylos (bearberry)	Ericaceae	Other	Rizzo et al. (2002)
Arctostaphylos canescens		Unknown	Rooney-Latham et al. (2017)
Arctostaphylos columbiana (Hairly manzanita)	Ericaceae	Other	DiLeo et al. (2008)
Arctostaphylos glandulosa	Ericaceae	Unknown	Rooney-Latham et al. (2017)
Arctostaphylos glauca (Bigberry manzanita)	Ericaceae	Unknown	Rooney-Latham et al. (2020)
Arctostaphylos manzanita		Other	
Arctostaphylos manzanita		Unknown	DiLeo et al. (2008); Hayden et al. (2004); Rizzo et al. (2002)
Arctostaphylos nummularia		Unknown	Rooney-Latham et al. (2017)
Arctostaphylos virgata		Unknown	Rooney-Latham et al. (2017)
Arctostaphylos viridissima		Unknown	Rooney-Latham et al. (2020)
Artemisia tridentata (big sagebrush)	Asteraceae	Unknown	Vettraino et al. (2010)
Azaleas		Unknown	O'Hanlon et al. (2016)

Plant name	Family	Context	References
Betula pendula (common silver birch)	Betulaceae	Unknown	King et al. (2015); Lilja et al. (2007)
Calluna vulgaris (heather)	Ericaceae	Other	Orlikowski and Szkuta (2004); Orlikowski et al. (2007)
Camellia	Theaceae	Other	Beales et al. (2004); Husson et al. (2007); King et al. (2015); Pintos et al. (2003); Yakabe and MacDonald (2010); Hansen et al. (2003)
Camellia japonica (camellia)	Theaceae	Other	Moralejo et al. (2006); O'Hanlon et al. (2016); O'Hanlon et al. (2017); Parke et al. (2004); Pintos et al. (2004); Pintos et al. (2003); Moralejo et al. (2009)
Camellia japonica (camellia)	Theaceae	Other	
Camellia sasanqua (Sasanqua)	Theaceae	Other	Ivors et al. (2004); Linderman et al. (2006); Parke et al. (2004); Shishkoff (2012); Tooley and Browning (2009)
Camellia sinensis (tea)	Theaceae	Unknown	Elliott et al. (2011); James et al. (2012)
Castanea sativa (chestnut)	Fagaceae	Other	Denman et al. (2005); King et al. (2015); O'Hanlon et al. (2016); O'Hanlon et al. (2017); Denman et al. (2005)
Castanopsis chrysophylla (Golden chestnut)	Fagaceae	Unknown	Rooney-Latham et al. (2017)
Castanopsis orthacantha		Unknown	King et al. (2015)
Ceanothus thyrsiflorus (Blueblossom ceanothus)	Rhamnaceae	Other	DiLeo et al. (2008)
Chamaecyparis lawsoniana (Port Orford cedar)	Cupressaceae	Other	Brasier and Webber (2012); King et al. (2015); O'Hanlon et al. (2016); Poucke et al. (2012)
Choisya	Rutaceae	Unknown	O'Hanlon et al. (2016); O'Hanlon et al. (2017)
Choisya ternata (mexican orange-blossom)	Rutaceae	Unknown	Elliott et al. (2018)
Cinnamomum camphora (camphor laurel)	Lauraceae	Other	King et al. (2015); Rooney-Latham et al. (2013)

Plant name	Family	Context	References
Corylus cornuta (beaked hazel)	Betulaceae	Other	Elliott et al. (2018); Vettrano et al. (2010)
Corylus cornuta var. californica (California hazel)	Betulaceae	Other	DiLeo et al. (2008)
Cryptantha torreyana		Unknown	Vettrano et al. (2010)
Cryptomeria	Taxodiaceae	Unknown	O'Hanlon et al. (2016)
Cytisus scoparius (Scotch broom)	Fabaceae	Unknown	Vettrano et al. (2010)
Eucalyptus haemastoma	Lithomyrtus	Unknown	King et al. (2015)
Fagus sylvatica (common beech)	Fagaceae	Other	Brown and Brasier (2007); King et al. (2015); O'Hanlon et al. (2016); O'Hanlon et al. (2017)
Frangula californica	Rhamnaceae	Other	Hayden et al. (2004); Rizzo et al. (2002)
Fraxinus excelsior (ash)	Oleaceae	Other	King et al. (2015)
Gaultheria		Unknown	Schlenzig et al. (2015)
Gaultheria procumbens (Aromatic wintergreen)	Ericaceae	Other	Osterbauer et al. (2014)
Gaultheria shallon (salal)	Ericaceae	Unknown	O'Hanlon et al. (2016); Osterbauer et al. (2014)
Griselinia littoralis	Cornaceae	Other	Giltrap et al. (2006); O'Hanlon et al. (2016); Giltrap et al. (2007)
Hamamelis (witchhazel)	Hamamelidaceae	Unknown	Elliott et al. (2011)
Hamamelis virginiana (Virginian witch- hazel)	Hamamelidaceae	Other	Giltrap et al. (2004)
Heteromeles salicifolia (toyon)	Rosaceae	Main	Hayden et al. (2004); Ivors et al. (2006); Rizzo et al. (2002); Vettrano et al. (2006); Vettrano et al. (2010)
Kalmia (laurel)	Ericaceae	Other	Herrero et al. (2006)

Plant name	Family	Context	References
Kalmia latifolia (Mountain laurel)	Ericaceae	Unknown	O'Hanlon et al. (2016); Schlenzig et al. (2015)
Larix (larches)	Pinaceae	Other	King et al. (2015)
Larix decidua (common larch)	Pinaceae	Unknown	King et al. (2015)
Larix kaempferi (Japanese larch)	Pinaceae	Other	Poucke et al. (2012); Harris and Webber (2016); King et al. (2015); O'Hanlon et al. (2016); O'Hanlon et al. (2017); Schenck et al. (2018)
Larix marschlinsii (hybrid larch)	Pinaceae	Unknown	King et al. (2015)
Laurus nobilis (sweet bay)	Lauraceae	Other	
Leucothoe walteri	Ericaceae	Unknown	O'Hanlon et al. (2016)
Lilium (lily)	Liliaceae	Unknown	Vettraino et al. (2010)
Lithocarpus (stone oaks)	Fagaceae	Wild host	
Lonicera hispidula	Caprifoliaceae	Other	Hayden et al. (2004); Rizzo et al. (2002); Vettraino et al. (2010)
Loropetalum chinense	Hamamelidaceae	Other	Blomquist et al. (2012)
Magnolia	Magnoliaceae	Unknown	James et al. (2012); King et al. (2015); O'Hanlon et al. (2016); O'Hanlon et al. (2017); Schlenzig et al. (2015)
Magnolia stellata (Star magnolia)	Magnoliaceae	Other	Giltrap et al. (2006); Giltrap et al. (2007)
Magnolia x loebneri	Magnoliaceae	Other	Giltrap et al. (2006)
Maianthemum racemosum	Asparagaceae	Other	Hüberli et al. (2005); Vettraino et al. (2010)
Marah fabacea		Unknown	Vettraino et al. (2010)
Michelia	Magnoliaceae	Unknown	O'Hanlon et al. (2016)
Michelia doltropa (champ)	Magnoliaceae	Other	King et al. (2015); O'Hanlon et al. (2016)

Plant name	Family	Context	References
Myristica fragrans (nutmeg)	Myristicaceae	Unknown	Mathew and Beena (2012)
Nerium oleander (oleander)	Apocynaceae	Unknown	O'Hanlon et al. (2016)
Nothofagus	Nothofagaceae	Unknown	King et al. (2015); O'Hanlon et al. (2017)
Nothofagus obliqua (roble)	Nothofagaceae	Unknown	King et al. (2015)
Notholithocarpus densiflorus (Tanoak)	Fagaceae	Main	DiLeo et al. (2008); Elliott et al. (2011); Hansen et al. (2005); Hayden et al. (2004); Ivors et al. (2004); James et al. (2012); Linderman et al. (2006); O'Hanlon et al. (2017); Rizzo et al. (2002); Sutton et al. (2009); Vettraino et al. (2006); Vettraino et al. (2010); Yakabe and MacDonald (2010); Elliott et al. (2015); Elliott et al. (2018); Grünwald et al. (2016); Leboldus et al. (2018); Poucke et al. (2012); Goheen et al. (2002a); Reeser et al. (2008)
Osmanthus	Oleaceae	Unknown	O'Hanlon et al. (2016); Schlenzig et al. (2015)
Osmanthus delavayi		Unknown	King et al. (2015)
Osmanthus fragrans	Oleaceae	Unknown	Grünwald et al. (2008)
Osmanthus heterophyllus (holly olive)	Oleaceae	Unknown	Grünwald et al. (2008)
Osmorhiza berteroi		Unknown	Elliott et al. (2018)
Oxalis (wood sorrels)	Oxalidaceae	Unknown	Vettraino et al. (2010)
Parrotia persica (persian ironwood)	Hamamelidaceae	Other	Hughes et al. (2006)
Phoradendron serotinum	Viscaceae	Unknown	Riley and Chastagner (2011)
Photinia fraseri	Rosaceae	Other	Orlikowski et al. (2007); O'Hanlon et al. (2016)
Picea sitchensis (Sitka spruce)	Pinaceae	Other	O'Hanlon et al. (2016); O'Hanlon et al. (2017)
Pickeringia montana		Unknown	Rooney-Latham et al. (2017)
Pieris (Ericaceae)	Ericaceae	Unknown	Ivors et al. (2004); King et al. (2015); O'Hanlon et al. (2017); Schlenzig et al. (2015); Poucke et al. (2012)

Plant name	Family	Context	References
Pieris formosa		Unknown	Inman et al. (2003)
Pieris japonica (Lily-of-the-valley shrub)	Pieridae	Other	Elliott et al. (2015); Elliott et al. (2011); Herrero et al. (2006); Husson et al. (2007); James et al. (2012); Linderman et al. (2006); O'Hanlon et al. (2016); Orlikowski and Szkuta (2004); Orlikowski et al. (2007); Parke et al. (2004); Tooley and Browning (2009)
Pittosporum undulatum (Australian cheesewood)	Pittosporaceae	Unknown	Hüberli et al. (2006)
Populus deltoides (poplar)	Salicaceae	Unknown	Vettrano et al. (2010)
Prunus (stone fruit)	Rosaceae	Unknown	O'Hanlon et al. (2016)
Prunus laurocerasus (cherry laurel)		Unknown	Elliott et al. (2021)
Prunus lusitanica	Rosaceae	Unknown	James et al. (2012); O'Hanlon et al. (2016); O'Hanlon et al. (2017)
Pseudotsuga menziesii (Douglas-fir)	Pinaceae	Main	DiLeo et al. (2008); Harris and Webber (2016); Hayden et al. (2004); King et al. (2015); Leboldus et al. (2018); Vettrano et al. (2010); Davidson et al. (2002)
Pteris	Pteridaceae	Unknown	Hansen et al. (2003)
Pyracantha koidzumii		Unknown	Briere et al. (2005)
Quercus (oaks)	Fagaceae	Unknown	King et al. (2015)
Quercus acuta (japanese evergreen oak)	Fagaceae	Unknown	Brown and Brasier (2007)
Quercus agrifolia (California live oak)	Fagaceae	Main	Elliott et al. (2011); Elliott et al. (2018); Hayden et al. (2004); Ivors et al. (2004); Moralejo et al. (2006); Rizzo et al. (2002); Vettrano et al. (2010); Vettrano et al. (2008)
Quercus cerris (European Turkey oak)	Fagaceae	Other	Brown and Brasier (2007); King et al. (2015)
Quercus chrysolepis (Canyon live oak)	Fagaceae	Main	Hayden et al. (2004); Murphy and Rizzo (2003)

Plant name	Family	Context	References
Quercus falcata (red oak)	Fagaceae	Main	Brasier et al. (2004); King et al. (2015)
Quercus ilex (holm oak)	Fagaceae	Other	Denman et al. (2005); Denman et al. (2009); King et al. (2015); Denman et al. (2005)
Quercus kelloggii (California black oak)	Fagaceae	Main	Hayden et al. (2004); Rizzo et al. (2002)
Quercus parvula		Unknown	Ivors et al. (2004)
Quercus parvula var. shrevei	Fagaceae	Main	Elliott et al. (2018); Hayden et al. (2004); Rizzo et al. (2002)
Quercus petraea (durmast oak)	Fagaceae	Unknown	Brown and Brasier (2007); King et al. (2015)
Quercus phillyraeoides (ubame oak)	Fagaceae	Unknown	O'Hanlon et al. (2016)
Quercus robur (common oak)	Fagaceae	Unknown	Poucke et al. (2012)
Quercus rubra (northern red oak)	Fagaceae	Unknown	King et al. (2015)
Rhamnus cathartica (buckthorn)	Rhamnaceae	Unknown	Elliott et al. (2018); Ivors et al. (2006)
Rhamnus purshiana (Cascara buckthorn)	Rhamnaceae	Other	Hansen et al. (2005); Vettraino et al. (2006); Vettraino et al. (2010); Vettraino et al. (2006)
Rhododendron (Azalea)	Ericaceae	Other	Bulajić et al. (2009); Elliott et al. (2011); Elliott et al. (2018); Husson et al. (2007); Ivors et al. (2004); Ivors et al. (2006); James et al. (2012); King et al. (2015); Lilja et al. (2007); Moralejo et al. (2006); O'Hanlon et al. (2016); O'Hanlon et al. (2017); Orlikowski et al. (2007); Parke et al. (2004); Prospero et al. (2013); Schlenzig et al. (2015); Tooley and Browning (2009); Poucke et al. (2012); Yakabe and MacDonald (2010); Žerjav et al. (2004); Garbelotto et al. (2014); Bulajic et al. (2010); Tsopelas et al. (2011)
Rhododendron arboreum	Ericaceae	Unknown	O'Hanlon et al. (2016)
Rhododendron catawbiense	Ericaceae	Other	Elliott et al. (2015); Elliott et al. (2011); Herrero et al. (2006); Ivors et al. (2004); James et al. (2012); Lilja et al. (2007); Prospero et al. (2013); Poucke et al. (2012); Žerjav et al. (2004)

Plant name	Family	Context	References
Rhododendron hirsutum		Unknown	Prospero et al. (2013)
Rhododendron impeditum		Unknown	Prospero et al. (2013)
Rhododendron macrophyllum (Pacific rhododendron)	Ericaceae	Unknown	Hansen et al. (2005); Linderman et al. (2006); Rizzo et al. (2002); Sutton et al. (2009)
Rhododendron ponticum (rhododendron)	Ericaceae	Unknown	Denman et al. (2009); King et al. (2015); O'Hanlon et al. (2017); Poucke et al. (2012); O'Hanlon et al. (2016); Schlenzig et al. (2016)
Rhus diversiloba (Pacific poisonoak)	Anacardiaceae	Unknown	Hansen et al. (2005)
Rosa (roses)	Rosaceae	Unknown	Elliott et al. (2011)
Rosa californica (California rose)	Rosaceae	Unknown	Vettraino et al. (2010)
Rosa gymnocarpa		Other	
Rosa gymnocarpa		Unknown	Hüberli et al. (2004)
Rubus spectabilis (salmonberry)	Rosaceae	Unknown	Hansen et al. (2005)
Rubus ursinus (boysenberry)	Rosaceae	Unknown	Rooney-Latham et al. (2017); Vettraino et al. (2010)
Salix caprea (pussy willow)	Salicaceae	Other	
Sambucus nigra (elder)	Caprifoliaceae	Other	
Sarcococca		Unknown	O'Hanlon et al. (2016); Schlenzig et al. (2015)
Schima wallichii (Chinese guger tree)	Theaceae	Unknown	Brown and Brasier (2007)
Sequoia sempervirens (coast redwood)	Taxodiaceae	Other	DiLeo et al. (2008); Elliott et al. (2018); Hayden et al. (2004); Hüberli et al. (2005); Ivors et al. (2004); Vettraino et al. (2010); Maloney et al. (2002)

Plant name	Family	Context	References
Symphoricarpos (snowberry)	Caprifoliaceae	Unknown	Vettrano et al. (2010)
Syringa vulgaris (lilac)	Oleaceae	Other	Beales et al. (2004); Schlenzig et al. (2015)
Taxus baccata (English yew)	Taxaceae	Other	Lane et al. (2004)
Toxicodendron diversilobum	Anacardiaceae	Other	
Trientalis latifolia	Primulaceae	Other	Hayden et al. (2004); Ivors et al. (2006); Hüberli et al. (2003)
Tsuga heterophylla (western hemlock)	Pinaceae	Unknown	King et al. (2015)
Umbellularia californica (California laurel)	Lauraceae	Other	Vettrano et al. (2006); Vettrano et al. (2010); Yakabe and MacDonald (2010); DiLeo et al. (2008); Elliott et al. (2011); Elliott et al. (2018); Hansen et al. (2005); Hayden et al. (2004); Ivors et al. (2004); O'Hanlon et al. (2016); O'Hanlon et al. (2017); Rizzo et al. (2002); Davidson et al. (2002); Wickland et al. (2008)
Vaccinium (blueberries)	Ericaceae	Wild host	Moralejo et al. (2006); O'Hanlon et al. (2016)
Vaccinium arboreum (Tree huckleberry)	Ericaceae	Unknown	Bily et al. (2018)
Vaccinium myrtillus (blueberry)	Ericaceae	Other	Herrero et al. (2011); King et al. (2015); O'Hanlon et al. (2016); O'Hanlon et al. (2017); Poucke et al. (2012)
Vaccinium ovatum (Box blueberry)	Ericaceae	Main	Goheen et al. (2002a); Hansen et al. (2005); Hayden et al. (2004); Ivors et al. (2004); Linderman et al. (2006); Rizzo et al. (2002)
Viburnum	Caprifoliaceae	Main	Ivors et al. (2004); O'Hanlon et al. (2016); O'Hanlon et al. (2017); Prospero et al. (2013); Schlenzig et al. (2015); Žerjav et al. (2004); Hansen et al. (2003)
Viburnum bodnantense	Caprifoliaceae	Other	Merlier et al. (2003); Husson et al. (2007); Ivors et al. (2004); Linderman et al. (2006); Parke et al. (2004); Prospero et al. (2013); Žerjav et al. (2004)
Viburnum davidii	Caprifoliaceae	Unknown	O'Hanlon et al. (2016); O'Hanlon et al. (2017)
Viburnum farreri		Unknown	Ivors et al. (2006); Prospero et al. (2013); Žerjav et al. (2004); Herrero et al. (2006)
Viburnum plicatum	Caprifoliaceae	Unknown	Elliott et al. (2015); Elliott et al. (2011); James et al. (2012); Linderman et al. (2006); Ivors et al. (2006)

Plant name	Family	Context	References
Viburnum plicatum var. tomentosum (Dubble-file viburnum)	Caprifoliaceae	Unknown	Linderman et al. (2006); Parke et al. (2004)
Viburnum tinus	Caprifoliaceae	Other	Elliott et al. (2018); Grünwald et al. (2008); Husson et al. (2007); Ivors et al. (2004); King et al. (2015); Lane et al. (2003); Moralejo et al. (2006); O'Hanlon et al. (2016); O'Hanlon et al. (2017); Pintos et al. (2004); Poucke et al. (2012); Pintos et al. (2003); Ginetti et al. (2014); Moralejo et al. (2009)
Vinca (periwinkle)	Apocynaceae	Unknown	Vettraino et al. (2010)
Vinca minor (common periwinkle)	Apocynaceae	Unknown	Elliott et al. (2021)

Growth Stages

Flowering stage, Fruiting stage, Post-harvest, Seedling stage, Vegetative growing stage

Symptoms

P. ramorum causes three distinct types of disease with corresponding symptoms.

Stem Cankers (Rizzo et al., 2002a).

The cankers resemble those caused by other *Phytophthora* species. Discoloration can be seen in the inner bark, the cambium and within the first few sapwood rings, in some hosts causing blockage or disruption of the vascular system (Parke et al., 2007). Discoloration is always associated with the cankers, but its intensity is extremely variable, ranging from dark-brown, almost black, lesions to slight discoloration of the infected tree tissue. Black zone lines are often, but not always, present at the edge of the cankers. Smaller tanoaks (*Notholithocarpus densiflorus*) tend not to have any zone lines. Most notably, *P. ramorum* cankers stop abruptly at the soil line, and there are few reports of root infection in tanoak. *Viburnum* is the only host in which root collar infection is common (Werres et al., 2001) and root infection is only reported for Rhododendrons (Parke and Lewis, 2007). Typical bleeding symptoms can be seen on the outside of the cankers. Bleeding is not necessarily associated with cracks or wounds, and tends to be rather viscous in consistency. A distinct fermentation smell (or alcoholic smell) emanates from bark seeps. Intensity and viscosity of bleeding changes with time. Older cankers may display a thin, brown-amber crust where seeps were originally present. Crown symptoms are often associated with expansion rate of cankers. Rapidly expanding cankers rapidly girdle the tree. In this case, there is no real crown decline, but once the tree has exhausted the resources accumulated in its aerial part, the whole crown browns. Normally this browning occurs 1-4 years post infection. The entire foliage turns orange-brown and then becomes grey with time. The name 'sudden oak death' was coined because of the high frequency of rapidly declining trees. In the phase between girdling and apparent death of the crown, secondary processes are initiated. These include growth and fruiting of *Annulohyphoxylon thouarsianum*, syn. *Hyphoxylon thouarsianum*. *A. thouarsianum* will cause a mottled decay of portions of the sapwood and will fruit abundantly on the bark. Other secondary processes include attacks by bark and ambrosia beetles and acceleration of decay processes, at times with basidiocarps produced on trees which are still green.

When cankers are slow-growing, typical decline symptoms can be seen in the crown and include: chlorosis of the foliage, premature leaf abscission resulting in sparse crowns, and sometimes dieback of branches corresponding to portions of the stem affected by the canker. Epicormic shoots are often associated with both types of cankers (slow and fast). On oak species, most cankers are found within 1 m of the root collar, but cankers higher up on the stem and on major branches are not uncommon, especially if oak branches are intertwined with California bay laurel branches. Oak leaves, twigs, and juvenile plants are rarely infected. Tanoak cankers tend to be present throughout the vertical length of the tree and most trees have multiple cankers on them. Plants of all ages can be infected and killed. Leaves and twigs can also be infected. Foliar infection can precede or follow twig infection and it results in leaf spotting and a characteristic blackening of the main rib of the leaf, with lesions continuing into the petiole.

Leaf Blight and Branch Dieback (Rizzo et al., 2002b; Garbelotto et al., 2003).

Leaves develop lesions often associated with twig dieback. The primary infection court can be either in the twig or in the leaf. Cankers develop on branches. Symptoms on leaves develop rather rapidly, with watersoaked lesions developing mainly along the mid-vein of the leaf, and may result in death of the leaf. *Rhododendron* spp., *Pieris* spp. and *Rhamnus* spp. display these symptoms. In ericaceous hosts with small leaves (e.g. *Vaccinium ovatum* and *Arctostaphylos* spp.), foliar symptoms are not as pronounced. Leaf abscission and cane cankers are more common, resulting in the death of clumps of branches. Symptoms on coniferous hosts such as Douglas fir (*Pseudotsuga menziesii*) and Grand fir (*Abies grandis*) fall into this general category. In these two hosts, branch tips are typically affected. Branch tips, especially the last year's growth, are girdled and will wilt. Needles hang from the infected branch at first and then will drop, leaving a barren branch tip appearing similar to browse injury.

Leaf Spots, Blotches, and Scorches (Rizzo et al., 2002b; Garbelotto et al., 2003).

In some hosts, the disease affects leaves but not the twigs or branches. Lesions are normally associated with the accumulation of water on the leaf. These symptoms are in general rather nondescript. Lesions on *Umbellularia californica* are generally dark in colour, often at the leaf tip where water accumulates, but can also be on the blade or near the petiole depending how the leaf is carried and on where water accumulates. Lesions are generally demarcated by an irregular margin, often followed by a chlorotic halo. Premature chlorosis of the entire leaf, followed by its abscission, is common in drier areas. Infection in *Aesculus californica* starts as light circular spots, coalescing into large blotches often affecting the whole leaf, and at times the petiole. In *Acer macrophyllum*, symptoms appear as a marginal leaf scorch. The scorch does not, at least initially, affect the whole leaf contour, and scorched portions are interrupted by healthy areas.

On redwood the disease affects mostly needles of the lower branches. Needles appear to be infected individually, and often partially infected needles will display a black demarcation line between healthy and diseased tissue. Such lines can be developed either longitudinally following the length of the needle, or transversally across the width of the needle. Eventually, most needles in a portion of the branch may be

infected and die. In general, dead needles remain attached to the branches. Basal sprouts of redwood can sometimes be girdled, cankers will appear as a dark lesion, and the entire portion of the sprout above the lesion will desiccate.

List of Symptoms/Signs

Sign	Life Stages	Type
Growing point / dieback		
Growing point / discoloration		
Growing point / lesions		
Growing point / wilt		
Leaves / abnormal colours		
Leaves / abnormal leaf fall		
Leaves / necrotic areas		
Leaves / wilting		
Leaves / yellowed or dead		
Stems / canker on woody stem		
Stems / dieback		
Stems / discoloration		
Stems / discoloration of bark		
Stems / gummosis or resinosis		
Stems / internal discoloration		
Stems / necrosis		
Stems / odour		
Stems / visible frass		
Whole plant / discoloration		
Whole plant / frass visible		
Whole plant / plant dead; dieback		
Whole plant / uprooted or toppled		

Biology and Ecology

Our understanding of *P. ramorum* is still limited and subject to be modified in the future. For reviews on current knowledge, refer to Rizzo et al. (2005), Sansford et al. (2009), Kliejunas (2010), Grünwald et al. (2011); Garbelotto and Hayden (2012); Grünwald et al. (2019).

The coastal distribution of the disease caused by *P. ramorum* (Rizzo et al., 2005) in California, USA, suggests that the pathogen is favoured by moist and moderate climates. Moisture in the infested region is provided both by precipitation and fog, and temperature fluctuations are relatively small when compared with the interior of California. Within the coastal region, eastern and southern slopes are significantly drier. A comparison of inoculum viability between these drier areas and the more mesic areas within the same region has indicated a much more pronounced seasonal pattern in drier climates (Davidson et al., 2002c). These observations, combined, indicate that maximum disease progression is to be expected in mesic areas with moderate climate. Meentemeyer et al. (2015) and Lione et al. (2017) have both identified high temperature in spring-summer-autumn as a limiting factor in the distribution and/or persistence of the pathogen in the interior of California. In the latter study, a yearly mean temperature of 20-25°C and a maximum temperature of 35-30°C were extremely limiting for *P. ramorum*.

Experimental evidence has indicated that infection of bay (*Umbellularia californica*) leaves is optimal when a film of free water remains on the leaf surface for at least 9-12 hours and temperatures are approximately 18°C (Garbelotto et al., 2003). These conditions are frequently met in the fog-drenched coastal region of California, where over 200 days of fog per year have been recorded. However, Garbelotto et al. (2017) have shown in a 9-year-long study that sporangia production is exclusively limited to the rainy season and is basically nil in other periods, including those when the marine layer brings in significant moisture to coastal forest. In the same study, Garbelotto et al. (2017) were also able to determine that oak infection is extremely episodic and as of 2020 may only have occurred a few times since the arrival of the pathogen in California forests (2000-2001, 2006-2007, 2010-2011, 2016-2017). The reason for the episodic nature of oak infection relies in the requirements necessary for infection namely: inoculum density needs to reach 5×10^4 zoospores per mL, temperature needs to be around 20°C multiple hours per day for a week before infection starts to be successful, and rainfall must have surpassed the 250 ml threshold in the 3-6 weeks prior to infection. Interestingly, the overwhelming majority of oak infections were also modelled to occur when oaks are within 5 m from more than one bay laurel (Garbelotto et al., 2017).

In the absence of free water, plant infection is significantly reduced. It has been presumed that zoospores are the main source of infection, and micrographs have shown zoospores producing infection pegs that enter the host through bark lenticels or leaf stomata. The most important feature of this forest *Phytophthora* is that all plant parts affected by the disease are aerial. Is this an aerial *Phytophthora*? There is no doubt that an aerial phase has to be invoked to explain the epidemiology of Sudden Oak Death (SOD), but current knowledge on dispersal, that is when sporangia are produced and dispersal scale strongly indicate *P. ramorum* to be an aerial splash dispersed species, such as *P. capsici* (Ristaino et al., 2000). Sporangia are extremely deciduous and are produced in abundance on leaves and sometimes twigs of hosts such as bay laurel (*U. californica*) and tanoak (*Notholithocarpus densiflorus*). Infections can vary greatly from extremely abundant on almost every leaf in the lower and mid crown of bay trees in infested areas to just a few leaves, and sporangia can be recovered from rainwater. The extent of the aerial spread of *P. ramorum* is becoming clearer as extensive population genetics studies in colonized forests have shown that leaf pathogen populations rather than soil, water or even populations from stem hosts are epidemiologically relevant and drive the genotypic composition and the microevolution of this pathogen (Hüberli and Garbelotto, 2012; Eyre et al., 2013; Eyre et al., 2015). It is unclear whether in nature, soil and water populations may be epidemiologically significant, possibly because selection pressure leading to adaptation to live in soil and water may not be beneficial to the aerial lifestyle of the pathogen.

In California the disease is almost always correlated to the presence of two species, bay laurel and tanoaks (although a few exceptions are known). In areas where tanoaks and California bay laurel coexist, infection of the latter tree species precedes and overwhelmingly surpasses infection of tanoaks, suggesting a key role is being played by this species in the epidemiology of the disease. In a study where position of tanoaks and bay laurels was studied at the landscape level, it was shown that tanoaks and bays are ecologically overlapping in terms of physiological requirements, but are not epidemiologically identical when studying SOD, as only bay laurels are strongly associated with oak infection (Garbelotto et al., 2017).

After the first few rains, *P. ramorum* can be detected in the environment (soil, rain traps) (Davidson et al., 2002c). Leaf infection will occur in a few hours, and infected leaves may persist on the branch for more than a year, providing a persistent source of inoculum on some trees. When relative humidity is high, and temperatures are warm, sporangia and chlamydospores will be produced on the infected leaves and will be splashed by rain onto other leaves and into the soil, and may become airborne in rain driven winds. In hosts like tanoaks, foliar infections are often associated with twig infection: the outcome is twig and branch dieback. Oaks and the main stems of tanoaks are probably infected in a final stage of the disease. Sporangia are the most effective transmission propagule, but the motile zoospores that they contain are the most effective infection propagules. Girdling cankers will proceed at varying rates, probably mostly affected by the genetic makeup of the individual infected tree (Dodd et al., 2005). Variations in susceptibility to the pathogen have been noticed in both bay laurel (Hüberli et al., 2012) and oaks (Dodd et al., 2005). Susceptible individuals will potentially be girdled in just a few weeks. Girdled trees will look apparently healthy for several more months, until all resources have been depleted and the trees undergo a rapid decline. Disease tolerance has been identified in tanoaks (Hayden et al., 2011; Hayden et al., 2013) and oaks (Conrad et al., 2017).

Soil, water and leaves may be infected/infested and infectious but only infected plants have been shown to be highly contagious (Serrano et al., 2020): it is possible to experimentally infect leaves by placing them over infested soil, and it is possible to infect wood by placing it under infected leaves. Conversely, it is extremely difficult to infect leaves by placing them near or on infected wood. These results indicate that leaves (including twigs) and not wood play a crucial role in the epidemiology of the disease. Because oak leaves are not generally infected by *P. ramorum*, oaks may not effectively spread the disease. In support of this hypothesis, surveys have indicated that oaks are much more likely to become infected by *P. ramorum* if they grow in proximity to bay laurel trees (Kelly and Meentemeyer, 2002; Swiecki and Bernhardt, 2002). While the epidemiological role of soil in infested areas is probably minor (Eyre et al., 2013), the epidemiological role of water remains an open question, and there is anecdotal evidence that occasionally floods may lead to infection. Serrano et al. (2020) and Tjosvold et al. (2008) have indicated that water used for irrigation is not a good infection pathway, however they have not tested flooding. On the other hand, Eyre et al. (2015) have shown that genotypic composition in water is different to that of leaf populations, so it remains to be seen whether genotypes that thrive in water may be able to start aerial outbreaks.

Sporangia can survive for several weeks even if dried, whereas the survival period for chlamydospores is still unknown. Chlamydospores are found in abundance in soil, streams and embedded in leaves. Chlamydospores embedded in bay leaves are quite resilient and will survive for a week with a constant temperature of 55°C (Harnik et al., 2004) and for multiple days at -20°C (Tooley et al., 2008). Both of these propagule types are potential means of long-range spread of the disease.

Notes on Natural Enemies

Both *Phytophthora nemorosa* and *Phytophthora pseudosyringae* have been found to be competitors of *P. ramorum*. Their interaction has been studied in the laboratory and in the field: in dry weather the competitors are more fit than *P. ramorum*, and vice versa in rainy years (Kozanitas et al., 2017).

Means of Movement and Dispersal

Natural dispersal of *P. ramorum* is by drifting plant material, possibly by waterborne and soilborne chlamydospores: most spread occurs via wind-blown rain containing sporangia.

There are no known vectors of the disease other than man but any animal that can move soil is potentially a vector. *P. ramorum* has been proven to be effectively moved through the trade of ornamental plants and green waste. There is compelling evidence that mature compost will not be infectious (Swain et al., 2006).

Pathway Vectors

Vector	Notes	Long Distance	Local	References
Clothing, footwear and possessions	Soil on clothing and equipment			
Land vehicles	All if soil moved.			
Machinery and equipment				
Soil, sand and gravel		Yes		

Plant Trade

Plant parts liable to carry the pest in trade/transport	Pest stages	Borne internally	Borne externally	Visibility of pest or symptoms
Bark	fungi/hyphae	Yes	Yes	Pest or symptoms usually visible to the naked eye
Growing medium accompanying plants	fungi/sporangia; fungi/spores			Pest or symptoms usually invisible
Leaves	fungi/fruiting bodies; fungi/hyphae; fungi/plasmodia; fungi/sclerotia; fungi/sporangia; fungi/spores	Yes	Yes	Pest or symptoms usually visible to the naked eye
Seedlings/Micropropagated plants	fungi/fruiting bodies; fungi/hyphae; fungi/plasmodia; fungi/sclerotia; fungi/sporangia; fungi/spores	Yes	Yes	Pest or symptoms usually visible to the naked eye
Stems (above ground)/Shoots/Trunks/Branches	fungi/fruiting bodies; fungi/hyphae; fungi/plasmodia; fungi/sclerotia; fungi/sporangia; fungi/spores	Yes	Yes	Pest or symptoms usually visible to the naked eye
Wood	fungi/hyphae	Yes		Pest or symptoms usually visible to the naked eye

Plant parts not known to carry the pest in trade/transport

Bulbs/Tubers/Corms/Rhizomes

Flowers/Inflorescences/Cones/Calyx

Fruits (inc. pods)

Roots

Wood Packaging

Wood Packaging liable to carry the pest in trade/transport	Timber type	Used as packing
Loose wood packing material		No
Solid wood packing material with bark		No
Solid wood packing material without bark		No

Wood Packaging not known to carry the pest in trade/transport

Non-wood

Processed or treated wood

Economic Impact

The overall economic impact of *P. ramorum* in California, USA, is hard to assess. Californian oaks (*Quercus* spp.) and tanoaks (*Notholithocarpus densiflorus*) affected by the pathogen are not commercial timber species but add to property values and offer a swath of ecosystem services ranging from protection from erosion, water quality, quality of pastures, recreation and biodiversity, all of difficult economic evaluation. The addition of redwood (*Sequoia sempervirens*), Douglas fir (*Pseudotsuga menziesii*), grand fir, red fir, western hemlock and other conifers as reported hosts poses a potential economic cost to the timber industry. Symptoms and impact on these hosts are somewhat limited, mortality is only reported from small (less than 1 inch diameter) trees. Dead tree counts have surpassed 15 million as of 2020, but the extreme patchiness and wide extent of the disease makes any assessment of tree mortality extremely difficult (Kelly and Meentemeyer, 2002; Meentemeyer et al., 2008). Oaks in particular are known to increase the real estate value of property: large numbers of landscape oaks have been infected, with significant financial repercussions for property owners. A decrease in property values has been shown in areas near infected forests in Marin County (Kovacs et al., 2011a; Kovacs et al., 2011b). Mortality of oaks is likely to have doubled and that of tanoaks quadrupled (Swiecki and Bernhardt, 2002; McPherson et al., 2002) due to this disease. Costs of removal of dead trees and of disposal of the infectious green waste are also significant. The need for precautionary and sanitary practices is an added indirect cost to arborists and other tree professionals.

In 2009, *P. ramorum* was confirmed as the cause of extensive dieback and mortality in mature and juvenile Japanese larch (*Larix kaempferi*) at a number of sites in south-west England. In 2010, *P. ramorum* was isolated from larch plantations displaying similar symptoms in south Wales. Overall, 2400 ha or ca. 0.6 million mature larch were affected (Webber et al., 2010) in addition to a large area of juvenile larch. This is the first widespread and lethal damage caused by *P. ramorum* to a commercially important conifer species anywhere in the world. Additional highly valued specimen rhododendron plants in historic gardens have been removed to maintain phytosanitary conditions.

Some industries have been particularly affected by *P. ramorum*, including the ornamental plants industry (Linderman et al., 2002; Parke et al., 2002), the composting industry (Garbelotto, 2003) and the spice industry (Harnik et al., 2004). It is not only Californian growers that are affected, but also those outside California due to the decreased availability of Californian-grown propagative material. Edible mycorrhizal mushrooms are reported to have decreased in numbers in areas highly affected by the disease (Bergemann et al., 2006; Bergemann et al., 2013). Economic impacts in Oregon were estimated by Hall and Albers (2009).

Death of large numbers of trees in popular parks and recreation areas, and the partial closure of some infested areas during the rainy season, are having an impact on the recreational value of open spaces. The cost of tree removal and disposal for agencies, public or private, running large open spaces can be extremely high. The need to lower the risk of spread in industries affected by Sudden Oak Death will translate into management practices with a significant price tag (e.g. the washing of logging trucks, the closure of some roads and accesses, the need to process bay leaves to ensure the pathogen is dead, the need to ensure mature compost does not become contaminated by the green waste in fresh compost piles, and so forth). These expenditures can be considered indirect economic costs of *P. ramorum*. Particular mention should be made of First Nations' tribal lands threatened by Sudden Oak Death and of the costly efforts to protect them (Cobb et al., 2013; Cobb et al., 2019).

The relationship between fire and SOD has an obvious economic component.

Kliejunas (2010) reviewed *P. ramorum* economic and environmental impacts. Sansford et al. (2009) reviews economic impacts in Europe.

Environmental Impact

Oaks and tanoaks are extremely susceptible to the disease. Tanoak (*Notholithocarpus densiflorus*) is the most susceptible species in California, USA. Some local populations, e.g. some canyons in the Big Sur area (Monterey County), have lost all of their adult trees because of Sudden Oak Death (SOD). The disease has the potential to cause a significant genetic bottleneck in this tree species. The demise of entire tanoak populations is changing the nature of those forests, in general moving towards pure redwood (*Sequoia sempervirens*) stands with marginal presence of oaks and Douglas firs. Wildlife depending on tanoaks and oaks is likely to be locally affected, and several studies already document that for some smaller vertebrates and birds (Monahan and Koenig, 2006; Swei et al., 2011).

Tanoak is also the major ectomycorrhizal host of most of these stands (Bergemann et al., 2006) and its disappearance is likely to have a significant impact on ectomycorrhizal populations. Besides loss of the symbiotic host, it has been shown that a stem-girdling disease such as SOD will cause a significant shift in mycorrhizal function. Bergemann et al. (2013) provide evidence that girdling causes a reduction in the mycorrhizal soil biomass, a key element in the relationship between mycorrhizae and plant hosts. This reduction is expected to greatly reduce the amount of P and micronutrients mycorrhizae will be able to absorb and transfer to their symbionts.

Abundance of dead and fallen woody material constitutes a significant fire hazard (Cobb et al., 2011); it is likely that the intensity of these fires may be much higher than the norm because of the large accumulation of woody debris (Forrestel et al., 2015). The arrangement of fuels is altered, posing serious challenges to firefighter response in infested stands (Valachovic et al., 2011). However, maybe the most surprising effect of SOD on fire behaviour is the creation of previously unreported hotspots in conjunction with dead standing oaks and tanoaks. These hotspots were unmanageable by fire crews, led to multiple fire jumps adding to unpredictability of fire spread and behaviour and caused unreported mortality of adult redwoods growing next to the dead trees and scorched by the intense heat (Metz et al., 2013).

The presence and incidence of coast live oak (*Quercus agrifolia*) is also bound to change, and some local strong shifts towards Douglas fir forests may be observed. The extremely adaptable and drought-resistant woodlands dominated by coast live oaks, are much more resilient than Douglas fir stands to prolonged periods of drought. While almost 100% of tanoaks have died in the worst-hit localized areas (Davis et al., 2010), rates of mortality for coast live oak are much lower, not exceeding 40% (McPherson et al., 2002; McPherson et al., 2010). However, yearly oak estimates were done prior to the understanding that oak infection is episodic and occurs approximately once every 5 years (Garbelotto et al., 2017). In spite of this, the amount of tree cover has decreased significantly in some areas affected by SOD. This reduced cover enhances the potential for erosion and for the establishment of undesirable plant species, including non-natives. Finally, *P. ramorum* may have a detrimental, but more subtle, effect on hosts other than oaks and tanoaks. Infected trees may be more susceptible to decline in the event of the onset of unfavourable climatic or ecological conditions. *P. ramorum* may also significantly affect the regeneration of some host species: by reducing overall seed productivity (killing mature plants, causing branch dieback) and by directly killing seedlings. One recent discovery is the ability of the pathogen to infect several rare and endangered manzanitas (Garbelotto et al., 2020) during particularly wet years, something that occurred for the first time in 2017, and not in previous years, in spite of comparable precipitation values. This finding suggests that *P. ramorum* has truly become endemic in the greater San Francisco Bay area where it was presumably first introduced as early as 1987 (Croucher et al., 2013).

Diagnosis

P. ramorum will grow on most media used for other *Phytophthora* species such as cornmeal agar, PDA (not optimal), V8 and carrot agar (Werres et al., 2001). It grows relatively well between 15 and 22°C, but slows down significantly when temperatures go over 25°C. The most widely used selective medium to isolate *P. ramorum* from infected plants is corn meal based PARP (Rizzo et al., 2002a). While colonies will generally emerge from plated plant material within 6 days, at times up to 3 weeks has been necessary to obtain cultures. Cultures can be obtained from the following substrates: canker margins from oaks (*Quercus* spp.) and tanoaks (*Notholithocarpus densiflorus*), rhododendron leaves and stems, bay (*Umbellularia californica*). It is harder to isolate the pathogen from *Rhamnus*, *Pseudotsuga*, *Arbutus* or *Heteromeles*. From hosts such as *Arctostaphylos*, *Acer*, *Aesculus* and *Lonicera*, isolations can be extremely difficult. In California, a state characterized by an extremely marked Mediterranean climate, isolation success of *P. ramorum* follows a seasonal pattern, a trait not uncommon among *Phytophthora* spp. Isolation success tends to be best during late winter and spring, while it progressively declines as the dry California summer progresses. Almost every host has some specific requirements to maximise isolation success. The length of time that has passed between sample collection and processing has been shown to strongly affect the sensitivity of culture-based diagnostic methods (Vettraino et al., 2010).

For some foliar hosts, such as *Umbellularia* and *Rhododendron*, incubation in a moist chamber for 48 to 64 hours results in abundant sporulation. Sporangia and chlamydospores can then be analysed.

It is possible to bait *P. ramorum* from soil, streams, infected leaves, and to a limited extent from wood (Werres et al., 2001; Davidson et al., 2002c). The most common baits used for *P. ramorum* are pears, and 'Cunningham White' rhododendron leaves. Baiting is normally done for 5-7 days, and appears to be facilitated by temperatures between 12 and 15°C, at least for some substrates such as wood. Baits are collected at the end of the baiting period, left to dry for a couple of days, and then plated on selective PARP medium and incubated at 18°C. From mid-summer on, baiting from soil becomes unsuccessful. It is unclear whether this corresponds to a temporary dormancy period of the pathogen, or whether viability of the inoculum may be permanently lost. In infested areas it is possible to bait *P. ramorum* directly from the air by using healthy susceptible foliar hosts such as rhododendrons. Baiting from streams is strongly affected by air temperatures and season: in San Mateo County, Eyre et al. (2015) could not bait the pathogen out of almost 20 baiting stations starting in July and ending in November. Water baiting from plant production facilities may also be influenced by temperature, oxygen levels and by the presence of other microorganisms: Serrano et al. (2020) report that baiting from tanks of recycled irrigation water was only successful when baiting from the top layer of the water tanks and was never successful from the bottom layers. Success of baiting from top layers was also negatively affected by warmer temperatures and by the presence in the water of *Phytophthora chlamydospora*.

There is a wide selection of DNA PCR-based protocols to identify the pathogen both from cultures and directly from infected plant material (Garbelotto et al., 2003). The first government sanctioned protocol was that of Hayden et al. (2004). A nested PCR approach is needed to obtain a signal from most foliar hosts with the exception of bay and rhododendron leaves. Because of the difficulty in isolating the pathogen from most foliar hosts, it is recommended to back up diagnosis based on isolations, with PCR-based data. Vettraino et al. (2010) concluded that a combination of either culturing and molecular diagnosis, or of two molecular assays was the most successful approach to identifying *P. ramorum*. The best comparative analysis of various PCR methods by ring trials is that reported by Martin et al. (2009).

Tomlinson et al. (2005) developed a sensitive and specific single-round real-time PCR (TaqMan) assay using a portable real-time PCR platform. This has the advantage of being able to diagnose *P. ramorum* entirely in the field, independent of laboratory facilities.

Diagnostic methods are reviewed in Kliejunas (2010). For the USA, diagnostic and sampling protocols for official regulatory confirmations are posted at the USDA Animal and Plant Health Inspection Service (APHIS) *P. ramorum* website http://www.aphis.usda.gov/plant_health/plant_pest_info/pram/protocols.shtml#diag. A duplexPCR detection method, based on the internal transcribed spacer (ITS) regions of the ribosomal DNA, was developed by Schlenzig (2011) to enable sensitive detection of *P. ramorum* and to distinguish it from the similar *P. kernoviae*. Chimento et al. (2012) developed a real-time RT-PCR which is able to clearly distinguish between dead and viable *P. ramorum* pathogens.

Detection and Inspection

P. ramorum is difficult to diagnose from dead trees, even if death has occurred recently. Looking around the dead tree for trees with obvious symptoms (see Symptoms section) that are still green is recommended. Bleeding can be an easily visible symptom, but it can be due to a myriad of causes including mechanical wounding, cracking, insect attack and wood decay. Using a blade, cut the outer part of the bark and check for discoloration under it. A *P. ramorum* lesion may or may not have a clear zone line, but it will almost never have a regular shape. Borders are in general angular, and shape is often irregular. It is essential to uncover the border of the canker in order to diagnose a tree as infected by *P. ramorum*. Cultures should also come from the margin of the lesion (see Diagnosis).

Bleeding is not always associated with cankers, and is normally absent in small tanoak (*Notholithocarpus densiflorus*) branches. In these cases, cankers will be visible as slight depressions in the bark, often appearing slightly water-soaked. A dark-brown or black lesion, without zone lines, will be present under the bark.

For all other hosts, inspection for leaf and branch symptoms is the first step. In rhododendron, look for both leaf blight and branch cankers. The two are often connected, so it will be possible to follow a lesion from the leaf into the bearing stem, and vice-versa. Lesions on rhododendrons often have diffuse margins, or conversely, dark lines in a concentric pattern highlighting growth patterns of the pathogen. Visible branch dieback is normally seen as a second stage of infection.

In the case of *Umbellularia* foliage, there is a good correspondence between the side of the leaf carried downwards and location of the *P. ramorum* lesion. This is due to the fact that swimming zoospores (requiring free water) are the main infection propagule responsible for foliar infections. If leaves are carried sideways, lesions will develop on the lower blade; if they are carried with their tip downwards, lesions will develop on the leaf tips, and so forth.

In California, USA, the most valuable diagnostic approach is to focus not on one tree but on an entire area. The diagnosis is strengthened by identifying a few different hosts, each displaying their characteristic symptoms. The use of the database SODmap both on the web (www.sodmap.org) and through the Application SODmap Mobile for smartphones and tables (www.sodmapmobile.org) allows to determine whether the pathogen is present in any given locality (Garbelotto et al., 2014). A new database called Calinvasives and part of the Calflora database will be accessible in 2020 to geolocate all proven infestations by SOD and other emergent pathogens in California (calflora.org).

Similarities to Other Species/Conditions

Symptoms on plants are fairly generic and can be easily confused with those caused by other *Phytophthora* species, or with other fungal diseases. Culturing or molecular diagnostics need to be used to confirm pathogen presence.

P. ramorum cankers are in general above ground and do not develop in the roots: this feature can be helpful, but at times other *Phytophthora* species also cause aerial cankers. Lesions on *Umbellularia* resemble symptoms caused by bay anthracnose and by other *Phytophthora* species, in particular *P. nemorosa* and *P. pseudosyringae*, which are very common on the West Coast of the USA (Davidson et al., 2002b). The lack of fungal reproductive structures can assist in differentiating *P. ramorum* symptoms from other symptoms caused by fungi. Also, while fungi are facilitated by high relative humidity, infection by *Phytophthora* spp. requires a film of water, so correspondence between lesion location on a leaf and where water would accumulate can be a helpful diagnostic feature to differentiate fungal from *Phytophthora* infections. On *Rhododendron* spp., symptoms are identical to those caused by species such as *Phytophthora cactorum*, *P. citricola*, *P. citrophthora* and *P. nicotianae* for twig symptoms, and *P. syringae* for foliar symptoms (Werres et al., 2001).

On some hosts, foliar infection by *P. ramorum* leads to early leaf abscission. This is particularly noticeable in *Camellia* species, but other plant species, at times characterized by smaller leaves, and even California Bay laurels growing in warmer sites may develop the same symptoms. Some foliar hosts both in North America and in Europe are known to bear viable infections that are not visible as necrotic lesions, blotches or spots, and can only be detected by isolation, PCR or baiting (Denman et al., 2009).

Prevention and Control

Best management practices for *P. ramorum* are available at: <http://www.suddenoakdeath.org/diagnosis-and-management/best-management-practices/> and at www.matteolab.org

- Removal of California bay laurels (Garbelotto et al., 2017), tanoaks (Cobb et al., 2017) and Japanese larch (O'Hanlon et al., 2018) have all been shown to be effective.
- Employment of disease tolerant plants (Hayden et al., 2013; Conrad and Bonello, 2016; Cobb et al., 2019) holds significant promise and some results have been produced on higher survival of tanoak recruitment using disease tolerance.
- Planting non-susceptible species and other strategies are being developed to prevent or manage *P. ramorum* in wildlands (Lee et al., 2010; Swain and Alexander, 2010; Cobb et al. 2019).
- It has been shown that fresh wounds will be optimal infection courts; pruning of large branches or of stems should occur in the autumn, months in California before the rain-driven spread of *P. ramorum* occurs, or 4 months before the infectious period in other parts of the world.
- In restoration projects, avoid bay laurel (*Umbellularia californica*) if possible, especially in areas where oaks may be growing. Eradication has been attempted in southern Oregon, USA, via the burn-and-slash technique (Goheen et al., 2002b).
- Kiln drying: 55°C for 30 minutes was insufficient to kill the pathogen. At least 1 hour is required but only for substrates without abundant chlamydospores such as wood. If substrate supports chlamydospores 2 weeks at 55°C were necessary to kill the pathogen. However, vacuum plus exposure at 55°C, together killed the pathogen after 22 hours (Harnik et al., 2004).
- Composting following EPA guidelines for California is completely successful in eliminating the pathogen (Swain et al., 2006), however mature compost can be re-infected by the pathogen if exposed to large amounts of inoculum (Swain and Garbelotto, 2015).
- *P. ramorum* is susceptible to label-dosages of copper sulfates and copper hydroxides (Garbelotto et al., 2009). In different formulations it is moderately susceptible to mancozeb. The pathogen is sensitive to phosphites or phosphonates. Phosphite injections are effective in oaks for 2 years (Garbelotto and Schmidt, 2009) and also temporarily in tanoaks (*Notholithocarpus densiflorus*). Phosphite foliar sprays are not effective on oaks and tanoaks. The pathogen is extremely sensitive to metalaxyl, but drenches and foliar sprays are ineffective in oaks (Garbelotto et al., 2007; Garbelotto et al., 2009).
- Water and moisture management are extremely important, especially when temperatures are between 15 and 20°C. Infection on bay (*Umbellularia californica*) leaves requires 9-12 hours of leaf wetness. Oak infection requires 250 mm of rain in for 3-6 weeks and at least 1 week when max temperature daily reaches 20°C (Garbelotto et al., 2017).
- Natural contagion from oaks is estimated to be low: susceptible oaks should not be planted near foliar hosts like bays and rhododendrons.
- Early infection can be detected on foliar hosts: new infection on bay leaves are good signs of inoculum level.
- Sites, soil and streams can be monitored by baiting with rhododendron leaves (Davidson et al., 2002c).
- Removal of California bays 10 and 20 m around oaks has been proven highly effective in reducing possible infection events and remains the main prescription to preventatively protect oaks from becoming infected (Garbelotto et al., 2017).
- Sanitation of small tools such as axes, hand saws or chain saws is best done by removing all organic debris, followed, if desired, by treatment with lysol, 70% ethanol, or a 10% dilution of commercial bleach.

References

- Alexander, J., 2012. The past, present, and future of sudden oak death. *Outlooks on Pest Management*, 23(2), 72-75. <http://www.pestoutlook.com> doi: 10.1564/23apr07
- Anacker, B. L., Rank, N. E., Hüberli, D., Garbelotto, M., Gordon, S., Harnik, T., Whitkus, R., Meentemeyer, R., 2008. Susceptibility to *Phytophthora ramorum* in a key infectious host: landscape variation in host genotype, host phenotype, and environmental factors. *New Phytologist*, 177(3), 756-766. doi: 10.1111/j.1469-8137.2007.02297.x
- Beales PA, Brokenshire T, Barnes AV, Barton VC, Hughes KJD, 2004. First report of ramorum leaf blight and dieback (*Phytophthora ramorum*) on *Camellia* spp. in the UK. *Plant Pathology* 53(4):524
- Beales PA, Schlenzig A, Inman AJ, 2004. First report of ramorum bud and leaf blight (*Phytophthora ramorum*) on *Syringa vulgaris* in the UK. *Plant Pathology* 53(4):525
- Beales, P. A., Brokenshire, T., Barnes, A. V., Barton, V. C., Hughes, K. J. D., 2004. First report of ramorum leaf blight and dieback (*Phytophthora ramorum*) on *Camellia* spp. in the UK. *Plant Pathology*, 53(4), 524. doi: 10.1111/j.1365-3059.2004.01028.x
- Beales, P. A., Schlenzig, A., Inman, A. J., 2004. First report of ramorum bud and leaf blight (*Phytophthora ramorum*) on *Syringa vulgaris* in the UK. *Plant Pathology*, 53(4), 525. doi: 10.1111/j.1365-3059.2004.01033.x
- Bergemann, S. E., Garbelotto, M., 2006. High diversity of fungi recovered from the roots of mature tanoak (*Lithocarpus densiflorus*) in northern California. *Canadian Journal of Botany*, 84(9), 1380-1394. doi: 10.1139/B06-097
- Bergemann, S. E., Kordesch, N. C., VanSant-Glass, W., Garbelotto, M., Metz, T. A., 2013. Implications of tanoak decline in forests impacted by *Phytophthora ramorum*: girdling decreases the soil hyphal abundance of ectomycorrhizal fungi associated with *Notholithocarpus densiflorus*. *Madroño*, 60(2), 95-106. doi: 10.3120/0024-9637-60.2.95
- Bilodeau GJ, Lévesque CA, Cock AWAMde, Brière SC, Hamelin RC, 2007. Differentiation of European and North American genotypes of *Phytophthora ramorum* by real-time polymerase chain reaction primer extension. *Canadian Journal of Plant Pathology*, 29(4):408-420. <http://pubs.nrc-cnrc.gc.ca/tcjpg/plant.html>
- Bily, D. S., Diehl, S. V., Cook, M., Wallace, L. E., Sims, L. L., Watson, C., Baird, R. E., 2018. Temporal and locational variations of a *Phytophthora* spp. community in an urban forested water drainage and stream-runoff system. *Southeastern Naturalist*, 17(1), 176-201. doi: 10.1656/058.017.0118
- Blomquist CL, Rooney-Latham S, Soriano MC, McCarty JC, 2012. First report of *Phytophthora ramorum* causing a leafspot on *Loropetalum chinense*, Chinese fringe flower in California. *Plant Disease*, 96(12):1829. <http://apsjournals.apsnet.org/loi/pdis>
- Boutet, X., Vercauteren, A., Heungens, K., Laurent, F., Chandelier, A., 2010. Oospores progenies from *Phytophthora ramorum*. *Fungal Biology*, 114(4), 369-378. doi: 10.1016/j.funbio.2010.02.009
- Brasier C, Webber J, 2010. Plant pathology: Sudden larch death. *Nature*, 466(7308):824-825
- Brasier CM, Webber JF, 2012. Natural stem infection of Lawson cypress (*Chamaecyparis lawsoniana*) caused by *Phytophthora ramorum*. *New Disease Reports*, 25:26. <http://www.ndrs.org.uk/article.php?id=025026>
- Brasier, C. M., Denman, S., Rose, J., Kirk, S. A., Hughes, K. J. D., Griffin, R. L., Lane, C. R., Inman, A. J., Webber, J. F., 2004. First report of ramorum bleeding canker on *Quercus falcata*, caused by *Phytophthora ramorum*. *Plant Pathology*, 53(6), 804. doi: 10.1111/j.1365-3059.2004.01079.x
- Brazee, N. J., Wick, R. L., Hulvey, J. P., 2016. *Phytophthora* species recovered from the Connecticut River Valley in Massachusetts, USA. *Mycologia*, 108(1), 6-19. <http://www.mycologia.org/content/108/1/6.abstract> doi: 10.3852/15-038
- Briere, S. C., Llewellyn, S., Kristjansson, G., 2005. First Report of *Pyraecanthia koidzumii* as a Host for *Phytophthora ramorum*. [Proceedings of the Sudden Oak Death Second Science Symposium: The State of Our Knowledge], USA: United States Department of Agriculture. 496. https://www.fs.fed.us/psw/publications/documents/psw_gtr196/psw_gtr196_008_P04Briere.pdf
- Brown, A. V., Brasier, C. M., 2007. Colonization of tree xylem by *Phytophthora ramorum*, *P. kernoviae* and other *Phytophthora* species. *Plant Pathology*, 56(2), 227-241. doi: 10.1111/j.1365-3059.2006.01511.x
- Bulajic A, Djekic I, Jovic J, Krnjajic S, Vucurovic A, Krstic B, 2010. *Phytophthora ramorum* occurrence in ornamentals in Serbia. *Plant Disease*, 94(6):703-708. <http://apsjournals.apsnet.org/loi/pdis>
- Bulajić, A., Jović, J., Krnjajić, S., Djekić, I., Krstić, B., 2009. First report of *Phytophthora ramorum* on *Rhododendron* sp. in Serbia. *Plant Pathology*, 58(4), 804. doi: 10.1111/j.1365-3059.2009.02033.x

- Bush, E. A., Stromberg, E. L., Hong, C., Richardson, P. A., Kong, P., 2006. Illustration of key morphological characteristics of *Phytophthora* species identified in Virginia nursery irrigation water. <https://www.plantmanagementnetwork.org/pub/php/diagnosticguide/2006/va/Phytophthora.pdf>
- CABI/EPPO, 2006. *Phytophthora ramorum*. Distribution Maps of Plant Diseases, No. 978. Wallingford, UK: CAB International
- CABI/EPPO, 2013. *Phytophthora ramorum*. [Distribution map]. Distribution Maps of Plant Diseases, No. April. Wallingford, UK: CABI, Map 978 (Edition 2)
- Chastagner G, Oak S, Omdal D, Ramsey-Kroll A, Coats K, Valachovic Y, Lee C, Hwang J, Jeffers S, Elliott M, 2009. Spread of *P. ramorum* from nurseries into waterways—implications for pathogen establishment in new areas. In: Proceedings of the sudden oak death fourth science symposium PSW-GTR-229 [ed. by Frankel, S. J. \Kliejunas, J. T. \Palmieri, K. M.]. Albany, California, USA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station, 22-25
- Chastagner, G. A., Riley, K. L., 2010. First report of *Phytophthora ramorum* infecting California red fir in California. *Plant Disease*, 94(9), 1170. doi: 10.1094/PDIS-94-9-1170B
- Chastagner, G., Coats, K., Elliott, M., 2012. An overview of *Phytophthora ramorum* in Washington State. In: Proceedings of the Sudden Oak Death Fifth Science Symposium, General Technical Report PSW-GTR-243, Petaluma, CA, 14-15
- Chastagner, G., Oak, S., Omdal, D., Ramsey-Kroll, A., Coats, K., Valachovic, Y., Lee, C., Hwang, J., Jeffers, S., Elliott, M., 2010. Spread of *P. ramorum* from Nurseries into Waterways—Implications for Pathogen Establishment in New Areas. In: S. J. Frankel, J. T. Kliejunas, and K. M. Palmieri, (tech coords.). Proceedings of the Sudden Oak Death Fourth Science Symposium, General Technical Report PSW-GTR-229. U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station, Santa Cruz, CA, 22-26
- Chimento A, Cacciola SO, Garbelotto M, 2012. Detection of mRNA by reverse-transcription PCR as an indicator of viability in *Phytophthora ramorum*. *Forest Pathology*, 42(1):14-21. [http://onlinelibrary.wiley.com/journal/10.1111/\(ISSN\)1439-0329](http://onlinelibrary.wiley.com/journal/10.1111/(ISSN)1439-0329)
- Cobb RC, Chan MN, Meentemeyer RK, Rizzo DM, 2011. Common Factors Drive Disease and Coarse Woody Debris Dynamics in Forests Impacted by Sudden Oak Death. *Ecosystems*, DOI: 10.1007/s10021-011-9506-y
- Cobb, R. C., Filipe, J. A. N., Meentemeyer, R. K., Gilligan, C. A., Rizzo, D. M., 2012. Ecosystem transformation by emerging infectious disease: loss of large tanoak from California forests. *Journal of Ecology (Oxford)*, 100(3), 712-722. doi: 10.1111/j.1365-2745.2012.01960.x
- Cobb, R. C., Hartsough, P., Frangioso, K., Klein, J., Swezy, M., Williams, A., Sanders, C., Frankel, S. J., Rizzo, D. M., 2017. Restoration management in redwood forests degraded by sudden oak death. In: General Technical Report - Pacific Southwest Research Station, USDA Forest Service,(No.PSW-GTR-258) . Berkeley, USA: Pacific Southwest Research Station, USDA Forest Service. 429-434. https://www.fs.fed.us/psw/publications/documents/psw_gtr258/psw_gtr258_429.pdf
- Cobb, R. C., Meentemeyer, R. K., Rizzo, D. M., 2010. Apparent competition in canopy trees determined by pathogen transmission rather than susceptibility. *Ecology*, 91(2), 327-333. doi: 10.1890/09-0680.1
- Cobb, R. C., Rizzo, D. M., Hayden, K. J., Garbelotto, M., Filipe, J. A. N., Gilligan, C. A., Dillon, W. W., Meentemeyer, R. K., Valachovic, Y. S., Goheen, E., Swiecki, T. J., Hansen, E. M., Frankel, S. J., 2013. Biodiversity conservation in the face of dramatic forest disease: an integrated conservation strategy for tanoak (*Notholithocarpus densiflorus*) threatened by sudden oak death. *Madroño*, 60(2), 151-164. doi: 10.3120/0024-9637-60.2.151
- Cobb, R. C., Ross, N., Hayden, K. J., Eyre, C. A., Dodd, R. S., Frankel, S. J., Garbelotto, M., Rizzo, D. M., 2019. Promise and pitfalls of endemic resistance for cultural resources threatened by *Phytophthora ramorum*. *Phytopathology*, 109(5), 760-769. doi: 10.1094/PHYTO-04-18-0142-R
- COMTF, 2017a. <http://www.suddenoakdeath.org/library/> California Oak Mortality Task Force, 5 pp
- COMTF, 2017b. http://www.suddenoakdeath.org/wp-content/uploads/2018/03/PRamorumChronology_3.7.18.pdf California Oak Mortality Task Force, 68 pp
- COMTF, 2017c. http://www.suddenoakdeath.org/wp-content/uploads/2018/03/Nursery_Chronology_3.7.18.pdf California Oak Mortality Task Force, 57 pp
- Condeso, T. E., Meentemeyer, R. K., 2007. Effects of landscape heterogeneity on the emerging forest disease sudden oak death. *Journal of Ecology (Oxford)*, 95(2), 364-375. doi: 10.1111/j.1365-2745.2006.01206.x
- Conrad, A. O., Bonello, P., 2016. Application of infrared and raman spectroscopy for the identification of disease resistant trees. *Frontiers in Plant Science*, 7(January), 1152. <http://journal.frontiersin.org/article/10.3389/fpls.2015.01152/full>
- Conrad, A. O., McPherson, B. A., Wood, D. L., Madden, L. V., Bonello, P., 2017. Constitutive phenolic biomarkers identify naïve *Quercus agrifolia* resistant to *Phytophthora ramorum*, the causal agent of sudden oak death. *Tree Physiology*, 37(12), 1686-1696. <https://academic.oup.com/treephys/article-abstract/37/12/1686/4237727>

- Croucher, P. J. P., Mascheretti, S., Garbelotto, M., 2013. Combining field epidemiological information and genetic data to comprehensively reconstruct the invasion history and the microevolution of the sudden oak death agent *Phytophthora ramorum* (Stramenopila: Oomycetes) in California. *Biological Invasions*, 15(10), 2281-2297. doi: 10.1007/s10530-013-0453-8
- Cunniffe, N. J., Cobb, R. C., Meentemeyer, R. K., Rizzo, D. M., Gilligan, C. A., 2016. Modeling when, where, and how to manage a forest epidemic, motivated by sudden oak death in California. *Proceedings of the National Academy of Sciences of the United States of America*, 113(20), 5640-5645. <http://www.pnas.org/content/113/20/5640.full> doi: 10.1073/pnas.1602153113
- Dale, A. L., Feau, N., Everhart, S. E., Dhillon, B., Wong, B., Sheppard, J., Bilodeau, G. J., Brar, A., Tabima, J. F., Shen, D., Brasier, C. M., Tyler, B. M., Grünwald, N. J., Hamelin, R. C., 2019. Mitotic recombination and rapid genome evolution in the invasive forest pathogen *Phytophthora ramorum*. *mBio*, 10(2), e02452-18. doi: 10.1128/mbio.02452-18
- Davidson JM, Garbelotto M, Koike ST, Rizzo DM, 2002. First report of *Phytophthora ramorum* on Douglas-fir in California. *Plant Disease*, 86(11):1274; 2 ref
- Davidson JM, Hansen EM, Garbelotto M, Reeser P, Rizzo DM, 2002. Another canker-causing *Phytophthora* on oaks and tanoak in forests of California and Oregon. *Phytopathology*, 92:S18
- Davidson JM, Rizzo DM, Garbelotto M, 2002. *Phytophthora ramorum* and Sudden Oak Death in California: II. Pathogen transmission and survival. In: Standiford R, McCreary D, eds. 5th Symposium on California Oak Woodlands, USDA Forest Service. Gen. Tech. PSW-GTR-184, 741-749
- Davis, F. W., Borchert, M., Meentemeyer, R. K., Flint, A., Rizzo, D. M., 2010. Pre-impact forest composition and ongoing tree mortality associated with sudden oak death in the Big Sur region; California. *Forest Ecology and Management*, 259(12), 2342-2354. doi: 10.1016/j.foreco.2010.03.007
- Denman, S., Kirk, S. A., Brasier, C. M., Barton, V. C., Hughes, K. J. D., Webber, J. F., 2005. *Phytophthora ramorum* on *Quercus ilex* in the United Kingdom. *Plant Disease*, 89(11), 1241. doi: 10.1094/PD-89-1241A
- Denman, S., Kirk, S. A., Brasier, C. M., Hughes, K. J. D., Griffin, R., Hobdon, E., Webber, J. F., 2005. Foliar infection of sweet chestnut (*Castanea sativa*) by *Phytophthora ramorum* in the UK. *Plant Pathology*, 54(4), 581. doi: 10.1111/j.1365-3059.2005.01222.x
- Denman, S., Kirk, S. A., Moralejo, E., Webber, J. F., 2009. *Phytophthora ramorum* and *Phytophthora kernoviae* on naturally infected asymptomatic foliage. *Bulletin OEPP/EPPO Bulletin*, 39(1), 105-111. doi: 10.1111/j.1365-2338.2009.02243.x
- DiLeo, M. V., Bienapfl, J. C., Rizzo, D. M., 2008. *Phytophthora ramorum* infects hazelnut, vine maple, blue blossom, and manzanita species in California. *Plant Health Progress*, (January), 0118-02.
- DiLeo, M. V., Bostock, R. M., Rizzo, D. M., 2014. Microclimate impacts survival and prevalence of *Phytophthora ramorum* in *Umbellularia californica*, a key reservoir host of sudden oak death in northern California forests. *PLoS ONE*, 9(8), e98195. doi: 10.1371/journal.pone.0098195
- Dodd, R. S., Hüberli, D., Douhovnikoff, V., Harnik, T. Y., Afzal-Rafii, Z., Garbelotto, M., 2005. Is variation in susceptibility to *Phytophthora ramorum* correlated with population genetic structure in coast live oak (*Quercus agrifolia*)?. *New Phytologist*, 165(1), 203-214. doi: 10.1111/j.1469-8137.2004.01200.x
- Elliott, M., Rollins, L., Bourret, T., Chastagner, G., 2021. First report of leaf blight caused by *Phytophthora ramorum* on cherry Laurel (*Prunus laurocerasus*) in Washington State, U.S.A. *Plant Disease*, 105(3), 712-712. doi: 10.1094/PDIS-07-20-1489-PDN
- Elliott, M., Rollins, L., Bourret, T., Chastagner, G., 2021. First report of leaf blight caused by *Phytophthora ramorum* on periwinkle (*Vinca minor*) in Washington State, U.S.A. *Plant Disease*, 105(7), 2023-2023. doi: 10.1094/PDIS-08-20-1721-PDN
- Elliott, M., Shamoun, S. F., Sumampong, G., 2015. Effects of systemic and contact fungicides on life stages and symptom expression of *Phytophthora ramorum* in vitro and in planta. *Crop Protection*, 67, 136-144. doi: 10.1016/j.cropro.2014.10.008
- Elliott, M., Sumampong, G., Varga, A., Shamoun, S. F., James, D., Masri, S., Grünwald, N. J., 2011. Phenotypic differences among three clonal lineages of *Phytophthora ramorum*. *Forest Pathology*, 41(1), 7-14. doi: 10.1111/j.1439-0329.2009.00627.x
- Elliott, M., Yuzon, J., Malar, C. M., Sucheta Tripathy, Bui, M., Chastagner, G. A., Coats, K., Rizzo, D. M., Garbelotto, M., Kasuga, T., 2018. Characterization of phenotypic variation and genome aberrations observed among *Phytophthora ramorum* isolates from diverse hosts. *BMC Genomics*, 19(320), (2 May 2018). doi: 10.1186/s12864-018-4709-7
- EPPO, 2011. EPPO Reporting Service. EPPO Reporting Service. Paris, France: EPPO. http://archives.eppo.org/EPPOReporting/Reporting_Archives.htm
- EPPO, 2014. PQR database. Paris, France: European and Mediterranean Plant Protection Organization. <http://www.eppo.int/DATABASES/pqr/pqr.htm>

EPPO, 2019. EPPO Global Database. Paris, France: EPPO.<https://gd.eppo.int>

Eyre, C. A., Garbelotto, M., 2015. Detection, diversity, and population dynamics of waterborne *Phytophthora ramorum* populations. *Phytopathology*, 105(1), 57-68. doi: 10.1094/PHYTO-07-13-0196-R

Eyre, C. A., Hayden, K. J., Kozanitas, M., Grünwald, N. J., Garbelotto, M., 2014. Lineage, temperature, and host species have interacting effects on lesion development in *Phytophthora ramorum*. *Plant Disease*, 98(12), 1717-1727. doi: 10.1094/PDIS-02-14-0151-RE

Eyre, C. A., Kozanitas, M., Garbelotto, M., 2013. Population dynamics of aerial and terrestrial populations of *Phytophthora ramorum* in a California forest under different climatic conditions. *Phytopathology*, 103(11), 1141-1152. doi: 10.1094/PHYTO-11-12-0290-R

Fichtner, E. J., Lynch, S. C., Rizzo, D. M., 2007. Detection, distribution, sporulation, and survival of *Phytophthora ramorum* in a California redwood-tanoak forest soil. *Phytopathology*, 97(10), 1366-1375. doi: 10.1094/PHYTO-97-10-1366

Florida Department of Agriculture and Consumer Services, 2004. Florida Department of Agriculture and Consumer Services. Florida, USA. <http://www.doacs.fl.us>

Forrestel, A. B., Ramage, B. S., Moody, T., Moritz, M. A., Stephens, S. L., 2015. Disease, fuels and potential fire behavior: impacts of Sudden Oak Death in two coastal California forest types. *Forest Ecology and Management*, 348, 23-30. doi: 10.1016/j.foreco.2015.03.024

Franceschini, S., Webber, J. F., Sancisi-Frey, S., Brasier, C. M., 2014. Gene × environment tests discriminate the new EU2 evolutionary lineage of *Phytophthora ramorum* and indicate that it is adaptively different. *Forest Pathology*, 44(3), 219-232. doi: 10.1111/efp.12085

Frankel SJ, 2008. Sudden oak death and *Phytophthora ramorum* in the USA: a management challenge. *Australasian Plant Pathology*, 37(1):19-25. <http://www.publish.csiro.au/nid/39/paper/AP07088.htm>

Frankel SJ, Hansen EM, 2011. Forest phytophthora diseases in the Americas: 2007-2010. New Zealand Journal of Forestry Science [Fifth Meeting of the IUFRO Working Party S07-02-09, Phytophthora Diseases in Forests and Natural Ecosystems, Auckland and Rotorua, New Zealand, 7-12 March 2010.], 41(Suppl.):S159-S167. http://www.scionresearch.com/__data/assets/pdf_file/0010/35947/NZJFS-41S2011S159-S167_FRANKEL.pdf

Frankel, S. J., Palmieri, K. M., 2014. Sudden Oak Death, *Phytophthora ramorum*: A persistent threat to oaks and other tree species. *International Oaks*, 25, 43-56.

Garbelotto M, 2003. Composting as a control for sudden oak death disease. *BioCycle*, 44(2):53-56

Garbelotto M, Barbosa D, Mehl H, Rizzo DM, 2014. First report of the NA2 lineage of *Phytophthora ramorum* from an ornamental rhododendron in the interior of California. *Plant Disease*, 98(6):849-850. <http://apsjournals.apsnet.org/loi/pdis>

Garbelotto M, Davidson JM, Ivors K, Maloney PE, Hnberli D, Koike ST, Rizzo DM, 2003. Non-oak native plants are main hosts for sudden oak death pathogen in California. *California Agriculture*, 57(1):18-23; 15 ref

Garbelotto M, Popenuck T, Hall B, Schweigkofler W, Dovana F, Goldstein de Salazar R, Schmidt D, Sims LL, 2020. *Plant Disease*

Garbelotto M, Rizzo DM, Hayden K, Davidson JM, Tjosvold S, 2002. *Phytophthora ramorum* and Sudden Oak Death in California: III. Pathogen genetics. In: Standiford R, McCreary D, eds. 5th Symposium on California Oak Woodlands, USDA Forest Service. Gen. Tech. PSW-GTR-184, 765-774

Garbelotto M, Rizzo DM, Marais L, 2002. *Phytophthora ramorum* and Sudden Oak Death in California: IV. Chemical control. In: Standiford R, McCreary D, eds. 5th Symposium on California Oak Woodlands, USDA Forest Service. Gen. Tech. PSW-GTR-184, 811-818

Garbelotto M, Svihra P, Rizzo DM, 2001. Sudden oak death syndrome fells three oak species. *California Agriculture*, 55:9-19

Garbelotto, M., Harnik, T. Y., Schmidt, D. J., 2009. Efficacy of phosphonic acid, metalaxyl-M and copper hydroxide against *Phytophthora ramorum* in vitro and in planta. *Plant Pathology*, 58(1), 111-119. doi: 10.1111/j.1365-3059.2008.01894.x

Garbelotto, M., Hayden, K. J., 2012. Sudden oak death: interactions of the exotic oomycete *Phytophthora ramorum* with naïve North American hosts. *Eukaryotic Cell*, 11(11), 1313-1323. doi: 10.1128/EC.00195-12

Garbelotto, M., Maddison, E. R., Schmidt, D., 2014. SODmap and SODmap mobile: two tools to monitor the spread of sudden oak death. *Forest Phytophthoras*, 4(1), 3335. <http://journals.library.oregonstate.edu/index.php/ForestPhytophthora/article/view/3560/3335>

Garbelotto, M., Schmidt, D. J., 2009. Phosphonate controls sudden oak death pathogen for up to 2 years. *California Agriculture*, 63(1), 10-17. doi: 10.3733/ca.v063n01p10

Garbelotto, M., Schmidt, D. J., Harnik, T. Y., 2007. Phosphite injections and bark application of phosphite+Pentrabark™ control sudden oak death in coast live oak. *Arboriculture & Urban Forestry*, 33(5), 309-317. <http://joa.isa-arbor.com/articles.asp?JournalID=1&VolumeID=33&IssueID=5>

- Garbelotto, M., Schmidt, D., Swain, S., Hayden, K., Lione, G., 2017. The ecology of infection between a transmissible and a dead-end host provides clues for the treatment of a plant disease. *Ecosphere*, 8(5), e01815. doi: 10.1002/ecs2.1815
- Gillman, D., 2011. Fact Sheet: *Phytophthora ramorum*. <https://ag.umass.edu/landscape/fact-sheets/phytophthora-ramorum>
- Giltrap PM, Inman AJ, Barton VC, Barnes AV, Lane CR, Hughes KJD, Tomlinson J, Dean ML, Izzard K, 2004. First report of *ramorum* dieback (*Phytophthora ramorum*) on *Hamamelis virginiana* in the UK. *Plant Pathology*, 53(4):526. <http://www.blackwellpublishing.com/ppa>
- Giltrap, P. M., Hughes, K. J. D., Barton, V. C., Hobden, E., Barber, P., Izzard, K., 2006. *Phytophthora ramorum* on three new hosts detected using on-site diagnostics. *New Disease Reports*, 14. <https://www.ndrs.org.uk/article.php?id=014034>
- Giltrap, P. M., Hughes, K. J. D., Barton, V. C., Hobden, E., Barber, P., Izzard, K., 2007. *Phytophthora ramorum* on three new hosts detected using on-site diagnostics. *Plant Pathology*, 56(4), 728. doi: 10.1111/j.1365-3059.2007.01590.x
- Ginetti B, Carmignani S, Ragazzi A, Werres S, Moricca S, 2014. Foliar blight and shoot dieback caused by *Phytophthora ramorum* on *Viburnum tinus* in the Pistoia area, Tuscany, central Italy. *Plant Disease*, 98(3):423. <http://apsjournals.apsnet.org/doi/abs/10.1094/PDIS-07-13-0767-PDN>
- Goheen EM, Hansen EM, Kanaskie A, McWilliams MG, Osterbauer N, Sutton W, 2002a. Sudden oak death caused by *Phytophthora ramorum* in Oregon. *Plant Disease*, 86(4), 441.
- Goheen EM, Hansen EM, Kanaskie A, McWilliams MG, Osterbauer N, Sutton W, 2002b. Eradication of sudden oak death in Oregon. *Phytopathology*, 92:S30 (abstract)
- Goheen, E. M., Kanaskie, A., Hansen, E., Sutton, W., Reeser, P., Osterbauer, N., 2013. Monitoring the effectiveness of *Phytophthora ramorum* eradication treatments in Oregon tanoak forests. In: Proceedings of the Sudden Oak Death Fifth Science Symposium Gen. Tech. Rep. PSW-GTR-243. U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station, Albany, CA, p. 119
- Goheen, E. M., Kanaskie, A., Navarro, S., Hansen, E., 2017. Sudden oak death management in Oregon tanoak forests. *Forest Phytophthoras*, 7(1), 45-53.
- Gomes Mde J, Amaro PT, 2008. Occurrence of *Phytophthora ramorum* in Portugal on *Viburnum* spp. (Ocorência de *Phytophthora ramorum* em Portugal sobre *Viburnum* spp.) *Revista de Ciências Agrárias (Portugal)*, 31(2):105-111
- Gruyter, J. de, Steeghs, M. H. C. G., 2006. Managing *Phytophthora ramorum* in the Netherlands. *Bulletin OEPP/EPPO Bulletin*, 36(2), 399-401. <http://www.blackwell-synergy.com/servlet/useragent?func=showIssues&code=epp>
- Grünwald NJ, Garbelotto M, Goss EM, Huengens K, Prospero S, 2012. Emergence of the sudden oak death pathogen *Phytophthora ramorum*. *Trends of Microbiology*, 20(3):131-138
- Grünwald NJ, Goss EM, Ivors K, Garbelotto M, Martin FN, Prospero S, Hansen E, Bonants PJM, Hamelin RC, Chastagner G, Werres S, Rizzo DM, Abad G, Beales P, Bilodeau GJ, Blomquist CL, Brasier C, Brière SC, Chandelier A, Davidson JM, Denman S, Elliott M, Frankel SJ, Goheen EM, Gruyter Hde, Heungens K(et al), 2009. Standardizing the nomenclature for clonal lineages of the sudden oak death pathogen, *Phytophthora ramorum*. *Phytopathology*, 99(7):792-795. <http://www.apsnet.org/phyto/>
- Grünwald NJ, Larsen MM, Kamvar ZN, Reeser PW, Kanaskie A, Laine J, Wiese R, 2016. First report of the EU1 clonal lineage of *Phytophthora ramorum* on tanoak in an Oregon forest. *Plant Disease*, 100(5):1024. <http://apsjournals.apsnet.org/loi/pdis>
- Grünwald, N. J., Goss, E. M., Larsen, M. M., Press, C. M., McDonald, V. T., Blomquist, C. L., Thomas, S. L., 2008. First report of the European lineage of *Phytophthora ramorum* on *Viburnum* and *Osmanthus* spp. in a California nursery. *Plant Disease*, 92(2), 314. doi: 10.1094/PDIS-92-2-0314B
- Grünwald, N. J., LeBoldus, J. M., Hamelin, R. C., 2019. Ecology and evolution of the sudden oak death pathogen *Phytophthora ramorum*. *Annual Review of Phytopathology*, 57, 301-321. doi: 10.1146/annurev-phyto-082718-100117
- Hall KM, Albers HJ, 2009. Economic Analysis for the Impact of *Phytophthora ramorum* on Oregon Forest Industries. Unpublished report. Department of Agricultural and Resource Economics, Oregon State University, 97331-3601. Corvallis, Oregon, USA: Department of Agricultural and Resource Economics, Oregon State University, 14. http://nature.berkeley.edu/comtf/pdf/SOD_ECON_ANALYSIS_%20Report_5-1-09.pdf
- Hansen EM, Kanaskie A, Prospero S, McWilliams M, Goheen EM, Osterbauer N, Reeser P, Sutton W, 2008. Epidemiology of *Phytophthora ramorum* in Oregon tanoak forests. *Canadian Journal of Forest Research*, 38(5):1133-1143. <http://cjfr.nrc.ca>
- Hansen EM, Sutton W, 2002. Log inoculations to assess tree susceptibility to sudden oak death. *Phytopathology*, 92:S33 (abstract)
- Hansen, E. M., Parke, J. L., Sutton, W., 2005. Susceptibility of Oregon forest trees and shrubs to *Phytophthora ramorum*: a comparison of artificial inoculation and natural infection. *Plant Disease*, 89(1), 63-70. doi: 10.1094/PD-89-0063

- Hansen, E. M., Reeser, P. W., Sutton, W., Winton, L. M., Osterbauer, N., 2003. First report of A1 mating type of *Phytophthora ramorum* in North America. *Plant Disease*, 87(10), 1267. doi: 10.1094/PDIS.2003.87.10.1267A
- Harnik, T. Y., Mejia-Chang, M., Lewis, J., Garbelotto, M., 2004. Efficacy of heat-based treatments in eliminating the recovery of the sudden oak death pathogen (*Phytophthora ramorum*) from infected California bay laurel leaves. *HortScience*, 39(7), 1677-1680.
- Harris, A. R., Webber, J. F., 2016. Sporulation potential, symptom expression and detection of *Phytophthora ramorum* on larch needles and other foliar hosts. *Plant Pathology*, 65(9), 1441-1451. doi: 10.1111/ppa.12538
- Hayden KJ, Nettel A, Dodd RS, Garbelotto M, 2011. Will all the trees fall? Variable resistance to an introduced forest disease in a highly susceptible host. *Forest Ecology and Management*, 261(11):1781-1791.
- Hayden, K. J., Garbelotto, M., Dodd, R., Wright, J. W., 2013. Scaling up from greenhouse resistance to fitness in the field for a host of an emerging forest disease. *Evolutionary Applications*, 6(6), 970-982. doi: 10.1111/eva.12080
- Hayden, K. J., Rizzo, D., Tse, J., Garbelotto, M., 2004. Detection and quantification of *Phytophthora ramorum* from California forests using a real-time polymerase chain reaction assay. *Phytopathology*, 94(10), 1075-1083. doi: 10.1094/PHYTO.2004.94.10.1075
- Herrero, M. L., Toppe, B., Brurberg, M. B., 2011. First report of *Phytophthora ramorum* causing shoot dieback on bilberry (*Vaccinium myrtillus*) in Norway. *Plant Disease*, 95(3), 355. doi: 10.1094/PDIS-10-10-0709
- Herrero, M. L., Toppe, B., Klemsdal, S. S., Stensvand, A., 2006. First report of *Phytophthora ramorum* in ornamental plants in Norway. *Plant Disease*, 90(11), 1458. doi: 10.1094/PD-90-1458B
- Hicks, C. B., 2018. 26 pp. Unpublished Report. USDA-APHIS, Raleigh, USA
- Hong, C., Richardson, P., Kong, P., Edgerton, T., Asaro, C., Oak, S., 2011. *Phytophthora* species identified from streams in Virginia. *Phytopathology*, 101(6S), 74.
- Hughes, K. J. D., Giltrap, P. M., Barton, V. C., Hobden, E., Tomlinson, J. A., Barber, P., 2006. On-site real-time PCR detection of *Phytophthora ramorum* causing dieback of *Parrotia persica* in the UK. *Plant Pathology*, 55(6), 813. doi: 10.1111/j.1365-3059.2006.01461.x
- Hulvey, J., Gobena, D., Finley, L., Lamour, K., 2010. Co-occurrence and genotypic distribution of *Phytophthora* species recovered from watersheds and plant nurseries of eastern Tennessee. *Mycologia*, 102(5), 1127-1133. doi: 10.3852/09-221
- Husson, C., Delatour, C., Frey, P., Marçais, B., Saurat, C., Schenck, N., 2007. First report of *Phytophthora ramorum* on ornamental plants in France. *Plant Disease*, 91(10), 1359. doi: 10.1094/PDIS-91-10-1359B
- Hüberli D, Sant-Glass Wvan, Tse JG, Garbelotto M, 2003. First report of foliar infection of starflower by *Phytophthora ramorum*. *Plant Disease*, 87(5):599; 2 ref
- Hüberli, D., Garbelotto, M., 2012. *Phytophthora ramorum* is a generalist plant pathogen with differences in virulence between isolates from infectious and dead-end hosts. *Forest Pathology*, 42(1), 8-13. doi: 10.1111/j.1439-0329.2011.00715.x
- Hüberli, D., Hayden, K. J., Calver, M., Garbelotto, M., 2012. Intraspecific variation in host susceptibility and climatic factors mediate epidemics of sudden oak death in western US forests. *Plant Pathology*, 61(3), 579-592. <http://onlinelibrary.wiley.com/doi/10.1111/j.1365-3059.2011.02535.x/full> doi: 10.1111/j.1365-3059.2011.02535.x
- Hüberli, D., Ivors, K. L., Smith, A., Tse, J. G., Garbelotto, M., 2005. First report of foliar infection of *Maianthemum racemosum* by *Phytophthora ramorum*. *Plant Disease*, 89(2), 204. doi: 10.1094/PD-89-0204C
- Hüberli, D., Reuther, K. D., Smith, A., Swain, S., Tse, J. G., Garbelotto, M., 2004. First report of foliar infection of *Rosa gymnocarpa* by *Phytophthora ramorum*. *Plant Disease*, 88(4), 430. doi: 10.1094/PDIS.2004.88.4.430
- Hüberli, D., Wilkinson, C., Smith, M. A., Meshriy, M., Harnik, T. Y., Garbelotto, M., 2006. *Pittosporum undulatum* is a potential Australian host of *Phytophthora ramorum*. *Australasian Plant Disease Notes*, 1(1), 19-21. <http://www.publish.csiro.au/nid/208/paper/DN06009.htm>
- Inman, A. J., Townend, V. C., Barnes, A. V., Lane, C. R., Hughes, K. J. D., Griffin, R. L., Eales, S. J., 2003. First report of ramorum dieback (*Phytophthora ramorum*) on *Pieris* in England. *Plant Pathology*, 52(6), 785. doi: 10.1111/j.1365-3059.2003.00894.x
- IPPC, 2006. IPP Report No. NL-5/1. Rome, Italy: FAO
- IPPC, 2009. Update on the *Phytophthora ramorum* situation in Canada (2009). IPPC Official Pest Report, CAN-02/2. Rome, Italy: FAO. https://www.ippc.int/index.php?id=1110520&no_cache=1&type=pestreport&L=0
- IPPC, 2016. Information on Pest Status in the Republic of Lithuania in 2015. IPPC Official Pest Report, No. LTU-01/2. Rome, Italy: FAO. <https://www.ippc.int/>
- IPPC, 2018. First report of *Phytophthora ramorum* in Slovenia. IPPC Official Pest Report, No. SVN-08/4. Rome, Italy: FAO. <https://www.ippc.int/>

- Ireland, K. B., St. J. Hardy, G. E., Kriticos, D. J., 2013. Combining inferential and deductive approaches to estimate the potential geographical range of the invasive plant pathogen, *Phytophthora ramorum*. *PLoS ONE*, 8(5), e63508. doi: 10.1371/journal.pone.0063508
- Ivors, K. L., Hayden, K. J., Bonants, P. J. M., Rizzo, D. M., Garbelotto, M., 2004. AFLP and phylogenetic analyses of North American and European populations of *Phytophthora ramorum*. *Mycological Research*, 108(4), 378-392. doi: 10.1017/S0953756204009827
- Ivors, K., Garbelotto, M., Vries, I. D. E., Ruyter-Spira, C., Hekkert, B. te, Rosenzweig, N., Bonants, P., 2006. Microsatellite markers identify three lineages of *Phytophthora ramorum* in US nurseries, yet single lineages in US forest and European nursery populations. *Molecular Ecology*, 15(6), 1493-1505. doi: 10.1111/j.1365-294X.2006.02864.x
- James, D., Varga, A., Becker, E., Sumampong, G., Bailey, K., Elliott, M., Masri, S., Shamoun, S. F., 2012. Screening of several disinfectants to assess their efficacy in controlling mycelia growth, sporangia germination, and recovery of viable *Phytophthora ramorum*. *Crop Protection*, 42, 186-192. doi: 10.1016/j.cropro.2012.07.007
- Jeffers, S. N., Hwang, J., Wamishe, Y. A., Oak, S. W., 2009. Detection of *Phytophthora ramorum* at retail nurseries in the Southeastern United States. In: S. J. Frankel, J. T. Kliejunas, and K. M. Palmieri, (tech coords.). *Proceedings of the Sudden Oak Death Fourth Science Symposium, General Technical Report PSW-GTR-229*. U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station, Santa Cruz, CA, 22-26
- Jung, T., Scanu, B., Brasier, C. M., Webber, J., Milenković, I., Corcobado, T., Tomšovský, M., Pánek, M., Bakonyi, J., Maia, C., Bačová, A., Raco, M., Rees, H., Pérez-Sierra, A., Jung, M. H., 2020. A survey in natural forest ecosystems of Vietnam reveals high diversity of both new and described *Phytophthora* taxa including *P. ramorum*. *Forests*, 11(1), 93. doi: 10.3390/f11010093
- Kamvar, Z. N., Larsen, M. M., Kanaskie, A. M., Hansen, E. M., Grünwald, N. J., 2015. Spatial and temporal analysis of populations of the Sudden Oak Death Pathogen in Oregon forests. *Phytopathology*, 105(7), 982-989.
- Kanaskie, A., Wiese, R., Norlander, D., Laine, J., Navarro, S., Goheen, E. M., Rhatigan, R., Hansen, E., Sutton, W., Reeser, P., Grünwald, N., Kamvar, Z., Osterbauer, N., 2017. Slowing Spread of Sudden Oak Death in Oregon Forests, 2001-2015. In: S. J. Frankel and K. M. Harrell, (tech coords.). *Proceedings of the Sudden Oak Death Sixth Science Symposium, Gen. Tech. Rep. GTR-PSW-255*. U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station, Albany, CA, p. 1
- Kasuga, T., Kozanitas, M., Bui, M., Hüberli, D., Rizzo, D. M., Garbelotto, M., 2012. Phenotypic diversification is associated with host-induced transposon derepression in the sudden oak death pathogen *Phytophthora ramorum*. *PLoS ONE*, 7(4), e34728. doi: 10.1371/journal.pone.0034728
- Kelly NM, Meentemeyer R, 2002. Landscape dynamics of the spread of Sudden Oak Death. *Photogrammetric Engineering and Remote Sensing*, 68:1001-1009
- King KM, Harris AR, Webber JF, 2015. In planta detection used to define the distribution of the European lineages of *Phytophthora ramorum* on larch (*Larix*) in the UK. *Plant Pathology*, 64(5):1168-1175. <http://onlinelibrary.wiley.com/doi/10.1111/ppa.12345/full>
- Kliejunas JT, 2010. Sudden oak death and *Phytophthora ramorum*: a summary of the literature. General Technical Report - Pacific Southwest Research Station, USDA Forest Service, No.PSW-GTR-234:181 pp. http://www.fs.fed.us/psw/publications/documents/psw_gtr234/psw_gtr234.pdf
- Kovacs K, Holmes TP, Englin JE, Alexander J, 2011. The dynamic response of housing values to a forest invasive disease: evidence from a sudden oak death infestation. *Environmental and Resource Economics*, 49(3):445-471. <http://springerlink.metapress.com/openurl.asp?genre=journal&issn=0924-6466>
- Kovacs K, Václavík T, Haight RG, Pang A, Cunniffe NJ, Gilligan CA, Meentemeyer RK, 2011. Predicting the economic costs and property value losses attributed to sudden oak death damage in California (2010-2020). *Journal of Environmental Management*, 92(4):1292-1302. <http://www.sciencedirect.com/science/journal/03014797>
- Kozanitas, M., Osmundson, T. W., Linzer, R., Garbelotto, M., 2017. Interspecific interactions between the Sudden Oak Death pathogen *Phytophthora ramorum* and two sympatric *Phytophthora* species in varying ecological conditions. *Fungal Ecology*, 28, 86-96. doi: 10.1016/j.funeco.2017.04.006
- Kurdyla, T., Pham, J., McBride, S., Appel, D., 2014. Survey and detection of *Phytophthora ramorum*, the Sudden Oak Death pathogen, in Texas. *Phytopathology*, 104(S2), 6.
- Lane CR, Beales PA, Hughes KJD, Tomilson JA, Inman AJ, Warwick K, 2004. First report of ramorum dieback (*Phytophthora ramorum*) on container-grown English yew (*Taxus baccata*) in England. *Plant Pathology* 53(4):522
- Lane, C. R., Beales, P. A., Hughes, K. J. D., Griffin, R. L., Munro, D., Brasier, C. M., Webber, J. F., 2003. First outbreak of *Phytophthora ramorum* in England, on *Viburnum tinus*. *Plant Pathology*, 52(3), 414. doi: 10.1046/j.1365-3059.2003.00835.x

- Lane, C. R., Beales, P. A., Hughes, K. J. D., Tomlinson, J. A., Inman, A. J., Warwick, K., 2004. First report of ramorum dieback (*Phytophthora ramorum*) on container-grown English yew (*Taxus baccata*) in England. *Plant Pathology*, 53(4), 522. doi: 10.1111/j.1365-3059.2004.01022.x
- Leboldus, J. M., Sondreli, K. L., Sutton, W., Reeser, P., Navarro, S., Kanaskie, A., Grünwald, N. J., 2018. First report of *Phytophthora ramorum* lineage EU1 infecting douglas fir and grand fir in Oregon. *Plant Disease*, 102(2), 455. doi: 10.1094/PDIS-05-17-0681-PDN
- Lee C, Valachovic Y, Garbelotto M, 2010. Protecting trees from sudden oak death before infection. University of California, Agricultural and Natural Resources Publication 8426, 8426:14
- Lee ChangSeok, Lee AnNa, Cho YongChan, 2008. Restoration planning for the Seoul Metropolitan Area, Korea. In: Ecology, planning, and management of urban forests: international perspectives [ed. by Carreiro, M. M., Song, Y. C., Wu, J.]. Heidelberg, Germany: Springer-Verlag GmbH, 393-419
- Lilja, A., Rytönen, A., Kokkola, M., Parikka, P., Hantula, J., 2007. First report of *Phytophthora ramorum* and *P. inflata* in ornamental rhododendrons in Finland. *Plant Disease*, 91(8), 1055. doi: 10.1094/PDIS-91-8-1055C
- Linderman RG, Parke JL, Hansen EM, 2002. Relative virulence of *Phytophthora* species, including the sudden oak death pathogen *P. ramorum*, on several ornamental species. *Phytopathology*, 92:S47 (abstract)
- Linderman, R. G., Davis, E. A., Marlow, J. L., 2006. Response of selected nursery crop plants to inoculation with isolates of *Phytophthora ramorum* and other *Phytophthora* species. *HortTechnology*, 16(2), 216-224.
- Lione, G., Gonthier, P., Garbelotto, M., 2017. Environmental factors driving the recovery of bay laurels from *Phytophthora ramorum* infections: an application of numerical ecology to citizen science. *Forests*, 8(8), 293. doi: 10.3390/f8080293
- Malar C, Mathu JD, Yuzon SD, Abhishek AP, Samrat G, Tyler BM, Kasuga T, Tripathy S, 2019. Haplotype-phased genome assembly of virulent *Phytophthora ramorum* isolate ND886 facilitated by long-read sequencing reveals effector polymorphisms and copy number variation. *Molecular Plant-Microbe Interactions*, 32, 1047-1060.
- Maloney PE, Lynch SC, Kane SF, Jensen CE, Rizzo DM, 2005. Establishment of an emerging generalist pathogen in redwood forest communities. *Journal of Ecology (Oxford)*, 93(5):899-905. <http://www.blackwell-synergy.com/servlet/useragent?func=showIssues&code=jec>
- Maloney PE, Rizzo DM, Koike ST, Harnik TY, Garbelotto M, 2002. First report of *Phytophthora ramorum* on coast redwood in California. *Plant Disease*, 86(11):1274; 2 ref
- Martin FN, Bensasson D, Tyler BM, Boore JL, 2007. Mitochondrial genome sequences and comparative genomics of *Phytophthora ramorum* and *P. sojae*. *Current Genetics*, 51(5):285-296. <http://www.springerlink.com/content/mx618v1723549560/?p=dbc3775273e84843ad94b4e19df45b2a&pi=0>
- Martin, F. N., Coffey, M. D., Zeller, K., Hamelin, R. C., Tooley, P., Garbelotto, M., Hughes, K. J. D., Kubisiak, T., Bilodeau, G. J., Levy, L., Blomquist, C., Berger, P. H., 2009. Evaluation of molecular markers for *Phytophthora ramorum* detection and identification: testing for specificity using a standardized library of isolates. *Phytopathology*, 99(4), 390-403. doi: 10.1094/PHYTO-99-4-0390
- Maryland Department of Agriculture, 2017. *Phytophthora ramorum* in Maryland: Current situation. Last accessed November 6, 2017. http://mda.maryland.gov/plants-pests/Pages/phytophthora_ramorum_current_situation.aspx
- Mascheretti, S., Croucher, P. J. P., Kozanitas, M., Baker, L., Garbelotto, M., 2009. Genetic epidemiology of the Sudden Oak Death pathogen *Phytophthora ramorum* in California. *Molecular Ecology*, 18(22), 4577-4590. doi: 10.1111/j.1365-294X.2009.04379.x
- Mascheretti, S., Croucher, P. J. P., Vettraino, A., Prospero, S., Garbelotto, M., 2008. Reconstruction of the Sudden Oak Death epidemic in California through microsatellite analysis of the pathogen *Phytophthora ramorum*. *Molecular Ecology*, 17(11), 2755-2768. doi: 10.1111/j.1365-294X.2008.03773.x
- Mathew, S. K., Beena, S., 2012. A new record of *Phytophthora ramorum* causing leaf fall and shoot rot of nutmeg (*Myristica fragrans*). *Journal of Mycology and Plant Pathology*, 42(4), 529-530.
- McCracken A, 2013. Current and emerging threats to Ireland's trees from diseases and pests. *Irish Forestry*, 70, 36-60.
- McPherson BA, Wood DL, Storer AJ, Kelly NM, Standiford RB, 2002. Sudden oak death: disease trends in Marin County plots after one year. In: Standiford R, McCreary D, eds. 5th Symposium on California Oak Woodlands. USDA Forest Service. Gen. Tech. PSW-GTR-184, 751-764
- McPherson, B. A., Mori, S. R., Wood, D. L., Kelly, M., Storer, A. J., Svihra, P., Standiford, R. B., 2010. Responses of oaks and tanoaks to the sudden oak death pathogen after 8 y of monitoring in two coastal California forests. *Forest Ecology and Management*, 259(12), 2248-2255. doi: 10.1016/j.foreco.2010.02.020

- MDA, 2009. *Phytophthora ramorum* and Maryland: Background. Maryland Department of Agriculture. Last accessed November 6, 2017, http://mda.maryland.gov/plants-pests/Pages/phytophthora_ramorum_background.aspx
- Meentemeyer RK, Cunniffe NJ, Cook AR, Filipe JAN, Hunter RD, Rizzo DM, Gilligan CA, 2011. Epidemiological modeling of invasion in heterogeneous landscapes: spread of sudden oak death in California (1990-2030). *Ecosphere*, 2(2), 1-24. <http://www.esajournals.org/doi/full/10.1890/ES10-00192.1>
- Meentemeyer RK, Dorning MA, Vogler JB, Schmidt D, Garbelotto M, 2015. Citizen science helps predict risk of emerging infectious disease. *Frontiers in Ecology and the Environment*, 13(4), 189-194.
- Meentemeyer, R., Rizzo, D., Mark, W., Lotz, E., 2004. Mapping the risk of establishment and spread of sudden oak death in California. *Forest Ecology and Management*, 200(1/3), 195-214. doi: 10.1016/j.foreco.2004.06.021
- Meentemeyer, RK, Rank NE, Shoemaker D, Oneal C, Wickland AC, Frangioso KM, Rizzo DM, 2008. Impacts of sudden oak death on tree mortality in the Big Sur ecoregion of California. *Biological Invasions*, 10:1243-1255
- Merlier, D. de, Chandelier, A., Cavelier, M., 2003. First report of *Phytophthora ramorum* on *Viburnum bodnantense* in Belgium. *Plant Disease*, 87(2), 203. doi: 10.1094/PDIS.2003.87.2.203C
- Metz, M. R., Varner, J. M., Frangioso, K. M., Meentemeyer, R. K., Rizzo, D. M., 2013. Unexpected redwood mortality from synergies between wildfire and an emerging infectious disease. *Ecology*, 94(10), 2152-2159. doi: 10.1890/13-0915.1
- Monahan, W. B., Koenig, W. D., 2006. Estimating the potential effects of sudden oak death on oak-dependent birds. *Biological Conservation*, 127(2), 146-157. doi: 10.1016/j.biocon.2005.08.005
- Moralejo E, Werres S, 2002. First report of *Phytophthora ramorum* on *Rhododendron* sp. in Spain. *Plant Disease*, 86(9):1052; 4 ref
- Moralejo, E., Pérez-Sierra, A. M., Álvarez, L. A., Belbahri, L., Lefort, F., Descals, E., 2009. Multiple alien *Phytophthora* taxa discovered on diseased ornamental plants in Spain. *Plant Pathology*, 58(1), 100-110. doi: 10.1111/j.1365-3059.2008.01930.x
- Moralejo, E., Puig, M., García, J. A., Descals, E., 2006. Stromata, sporangiomata and chlamydosori of *Phytophthora ramorum* on inoculated Mediterranean woody plants. *Mycological Research*, 110(11), 1323-1332. doi: 10.1016/j.mycres.2006.09.004
- Murphy, S. K., Rizzo, D. M., 2003. First report of *Phytophthora ramorum* on canyon live oak in California. *Plant Disease*, 87(3), 315. doi: 10.1094/PDIS.2003.87.3.315C
- NAPPO, 2016. <http://www.pestalert.org/oprDetail.cfm?oprID=646&keyword=PHYTOPHTHORA%20RAMORUM>
- NCDA&CS, 2013. North Carolina Department of Agriculture & Consumer Services, <http://www.ncagr.gov/plantindustry/plant/disease/sod.htm>.
- North Carolina Forest Service, 2017. Last accessed November 8, 2017, http://www.ncforestservice.gov/forest_health/current_concerns.htm
- O'Hanlon, R., Choiseul, J., Brennan, J. M., Grogan, H., 2018. Assessment of the eradication measures applied to *Phytophthora ramorum* in Irish *Larix kaempferi* forests. *Forest Pathology*, 48(1), e12389. doi: 10.1111/efp.12389
- O'Hanlon, R., Choiseul, J., Corrigan, M., Catarame, T., Destefanis, M., 2016. Diversity and detections of *Phytophthora* species from trade and non-trade environments in Ireland. *Bulletin OEPP/EPPO Bulletin*, 46(3), 594-602. doi: 10.1111/epp.12331
- O'Hanlon, R., Choiseul, J., Grogan, H., Brennan, J. M., 2017. In-vitro characterisation of the four lineages of *Phytophthora ramorum*. *European Journal of Plant Pathology*, 147(3), 517-525. doi: 10.1007/s10658-016-1019-2
- Orlikowski LB, Szkuta G, 2002. First record of *Phytophthora ramorum* in Poland. *Phytopathologia Polonica*, No.25:69-79; 10 ref
- Orlikowski, L. B., Oszako, T., Trzewik, A., Orlikowska, T., 2007. Occurrence of *Phytophthora ramorum* and other *Phytophthora* species in nurseries, trade stands, forests and water. *Journal of Plant Protection Research*, 47(4), 445-455. <http://www.ior.poznan.pl/Journal/>
- Orlikowski, L. B., Szkuta, G., 2004. First notice of *Phytophthora ramorum* on *Calluna vulgaris*, *Photinia fraseri* and *Pieris japonica* in Polish container-ornamental nurseries. *Phytopathologia Polonica*, (No.34), 87-92.
- Osterbauer NK, Lane S, Trippe A, 2014. *Phytophthora ramorum* identified infecting eastern teaberry (*Gaultheria procumbens*) plants shipped to Oregon. *Plant Health Progress*, No.January:PHP-BR-13-0109. <http://www.plantmanagementnetwork.org/php/elements/sum2.aspx?id=10739>
- Parke JL, Linderman RG, Hansen EM, 2002. Susceptibility of *Vaccinium* to *Phytophthora ramorum*, cause of the sudden oak death pathogen. *Phytopathology*, 92:S63 (abstract)
- Parke, J. L., Lewis, C., 2007. Root and stem infection of *Rhododendron* from potting medium infested with *Phytophthora ramorum*. *Plant Disease*, 91(10), 1265-1270. doi: 10.1094/PDIS-91-10-1265

- Parke, J. L., Linderman, R. G., Osterbauer, N. K., Griesbach, J. A., 2004. Detection of *Phytophthora ramorum* blight in Oregon nurseries and completion of Koch's postulates on *Pieris*, *Rhododendron*, *Viburnum*, and *Camellia*. *Plant Disease*, 88(1), 87. doi: 10.1094/PDIS.2004.88.1.87A
- Parke, J. L., Oh, E., Voelker, S., Hansen, E. M., Buckles, G., Lachenbruch, B., 2007. *Phytophthora ramorum* colonizes tanoak xylem and is associated with reduced stem water transport. *Phytopathology*, 97(12), 1558-1567. doi: 10.1094/PHYTO-97-12-1558
- Patel, J. S., Vitoreli, A., Palmateer, A. J., El-Sayed, A., Norman, D. J., Goss, E. M., Brennan, M. S., Ali, G. S., 2016. Characterization of *Phytophthora* spp. isolated from ornamental plants in Florida. *Plant Disease*, 100(2), 500-509. <http://apsjournals.apsnet.org/loi/pdis> doi: 10.1094/PDIS-05-15-0598-RE
- Pintos Varela, C., Mansilla Vázquez, J. P., Aguín Casal, O., 2003. First report of *Phytophthora ramorum* on *Camellia japonica* in Spain. *Plant Disease*, 87(11), 1396. doi: 10.1094/PDIS.2003.87.11.1396A
- Pintos Varela, C., Mansilla Vázquez, J. P., Aguín Casal, O., 2004. *Phytophthora ramorum*, a new pathogen in Spain on *Camellia japonica* and *Viburnum tinus*. (*Phytophthora ramorum* nuevo patógeno en España sobre *Camellia japonica* y *Viburnum tinus*). *Boletín de Sanidad Vegetal, Plagas*, 30(1), 97-111.
- Poucke, K. van, Franceschini, S., Webber, J. F., Vercauteren, A., Turner, J. A., McCracken, A. R., Heungens, K., Brasier, C. M., 2012. Discovery of a fourth evolutionary lineage of *Phytophthora ramorum*: EU2. *Fungal Biology*, 116(11), 1178-1191. doi: 10.1016/j.funbio.2012.09.003
- Preuett JA, Collins DJ, Luster D, Widmer TL, 2013. Screening selected Gulf Coast and southeastern forest species for susceptibility to *Phytophthora ramorum*. *Plant Health Progress*, No.July:PHP-2013-0730-01-RS. <http://www.plantmanagementnetwork.org/php/elements/sum2.aspx?id=10669>
- Preuett, J. A., Collins, D., Williams, A., Deahl, K., Jones, R., 2012. Stream Baiting in Southern Louisiana for *Phytophthora ramorum*. In: *Proceedings of Sudden Oak Death Fifth Science Symposium*, Gen. Tech. Rep. PSW-GTR-243, Petaluma, California, p. 159
- Prospero, S., Vercauteren, A., Heungens, K., Belbahri, L., Rigling, D., 2013. *Phytophthora* diversity and the population structure of *Phytophthora ramorum* in Swiss ornamental nurseries. *Plant Pathology*, 62(5), 1063-1071. doi: 10.1111/ppa.12027
- Reeser, P. W., Sutton, W., Hansen, E. M., 2008. *Phytophthora* species causing tanoak stem cankers in southwestern Oregon. *Plant Disease*, 92(8), 1252. doi: 10.1094/PDIS-92-8-1252B
- Riley KL, Chastagner GA, 2011. First report of *Phytophthora ramorum* infecting mistletoe in California. *Plant Health Progress*, No.February:PHP-2011-0209-02-BR. <http://www.plantmanagementnetwork.org/php/elements/sum.aspx?id=9402&photo=5200>
- Riley KL, Chastagner GA, Blomquist C, 2011. First report of *Phytophthora ramorum* infecting grand fir in California. *Plant Health Progress*, No.April:PHP-2011-0401-01-BR. <http://www.plantmanagementnetwork.org/php/elements/sum.aspx?id=9437&photo=5278>
- Ristaino, J. B., Gumpertz, M. L., 2000. New frontiers in the study of dispersal and spatial analysis of epidemics caused by species in the genus *Phytophthora*. *Annual Review of Phytopathology*, 38, 541-576. doi: 10.1146/annurev.phyto.38.1.541
- Rizzo D, Garbelotto M, 2003. Sudden oak death: endangering California and Oregon forest ecosystems. *Front. Ecol. Environ.*, 1(5):197-204
- Rizzo DM, Garbelotto M, Davidson JM, Slaughter GW, Koike ST, 2002a. *Phytophthora ramorum* and Sudden Oak Death in California: I. Host Relationships. In: Standiford R, McCreary D, eds. 5th Symposium on California Oak Woodlands, USDA Forest Service. Gen. Tech. PSW-GTR-184, 733-740
- Rizzo DM, Garbelotto M, Davidson JM, Slaughter GW, Koike ST, 2002b. *Phytophthora ramorum* as the cause of extensive mortality of *Quercus* spp. and *Lithocarpus densiflorus* in California. *Plant Disease*, 86(3):205-214; 34 ref
- Rizzo DM, Garbelotto M, Hansen EM, 2005. *Phytophthora ramorum*: integrative research and management of an emerging pathogen in California and Oregon forests. *Annual Review of Phytopathology*, 43:309-335. <http://www.annualreviews.org>
- Rizzo, D. M., Garbelotto, M., Davidson, J. M., Slaughter, G. W., Koike, S. T., 2002. *Phytophthora ramorum* and sudden oak death in California: I. Host relationships. In: *General Technical Report - Pacific Southwest Research Station, USDA Forest Service*, (No.PSW-GTR-184) [ed. by Standiford, R. B., McCreary, D., Purcell, K. L.]. Berkeley, USA: Pacific Southwest Research Station, USDA Forest Service. 733-740. http://www.fs.fed.us/psw/publications/documents/psw_gtr184/psw_gtr184_062_Rizzo.pdf
- Rooney-Latham S, Blomquist CL, Williams A, Gunnison E, Pastalka T, 2017. Identification of five new hosts of *Phytophthora ramorum* in an infested forest in California. In: *Proceedings of the sudden oak death sixth science symposium*. Gen. Tech. Rep. GTR-PSW-255. Albany, California, USA: US Department of Agriculture, Forest Service, Pacific Southwest Research Station. 83-84.
- Rooney-Latham S, Honeycutt E, Ochoa J, Grünwald NJ, Blomquist CL, 2013. First report of camphor tree (*Cinnamomum camphora*) as a host of *Phytophthora ramorum*. *Plant Disease*, 97(10):1377-1378. <http://apsjournals.apsnet.org/loi/pdis>

Rooney-Latham, S., Blomquist, C. L., Soriano, M. C., Uhler, M., 2020. First report of *Phytophthora ramorum* causing foliar and stem blight of two California native *Arctostaphylos* species, *A. viridissima* and *A. glauca*. *Plant Disease*, 104(10), 2741-2741. doi: 10.1094/PDIS-07-19-1359-PDN

Rooney-Latham, S., Blomquist, C. L., Williams, A., Gunnison, E., Pastalka, T., 2017. Identification of five new hosts of *Phytophthora ramorum* in an infested forest in California. [Proceedings of the Sudden Oak Death Sixth Science Symposium], 83-84. https://www.fs.fed.us/psw/publications/documents/psw_gtr255/psw_gtr255_083.pdf

Rytkönen A, Lilja A, Vercauteren A, Sirkiä S, Parikka P, Soukainen M, Hantula J, 2012. Identity and potential pathogenicity of *Phytophthora* species found on symptomatic *Rhododendron* plants in a Finnish nursery. *Canadian Journal of Plant Pathology*, 34(2):255-267. <http://www.tandfonline.com/loi/tcjp20>

Sansford CE, Inman AJ, Baker R, Brasier C, Frankel S, Gruyter Jde, Husson C, Kehlenbeck H, Kessel G, Moralejo E, Steeghs M, Webber J, Werres S, 2009. Report on the risk of entry, establishment, spread and socio-economic loss and environmental impact and the appropriate level of management for *Phytophthora ramorum* for the EU. Deliverable Report 28. Forest Research, Central Science Laboratory, York, UK. EU Sixth Framework Project, RAPRA. York, UK: Forest Research, Central Science Laboratory, 310. http://rapra.csl.gov.uk/RAPRAPRA_26feb09.pdf

Schenck, N., Saurat, C., Guinet, C., Fourrier-Jeandel, C., Roche, L., Bouvet, A., Husson, C., Saintonge, F. X., Contal, C., Ios, R., 2018. First report of *Phytophthora ramorum* causing Japanese larch dieback in France. *Plant Disease*, 102(10), 2045. doi: 10.1094/pdis-02-18-0288-pdn

Schlenzig A, 2011. A duplex PCR method for the simultaneous identification of *Phytophthora ramorum* and *Phytophthora kernoviae*. *Bulletin OEPP/EPPO Bulletin*, 41(1):27-29. [http://onlinelibrary.wiley.com/journal/10.1111/\(ISSN\)1365-2338](http://onlinelibrary.wiley.com/journal/10.1111/(ISSN)1365-2338)

Schlenzig, A., Campbell, R., Chard, J., 2015. *Phytophthora* species infecting hardy ornamentals in nurseries and the managed environment in Scotland. *Journal of Phytopathology*, 163(7/8), 686-689. [http://onlinelibrary.wiley.com/journal/10.1111/\(ISSN\)1439-0434](http://onlinelibrary.wiley.com/journal/10.1111/(ISSN)1439-0434)

Schlenzig, A., Purser, E., Perez-Sierra, A., 2016. First finding of *Phytophthora foliorum* in the United Kingdom. *New Disease Reports*, 34, 2. doi: 10.5197/j.2044-0588.2016.034.002

Serrano, M. S., Eyre, C., Garbelotto, M., 2020. Epidemiology and microevolution of *Phytophthora ramorum* during a controlled disease outbreak in a simulated plant production facility. *Plant Pathology*, 69(2), 320-333. <https://bsppjournals.onlinelibrary.wiley.com/doi/full/10.1111/ppa.13127>

Shishkoff, N., 2012. Susceptibility of some common container weeds to *Phytophthora ramorum*. *Plant Disease*, 96(7), 1026-1032. doi: 10.1094/PDIS-09-10-0695-RE

Shrestha, S. K., Zhou, Y., Lamour, K., 2013. Oomycetes baited from streams in Tennessee 2010–2012. *Mycologia*, 105(6), 1516-1523.

Slawson, D., Bennett, L., Parry, N., Lane, C., 2006. The current situation with *Phytophthora ramorum* in England and Wales. In: General Technical Report - Pacific Southwest Research Station, USDA Forest Service, (No. PSW-GTR-196) [ed. by Frankel, S. J., Shea, P. J., Haverty, M. I.]. Berkeley, USA: Pacific Southwest Research Station, USDA Forest Service. 455-457. http://www.fs.fed.us/psw/publications/documents/psw_gtr196/psw_gtr196_007_066Slawson.pdf

South Carolina Forestry Commission/USDA Forest Service, 2010. United States Department of Agriculture Forest Service, Southern Region, State & Private Forestry, Asheville, NC. 2 pp

Sutton, W., Hansen, E. M., Reeser, P. W., Kanaskie, A., 2009. Stream monitoring for detection of *Phytophthora ramorum* in Oregon tanoak forests. *Plant Disease*, 93(11), 1182-1186. doi: 10.1094/PDIS-93-11-1182

Swain S, Alexander JM, 2010. Pest note: Sudden oak death. UC ANR Publication 74151. UC IPM online, 74151. Davis, USA: University of California Agriculture and Natural Resources. <http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn74151.html>

Swain, S., Garbelotto, M., 2015. *Phytophthora ramorum* can survive introduction into finished compost. *California Agriculture*, 69(4), 237-241. doi: 10.3733/ca.v069n04p237

Swain, S., Harnik, T., Mejia-Chang, M., Hayden, K., Bakx, W., Creque, J., Garbelotto, M., 2006. Composting is an effective treatment option for sanitization of *Phytophthora ramorum*-infected plant material. *Journal of Applied Microbiology*, 101(4), 815-827. doi: 10.1111/j.1365-2672.2006.03008.x

Swei, A., Ostfeld, R. S., Lane, R. S., Briggs, C. J., 2011. Effects of an invasive forest pathogen on abundance of ticks and their vertebrate hosts in a California Lyme disease focus. *Oecologia*, 166(1), 91-100. doi: 10.1007/s00442-010-1796-9

Swiecki TJ, Bernhardt E, 2002. Evaluation of stem water potential and other tree and stand variables as risk factors for *Phytophthora ramorum* canker development in coast live oak. In: Standiford R, McCreary D, eds. 5th Symposium on California Oak Woodlands, USDA Forest Service. Gen. Tech. PSW-GTR-184, 787-798

- Swiecki TJ, Bernhardt E, 2008. Phytosphere Research Project No. 2005-0801. 2007-2008 Contract Year Annual Report, No. 2005-0801. Vacaville, California, USA: Phytosphere Research. http://phytosphere.com/publications/Phytophthora_case-control2007-2008.htm
- Swiecki, T. J., Bernhardt, E. A., 2017. Field studies evaluate methods to prevent sudden oak death in oaks and tanoak. *Forest Phytophthoras*, 7(1), 15-29.
- Tjosvold, S. A., Chambers, D. L., Fichtner, E. J., Koike, S. T., Mori, S. R., 2009. Disease risk of potting media infested with *Phytophthora ramorum* under nursery conditions. *Plant Disease*, 93(4), 371-376. doi: 10.1094/PDIS-93-4-0371
- Tjosvold, S. A., Chambers, D. L., Koike, S. T., Mori, S. R., 2008. Disease on nursery stock as affected by environmental factors and seasonal inoculum levels of *Phytophthora ramorum* in stream water used for irrigation. *Plant Disease*, 92(11), 1566-1573. doi: 10.1094/PDIS-92-11-1566
- Tomlinson JA, Boonham N, Hughes KJD, Griffin RL, Barker I, 2005. On-site DNA extraction and real-time PCR for detection of *Phytophthora ramorum* in the field. *Applied and Environmental Microbiology*, 71(11):6702-6710. <http://aem.asm.org/cgi/content/abstract/71/11/6702>
- Tooley PW, Englander L, 2002. Infectivity of *Phytophthora ramorum* on selected Ericaceous host species. *Phytopathology*, 92:S81 (abstract)
- Tooley, P. W., Browning, M., 2009. Susceptibility to *Phytophthora ramorum* and inoculum production potential of some common eastern forest understory plant species. *Plant Disease*, 93(3), 249-256. doi: 10.1094/PDIS-93-3-0249
- Tooley, P. W., Browning, M., Berner, D., 2008. Recovery of *Phytophthora ramorum* following exposure to temperature extremes. *Plant Disease*, 92(3), 431-437. doi: 10.1094/PDIS-92-3-0431
- Tsopelas P, Paplomatas EJ, Tjamos SE, Soulioti N, Elena K, 2011. First report of *Phytophthora ramorum* on *Rhododendron* in Greece. *Plant Disease*, 95(2):223. <http://apsjournals.apsnet.org/loi/pdis>
- Tyler BM, Tripathy S, Zhang XM, Dehal P, Jiang RHY, Aerts A, Arredondo FD, Baxter L, Bensasson D, Beynon JL, Chapman J, Damasceno CMB, Dorrance AE, Dou DL, Dickerman AW, Dubchak IL, Garbelotto M, Gijzen M, Gordon SG, Govers F, Grunwald NJ, Huang W, Ivors KL, Jones RW, Kamoun S, Krampis K(et al), 2006. *Phytophthora* genome sequences uncover evolutionary origins and mechanisms of pathogenesis. *Science (Washington)*, 313(5791):1261-1266. <http://www.sciencemag.org>
- US Forest Service Northeastern Area, 2016. 2015 Forest Health Highlights: Pennsylvania, 1-11. Last accessed December 18, 2017, https://www.fs.fed.us/foresthealth/fhm/fhh/fhh_15/PA_FHH_2015.pdf.
- US Forest Service/Animal Plant Health Inspection Service/National Association of State Foresters/National Plant Board, 2011. National Framework for Managing Sudden Oak Death caused by *Phytophthora ramorum* in Forests and Wildlands. 1-14. Last accessed December 13, 2017, http://www.suddenoakdeath.org/wp-content/uploads/2012/08/SOD_National_Framework.final_July2012dated.2011.pdf
- USDA-APHIS, 2016. USDA-APHIS. <https://www.aphis.usda.gov/aphis/ourfocus/planthealth/plant-pest-and-disease-programs/pests-and-diseases/phytophthora-ramorum>
- USDA-APHIS-PPQ, 2016. https://www.aphis.usda.gov/plant_health/plant_pest_info/pram/downloads/pdf_files/quarantine_map.pdf
- Valachovic YS, Lee CA, Scanlon H, Varner JM, Glebocki R, Graham BD, Rizzo DM, 2011. Sudden oak death-caused changes to surface fuel loading and potential fire behavior in Douglas-fir-tanoak forests. *Forest Ecology and Management*, 261(11):1973-1986
- Venette, R. C., Cohen, S. D., 2006. Potential climatic suitability for establishment of *Phytophthora ramorum* within the contiguous United States. *Forest Ecology and Management*, 231(1/3), 18-26. doi: 10.1016/j.foreco.2006.04.036
- Vercauteren, A., Boutet, X., D'hondt, L., Bockstaele, E. van, Maes, M., Leus, L., Chandelier, A., Heungens, K., 2011. Aberrant genome size and instability of *Phytophthora ramorum* oospore progenies. *Fungal Genetics and Biology*, 48(5), 537-543. doi: 10.1016/j.fgb.2011.01.008
- Vettrano AM, Sukno S, Vannini A, Garbelotto M, 2010. Diagnostic sensitivity and specificity of different methods used by two laboratories for the detection of *Phytophthora ramorum* on multiple natural hosts. *Plant Pathology*, 59(2):289-300. <http://www.blackwell-synergy.com/loi/ppa>
- Vettrano, A. M., Hüberli, D., Garbelotto, M., 2008. *Phytophthora ramorum* infection of coast live oak leaves in Californian forests and its capacity to sporulate in vitro. *Australasian Plant Pathology*, 37(1), 72-73. doi: 10.1071/AP07085
- Vettrano, A. M., Hüberli, D., Swain, S., Bienapfl, J. C., Smith, A., Garbelotto, M., 2006. First report of infection of maiden-hair fern (*Adiantum jordanii* and *A. aleuticum*) by *Phytophthora ramorum* in California. *Plant Disease*, 90(3), 379. doi: 10.1094/PD-90-0379B
- Vettrano, A. M., Hüberli, D., Swain, S., Smith, A., Garbelotto, M., 2006. A new report of *Phytophthora ramorum* on *Rhamnus purshiana* in Northern California. *Plant Disease*, 90(2), 246. doi: 10.1094/PD-90-0246C
- Warfield, C. Y., Hwang, J., Benson, D. M., 2008. *Phytophthora* blight and dieback in North Carolina nurseries during a 2003 survey. *Plant Disease*, 92(3), 474-481. <HTTP://www.apsnet.org> doi: 10.1094/PDIS-92-3-0474

- WDNR/USFS, 2017. Forest Health Highlights in Washington—2016. Washington Department of Natural Resources (WDNR) Department of Agriculture, Forest Service (USFS). 37 pp.
- Webber JF, Mullett M, Brasier CM, 2010. Dieback and mortality of plantation Japanese larch (*Larix kaempferi*) associated with infection by *Phytophthora ramorum*. *New Disease Reports*, 22(19), 2044-0588. <http://www.ndrs.org.uk/article.php?id=22019>
- Werres S, Marwitz R, 1997. Triebsterben an Rhododendron: Unbekannte *Phytophthora*. *Deutscher Gartenbau*, 21:1166-1168
- Werres S, Marwitz R, Man in't Veld WA, Cock AWAMde, Bonants PJM, Weerdt Mde, Themann K, Ilieva E, Baayen RP, 2001. *Phytophthora ramorum* sp. nov., a new pathogen on Rhododendron and Viburnum. *Mycological Research*, 105(10):1155-1165; 39 ref
- Wickland, A. C., Jensen, C. E., Rizzo, D. M., 2008. Geographic distribution, disease symptoms and pathogenicity of *Phytophthora nemorosa* and *Phytophthora pseudosyringae* in California, USA. *Forest Pathology*, 38(4), 288-298. doi: 10.1111/j.1439-0329.2008.00552.x
- Widmer TL, 2010. Differentiating *Phytophthora ramorum* and *P. kernoviae* from other species isolated from foliage of rhododendrons. *Plant Health Progress*, No.March:PHP-2010-0317-01-RS. <http://www.plantmanagementnetwork.org/php/elements/sum2.aspx?id=8677>
- WSDA, 2016. Annual Report - Sudden Oak Death (SOD) - *Phytophthora ramorum*. State of Washington, Department of Agriculture. 6 pp
- Yakabe, L. E., MacDonald, J. D., 2010. Soil treatments for the potential elimination of *Phytophthora ramorum* in ornamental nursery beds. *Plant Disease*, 94(3), 320-324. doi: 10.1094/PDIS-94-3-0320
- Zerjav M, Munda A, Lane CR, Barnes AV, Hughes KJD, 2004. First report of *Phytophthora ramorum* on container-grown plants of rhododendron and viburnum in Slovenia. *Plant Pathology* 53(4):523
- Žerjav, M., Munda, A., Lane, C. R., Barnes, A. V., Hughes, K. J. D., 2004. First report of *Phytophthora ramorum* on container-grown plants of rhododendron and viburnum in Slovenia. *Plant Pathology*, 53(4), 523. doi: 10.1111/j.1365-3059.2004.01023.x

References

Distribution References

- Alexander J, 2012. The past, present, and future of sudden oak death. *Outlooks on Pest Management*. 23 (2), 72-75. DOI:10.1564/23apr07
- Arizona Department of Agriculture, 2022. NPPO communication to CABI., Phoenix, Arizona, USA: Arizona Department of Agriculture.
- Arkansas Department of Agriculture, 2022. NPPO communication to CABI., Little Rock, Arkansas, USA: Arkansas Department of Agriculture.
- Beales P A, Brokenshire T, Barnes A V, Barton V C, Hughes K J D, 2004. First report of ramorum leaf blight and dieback (*Phytophthora ramorum*) on *Camellia* spp. in the UK. *Plant Pathology*. 53 (4), 524. DOI:10.1111/j.1365-3059.2004.01028.x
- Beales P A, Schlenzig A, Inman A J, 2004a. First report of ramorum bud and leaf blight (*Phytophthora ramorum*) on *Syringa vulgaris* in the UK. *Plant Pathology*. 53 (4), 525. DOI:10.1111/j.1365-3059.2004.01033.x
- Blomquist C L, Rooney-Latham S, Soriano M C, McCarty J C, 2012. First report of *Phytophthora ramorum* causing a leafspot on *Loropetalum chinense*, Chinese fringe flower in California. *Plant Disease*. 96 (12), 1829. <http://apsjournals.apsnet.org/loi/pdis> DOI:10.1094/PDIS-01-12-0062-PDN
- Brasier C M, Denman S, Rose J, Kirk S A, Hughes K J D, Griffin R L, Lane C R, Inman A J, Webber J F, 2004. First report of ramorum bleeding canker on *Quercus falcata*, caused by *Phytophthora ramorum*. *Plant Pathology*. 53 (6), 804. DOI:10.1111/j.1365-3059.2004.01079.x
- Brasier C M, Webber J F, 2012. Natural stem infection of Lawson cypress (*Chamaecyparis lawsoniana*) caused by *Phytophthora ramorum*. *New Disease Reports*. 26. <http://www.ndrs.org.uk/article.php?id=025026> DOI:10.5197/j.2044-0588.2012.025.026
- Brazee N J, Wick R L, Hulvey J P, 2016. *Phytophthora* species recovered from the Connecticut River Valley in Massachusetts, USA. *Mycologia*. 108 (1), 6-19. DOI:10.3852/15-038
- Bulajić A, Djekić I, Jović J, Krnjajić S, Vučurović A, Krstić B, 2010. *Phytophthora ramorum* occurrence in ornamentals in Serbia. *Plant Disease*. 94 (6), 703-708. <http://apsjournals.apsnet.org/loi/pdis> DOI:10.1094/PDIS-94-6-0703
- Bulajić A, Jović J, Krnjajić S, Djekić I, Krstić B, 2009. First report of *Phytophthora ramorum* on *Rhododendron* sp. in Serbia. *Plant Pathology*. 58 (4), 804. DOI:10.1111/j.1365-3059.2009.02033.x
- CABI, 2022. CABI Distribution Database: Status as determined by CABI editor. Wallingford, UK: CABI
- CABI, Undated. Compendium record. Wallingford, UK: CABI
- CABI, Undated a. CABI Compendium: Status as determined by CABI editor. Wallingford, UK: CABI
- CABI/EPPO, 2013. *Phytophthora ramorum*. [Distribution map]. In: *Distribution Maps of Plant Diseases*, Wallingford, UK: CABI. Map 978 (Edition 2). DOI:10.1079/DMPD/20133161821
- Chastagner G A, Riley K L, 2010. First report of *Phytophthora ramorum* infecting California red fir in California. *Plant Disease*. 94 (9), 1170. DOI:10.1094/PDIS-94-9-1170B
- Chastagner G, Coats K, Elliott M, 2012. An overview of *Phytophthora ramorum* in Washington State. [Proceedings of the Sudden Oak Death Fifth Science Symposium, General Technical Report PSW-GTR-243, Petaluma, CA], Petaluma, CA, 14-15.
- Chastagner G, Oak S, Omdal D, Ramsey-Kroll A, Coats K, Valachovic Y, Lee C, Hwang J, Jeffers S, Elliott M, 2010. Spread of *P. ramorum* from Nurseries into Waterways-Implications for Pathogen Establishment in New Areas. [Proceedings of the Sudden Oak Death Fourth Science Symposium, General Technical Report PSW-GTR-229], [ed. by Frankel SJ, Kliejunas JT, Palmieri KM]. Santa Cruz, CA, U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station. 22-26.
- Clark C, 2011. *Phytophthora ramorum* in larch trees - Update., UK: Forestry Commission. 1-14. http://forestphytophthoras.org/sites/default/files/educational_materials/IdentifyingPramorumlarchjune2011.pdf
- Connecticut Agricultural Experiment Station, 2022. NPPO communication to CABI., New Haven, USA: Connecticut Agricultural Experiment Station.
- Dart N L, Chastagner G A, Rugarber E F, Riley K L, 2007. Recovery frequency of *Phytophthora ramorum* and other *Phytophthora* spp. in the soil profile of ornamental retail nurseries. *Plant Disease*. 91 (11), 1419-1422. DOI:10.1094/PDIS-91-11-1419
- Davidson J M, Garbelotto M, Koike S T, Rizzo D M, 2002. First report of *Phytophthora ramorum* on Douglas-fir in California. *Plant Disease*. 86 (11), 1274. DOI:10.1094/PDIS.2002.86.11.1274B
- Denman S, Kirk S A, Brasier C M, Barton V C, Hughes K J D, Webber J F, 2005a. *Phytophthora ramorum* on *Quercus ilex* in the United Kingdom. *Plant Disease*. 89 (11), 1241. DOI:10.1094/PD-89-1241A

- Denman S, Kirk S A, Brasier C M, Hughes K J D, Griffin R, Hobdon E, Webber J F, 2005. Foliar infection of sweet chestnut (*Castanea sativa*) by *Phytophthora ramorum* in the UK. *Plant Pathology*. 54 (4), 581. DOI:10.1111/j.1365-3059.2005.01222.x
- Denman S, Kirk S A, Moralejo E, Webber J F, 2009. *Phytophthora ramorum* and *Phytophthora kernoviae* on naturally infected asymptomatic foliage. *Bulletin OEPP/EPPO Bulletin*. 39 (1), 105-111. DOI:10.1111/j.1365-2338.2009.02243.x
- Elliott M, Rollins L, Bourret T, Chastagner G, 2021. First report of leaf blight caused by *Phytophthora ramorum* on cherry Laurel (*Prunus laurocerasus*) in Washington State, U.S.A. *Plant Disease*. 105 (3), 712-712. DOI:10.1094/PDIS-07-20-1489-PDN
- Elliott M, Rollins L, Bourret T, Chastagner G, 2021a. First report of leaf blight caused by *Phytophthora ramorum* on periwinkle (*Vinca minor*) in Washington State, U.S.A. *Plant Disease*. 105 (7), 2023-2023. DOI:10.1094/PDIS-08-20-1721-PDN
- EPPO, 2022. EPPO Global database. In: EPPO Global database, Paris, France: EPPO. 1 pp. <https://gd.eppo.int/>
- Garbelotto M, Barbosa D, Mehl H, Rizzo D M, 2014. First report of the NA2 lineage of *Phytophthora ramorum* from an ornamental rhododendron in the interior of California. *Plant Disease*. 98 (6), 849-850. <http://apsjournals.apsnet.org/loi/pdis> DOI:10.1094/PDIS-10-13-1043-PDN
- Gillman D, 2011. Fact Sheet: *Phytophthora ramorum*., <https://ag.umass.edu/landscape/fact-sheets/phytophthora-ramorum>
- Giltrap P M, Hughes K J D, Barton V C, Hobden E, Barber P, Izzard K, 2006. *Phytophthora ramorum* on three new hosts detected using on-site diagnostics. *New Disease Reports*. <https://www.ndrs.org.uk/article.php?id=014034>
- Giltrap P M, Hughes K J D, Barton V C, Hobden E, Barber P, Izzard K, 2007. *Phytophthora ramorum* on three new hosts detected using on-site diagnostics. *Plant Pathology*. 56 (4), 728. DOI:10.1111/j.1365-3059.2007.01590.x
- Giltrap P M, Inman A J, Barton V C, Barnes A V, Lane C R, Hughes K J D, Tomlinson J, Dean M L, Izzard K, 2004. First report of ramorum dieback (*Phytophthora ramorum*) on *Hamamelis virginiana* in the UK. *Plant Pathology*. 53 (4), 526. <http://www.blackwellpublishing.com/ppa> DOI:10.1111/j.1365-3059.2004.01034.x
- Ginetti B, Carmignani S, Ragazzi A, Werres S, Moricca S, 2014. Foliar blight and shoot dieback caused by *Phytophthora ramorum* on *Viburnum tinus* in the Pistoia area, Tuscany, central Italy. *Plant Disease*. 98 (3), 423. <http://apsjournals.apsnet.org/doi/abs/10.1094/PDIS-07-13-0767-PDN>
- Goheen E M, Hansen E M, Kanaskie A, McWilliams M G, Osterbauer N, Sutton W, 2002. Sudden oak death caused by *Phytophthora ramorum* in Oregon. *Plant Disease*. 86 (4), 441. DOI:10.1094/PDIS.2002.86.4.441C
- Gomes M de J, Amaro P T, 2008. Occurrence of *Phytophthora ramorum* in Portugal on *Viburnum* spp. (Ocorência de *Phytophthora ramorum* em Portugal sobre *Viburnum* spp.). *Revista de Ciências Agrárias (Portugal)*. 31 (2), 105-111.
- Grünwald N J, Goss E M, Larsen M M, Press C M, McDonald V T, Blomquist C L, Thomas S L, 2008. First report of the European lineage of *Phytophthora ramorum* on *Viburnum* and *Osmanthus* spp. in a California nursery. *Plant Disease*. 92 (2), 314. DOI:10.1094/PDIS-92-2-0314B
- Grünwald N J, Kitner M, McDonald V, Goss E M, 2008a. Susceptibility in *Viburnum* to *Phytophthora ramorum*. *Plant Disease*. 92 (2), 210-214. DOI:10.1094/PDIS-92-2-0210
- Grünwald N J, Larsen M M, Kamvar Z N, Reeser P W, Kanaskie A, Laine J, Wiese R, 2016. First report of the EU1 clonal lineage of *Phytophthora ramorum* on tanoak in an Oregon forest. *Plant Disease*. 100 (5), 1024. <http://apsjournals.apsnet.org/loi/pdis> DOI:10.1094/PDIS-10-15-1169-PDN
- Hansen E M, Reeser P W, Sutton W, Winton L M, Osterbauer N, 2003. First report of A1 mating type of *Phytophthora ramorum* in North America. *Plant Disease*. 87 (10), 1267. DOI:10.1094/PDIS.2003.87.10.1267A
- Herrero M L, Toppe B, Brurberg M B, 2011. First report of *Phytophthora ramorum* causing shoot dieback on bilberry (*Vaccinium myrtillus*) in Norway. *Plant Disease*. 95 (3), 355. DOI:10.1094/PDIS-10-10-0709
- Herrero M L, Toppe B, Klemsdal S S, Stensvand A, 2006. First report of *Phytophthora ramorum* in ornamental plants in Norway. *Plant Disease*. 90 (11), 1458. DOI:10.1094/PD-90-1458B
- Hicks CB, 2018. Unpublished Report., Raleigh, USA: USDA-APHIS. 26 pp.
- Hüberli D, Hayden K J, Calver M, Garbelotto M, 2012. Intraspecific variation in host susceptibility and climatic factors mediate epidemics of sudden oak death in western US forests. *Plant Pathology*. 61 (3), 579-592. <http://onlinelibrary.wiley.com/doi/10.1111/j.1365-3059.2011.02535.x/full> DOI:10.1111/j.1365-3059.2011.02535.x
- Hüberli D, Ivors K L, Smith A, Tse J G, Garbelotto M, 2005. First report of foliar infection of *Maianthemum racemosum* by *Phytophthora ramorum*. *Plant Disease*. 89 (2), 204. DOI:10.1094/PD-89-0204C

Hüberli D, Reuther K D, Smith A, Swain S, Tse J G, Garbelotto M, 2004. First report of foliar infection of *Rosa gymnocarpa* by *Phytophthora ramorum*. *Plant Disease*. 88 (4), 430. DOI:10.1094/PDIS.2004.88.4.430

Hüberli D, Sant-Glass W van, Tse J G, Garbelotto M, 2003. First report of foliar infection of starflower by *Phytophthora ramorum*. *Plant Disease*. 87 (5), 599. DOI:10.1094/PDIS.2003.87.5.599B

Hughes K J D, Giltrap P M, Barton V C, Hobden E, Tomlinson J A, Barber P, 2006. On-site real-time PCR detection of *Phytophthora ramorum* causing dieback of *Parrotia persica* in the UK. *Plant Pathology*. 55 (6), 813. DOI:10.1111/j.1365-3059.2006.01461.x

Hulvey J, Gobena D, Finley L, Lamour K, 2010. Co-occurrence and genotypic distribution of *Phytophthora* species recovered from watersheds and plant nurseries of eastern Tennessee. *Mycologia*. 102 (5), 1127-1133. DOI:10.3852/09-221

Husson C, Delatour C, Frey P, Marçais B, Saurat C, Schenck N, 2007. First report of *Phytophthora ramorum* on ornamental plants in France. *Plant Disease*. 91 (10), 1359. DOI:10.1094/PDIS-91-10-1359B

Hwang J, Warfield C Y, Parker K C, Benson D M, 2006. First report of *Phytophthora cambivora* on hybrid rhododendron in North Carolina. *Plant Health Progress*. 1-3. <http://www.plantmanagementnetwork.org/php/>

Inman A J, Townend V C, Barnes A V, Lane C R, Hughes K J D, Griffin R L, Eales S J, 2003. First report of ramorum dieback (*Phytophthora ramorum*) on *Pieris* in England. *Plant Pathology*. 52 (6), 785. DOI:10.1111/j.1365-3059.2003.00894.x

IPPC, 2006. IPP Report No. NL-5/1., Rome, Italy: FAO.

IPPC, 2009. Update on the *Phytophthora ramorum* situation in Canada (2009). In: IPPC Official Pest Report, Rome, Italy: FAO. https://www.ippc.int/index.php?id=1110520&no_cache=1&type=pestreport&L=0

IPPC, 2016. Information on Pest Status in the Republic of Lithuania in 2015. In: IPPC Official Pest Report, No. LTU-01/2, Rome, Italy: FAO. <https://www.ippc.int/>

IPPC, 2018. First report of *Phytophthora ramorum* in Slovenia. In: IPPC Official Pest Report, Rome, Italy: FAO. <https://www.ippc.int/>

Jeffers SN, Hwang J, Wamische YA, Oak SW, 2009. Detection of *Phytophthora ramorum* at retail nurseries in the Southeastern United States. [Proceedings of the Sudden Oak Death Fourth Science Symposium, General Technical Report PSW-GTR-229], [ed. by Frankel SJ, Kliejunas JT, Palmieri KM]. Santa Cruz, CA, US Department of Agriculture, Forest Service, Pacific Southwest Research Station. 22-26.

Jung T, Scanu B, Brasier C M, Webber J, Milenković I, Corcobado T, Tomšovský M, Pánek M, Bakonyi J, Maia C, Bačová A, Raco M, Rees H, Pérez-Sierra A, Jung M H, 2020. A survey in natural forest ecosystems of Vietnam reveals high diversity of both new and described *Phytophthora* taxa including *P. ramorum*. *Forests*. 11 (1), 93. DOI:10.3390/f11010093

Kamvar ZN, Larsen MM, Kanaskie AM, Hansen EM, Grünwald NJ, 2015. Spatial and temporal analysis of populations of the Sudden Oak Death Pathogen in Oregon forests. In: *Phytopathology*, 105 (7) 982-989.

Kanaskie A, Wiese R, Norlander D, Laine J, Navarro S, Goheen EM, Rhatigan R, Hansen E, Sutton W, Reeser P, Grünwald N, Kamvar Z, Osterbauer N, 2017. Slowing Spread of Sudden Oak Death in Oregon Forests, 2001-2015. [Proceedings of the Sudden Oak Death Sixth Science Symposium, Gen. Tech. Rep. GTR-PSW-255], [ed. by Frankel SJ, Harrell KM]. Albany, CA, US Department of Agriculture, Forest Service, Pacific Southwest Research Station. 1.

King K M, Harris A R, Webber J F, 2015. In planta detection used to define the distribution of the European lineages of *Phytophthora ramorum* on larch (*Larix*) in the UK. *Plant Pathology*. 64 (5), 1168-1175. <http://onlinelibrary.wiley.com/doi/10.1111/ppa.12345/full> DOI:10.1111/ppa.12345

Kurdyla T, Pham J, McBride S, Appel D, 2014. Survey and detection of *Phytophthora ramorum*, the Sudden Oak Death pathogen, in Texas. In: *Phytopathology*, 104 (S2) 6.

Lane C R, Beales P A, Hughes K J D, Griffin R L, Munro D, Brasier C M, Webber J F, 2003. First outbreak of *Phytophthora ramorum* in England, on *Viburnum tinus*. *Plant Pathology*. 52 (3), 414. DOI:10.1046/j.1365-3059.2003.00835.x

Lane C R, Beales P A, Hughes K J D, Tomlinson J A, Inman A J, Warwick K, 2004. First report of ramorum dieback (*Phytophthora ramorum*) on container-grown English yew (*Taxus baccata*) in England. *Plant Pathology*. 53 (4), 522. DOI:10.1111/j.1365-3059.2004.01022.x

Leboldus J M, Sondreli K L, Sutton W, Reeser P, Navarro S, Kanaskie A, Grünwald N J, 2018. First report of *Phytophthora ramorum* lineage EU1 infecting douglas fir and grand fir in Oregon. *Plant Disease*. 102 (2), 455. DOI:10.1094/PDIS-05-17-0681-PDN

Lilja A, Rytönen A, Kokkola M, Parikka P, Hantula J, 2007. First report of *Phytophthora ramorum* and *P. inflata* in ornamental rhododendrons in Finland. *Plant Disease*. 91 (8), 1055. DOI:10.1094/PDIS-91-8-1055C

Maloney P E, Rizzo D M, Koike S T, Harnik T Y, Garbelotto M, 2002. First report of *Phytophthora ramorum* on coast redwood in California. *Plant Disease*. 86 (11), 1274. DOI:10.1094/PDIS.2002.86.11.1274A

Maryland Department of Agriculture, 2017. *Phytophthora ramorum* in Maryland: Current situation., http://mda.maryland.gov/plants-pests/Pages/phytophthora_ramorum_current_situation.aspx

Maryland Department of Agriculture, 2022. NPPO communication to CABI., Annapolis, Maryland, USA: Maryland Department of Agriculture.

MDA, 2009. *Phytophthora ramorum* and Maryland: Background., Maryland Department of Agriculture. http://mda.maryland.gov/plants-pests/Pages/phytophthora_ramorum_background.aspx

Merlier D de, Chandelier A, Cavelier M, 2003. First report of *Phytophthora ramorum* on *Viburnum bodnantense* in Belgium. *Plant Disease*. 87 (2), 203. DOI:10.1094/PDIS.2003.87.2.203C

Mississippi Department of Agriculture and Commerce, 2022. NPPO communication to CABI., USA: Mississippi Department of Agriculture and Commerce.

Missouri Department of Agriculture, 2022. NPPO communication to CABI., Jefferson City, Missouri, USA: Missouri Department of Agriculture.

Moralejo E, Pérez-Sierra A M, Álvarez L A, Belbahri L, Lefort F, Descals E, 2009. Multiple alien *Phytophthora* taxa discovered on diseased ornamental plants in Spain. *Plant Pathology*. 58 (1), 100-110. DOI:10.1111/j.1365-3059.2008.01930.x

Moralejo E, Werres S, 2002. First report of *Phytophthora ramorum* on *Rhododendron* sp. in Spain. *Plant Disease*. 86 (9), 1052. DOI:10.1094/PDIS.2002.86.9.1052A

Murphy S K, Rizzo D M, 2003. First report of *Phytophthora ramorum* on canyon live oak in California. *Plant Disease*. 87 (3), 315. DOI:10.1094/PDIS.2003.87.3.315C

NAPPO, 2016. Phytosanitary Alert System: *Phytophthora ramorum* – Expansion of Quarantine Area in Oregon to Include Curry County., <http://www.pestalert.org/oprDetail.cfm?oprID=646&keyword=PHYTOPHTHORA%20RAMORUM>

NAPPO, 2016a. *Phytophthora ramorum* - Expansion of Quarantine Area in Oregon to Include Curry County., <https://www.pestalerts.org/official-pest-report/phytophthora-ramorum-expansion-quarantine-area-oregon-include-curry-county>

New Jersey Department of Agriculture, Division of Plant Industry, 2022. NPPO communication to CABI., USA: New Jersey Department of Agriculture, Division of Plant Industry.

New York State Department of Agriculture & Markets, 2022. NPPO communication to CABI., Albany, USA: New York State Department of Agriculture & Markets.

North Carolina Forest Service, 2017. Current Forest Health Concerns: Sudden Oak Death., http://www.ncforestservice.gov/forest_health/current_concerns.htm

NPPO of the Netherlands, 2013. Pest status of harmful organisms in the Netherlands., Wageningen, Netherlands:

O'Hanlon R, Choiseul J, Corrigan M, Catarama T, Destefanis M, 2016. Diversity and detections of *Phytophthora* species from trade and non-trade environments in Ireland. *Bulletin OEPP/EPPO Bulletin*. 46 (3), 594-602. DOI:10.1111/epp.12331

Orlikowski L B, Szkuta G, 2002. First record of *Phytophthora ramorum* in Poland. *Phytopathologia Polonica*. 69-79.

Osterbauer N K, Lane S, Trippe A, 2014. *Phytophthora ramorum* identified infecting eastern teaberry (*Gaultheria procumbens*) plants shipped to Oregon. *Plant Health Progress*. PHP-BR-13-0109. <http://www.plantmanagementnetwork.org/php/elements/sum2.aspx?id=10739>

Patel J S, Vitoreli A, Palmateer A J, El-Sayed A, Norman D J, Goss E M, Brennan M S, Ali G S, 2016. Characterization of *Phytophthora* spp. isolated from ornamental plants in Florida. *Plant Disease*. 100 (2), 500-509. <http://apsjournals.apsnet.org/loi/pdis> DOI:10.1094/PDIS-05-15-0598-RE

Pennsylvania Department of Agriculture, 2022. NPPO communication to CABI., Harrisburgh, Pennsylvania, USA: Pennsylvania Department of Agriculture.

Pintos Varela C, Mansilla Vázquez J P, Aguín Casal O, 2003. First report of *Phytophthora ramorum* on *Camellia japonica* in Spain. *Plant Disease*. 87 (11), 1396. DOI:10.1094/PDIS.2003.87.11.1396A

Press C M, Fieland V J, Creswell T, Bonkowski J, Miles L, Grünwald N J, 2020. First report of the NA2 clonal lineage of *Phytophthora ramorum* in Indiana. *Plant Disease*. 104 (6), 1875-1876. DOI:10.1094/PDIS-12-19-2543-PDN

Preuett JA, Collins D, Williams A, Deahl K, Jones R, 2012. Stream Baiting in Southern Louisiana for *Phytophthora ramorum*. [Proceedings of Sudden Oak Death Fifth Science Symposium, Gen. Tech. Rep. PSW-GTR-243, Petaluma, California], 159.

Reeser P W, Sutton W, Hansen E M, 2008. *Phytophthora* species causing tanoak stem cankers in southwestern Oregon. *Plant Disease*. 92 (8), 1252. DOI:10.1094/PDIS-92-8-1252B

Riley K L, Chastagner G A, 2011. First report of *Phytophthora ramorum* infecting mistletoe in California. Plant Health Progress. PHP-2011-0209-02-BR. <http://www.plantmanagementnetwork.org/php/elements/sum.aspx?id=9402&photo=5200>

Riley K L, Chastagner G A, Blomquist C, 2011. First report of *Phytophthora ramorum* infecting grand fir in California. Plant Health Progress. PHP-2011-0401-01-BR. <http://www.plantmanagementnetwork.org/php/elements/sum.aspx?id=9437&photo=5278>

Rooney-Latham S, Blomquist C L, Soriano M C, Uhler M, 2020. First report of *Phytophthora ramorum* causing foliar and stem blight of two California native *Arctostaphylos* species, *A. viridissima* and *A. glauca*. Plant Disease. 104 (10), 2741-2741. DOI:10.1094/PDIS-07-19-1359-PDN

Rooney-Latham S, Blomquist C L, Williams A, Gunnison E, Pastalka T, 2017. Identification of five new hosts of *Phytophthora ramorum* in an infested forest in California. [Proceedings of the Sudden Oak Death Sixth Science Symposium], 83-84. https://www.fs.fed.us/psw/publications/documents/psw_gtr255/psw_gtr255_083.pdf

Rytkönen A, Lilja A, Vercauteren A, Sirkiä S, Parikka P, Soukainen M, Hantula J, 2012. Identity and potential pathogenicity of *Phytophthora* species found on symptomatic *Rhododendron* plants in a Finnish nursery. Canadian Journal of Plant Pathology. 34 (2), 255-267. <http://www.tandfonline.com/loi/tcjp20>

Schenck N, Saurat C, Guinet C, Fourrier-Jeandel C, Roche L, Bouvet A, Husson C, Saintonge F X, Contal C, Iosifidis R, 2018. First report of *Phytophthora ramorum* causing Japanese larch dieback in France. Plant Disease. 102 (10), 2045. DOI:10.1094/pdis-02-18-0288-pdn

Schlenzig A, Purser E, Perez-Sierra A, 2016. First finding of *Phytophthora foliorum* in the United Kingdom. New Disease Reports. 2. DOI:10.5197/j.2044-0588.2016.034.002

Seebens H, Blackburn T M, Dyer E E, Genovesi P, Hulme P E, Jeschke J M, Pagad S, Pyšek P, Winter M, Arianoutsou M, Bacher S, Blasius B, Brundu G, Capinha C, Celesti-Grapo L, Dawson W, Dullinger S, Fuentes N, Jäger H, Kartesz J, Kenis M, Kreft H, Kühn I, Lenzner B, Liebhold A, Mosena A (et al), 2017. No saturation in the accumulation of alien species worldwide. Nature Communications. 8 (2), 14435. <http://www.nature.com/articles/ncomms14435>

Shrestha SK, Zhou Y, Lamour K, 2013. Oomycetes baited from streams in Tennessee 2010-2012. In: Mycologia, 105 (6) 1516-1523.

Søndreli K L, Kanaskie A, Navarro S M, Reeser P, Leboldus J M, 2021. Characterizing the variation in aggressiveness and sporulation of the NA1 and EU1 lineages of *Phytophthora ramorum* in Oregon. Plant Pathology. 70 (6), 1342-1353. DOI:10.1111/ppa.13377

South Carolina Forestry Commission/USDA Forest Service, 2010. South Carolina Forest Health Highlights 2010., Asheville, NC, USA: United States Department of Agriculture Forest Service, Southern Region, State & Private Forestry, Asheville. 2 pp.

Sutton W, Hansen E M, Reeser P W, Kanaskie A, 2009. Stream monitoring for detection of *Phytophthora ramorum* in Oregon tanoak forests. Plant Disease. 93 (11), 1182-1186. DOI:10.1094/PDIS-93-11-1182

Tjosvold S A, Koike S T, Chambers D L, 2008. Evaluation of fungicides for the control of *Phytophthora ramorum* infecting *Rhododendron*, *Camellia*, *Pieris*, and *Viburnum*. Plant Health Progress. 0208-01.

Tsopelas P, Paplomatas E J, Tjamos S E, Soulioti N, Elena K, 2011. First report of *Phytophthora ramorum* on *Rhododendron* in Greece. Plant Disease. 95 (2), 223. <http://apsjournals.apsnet.org/loi/pdis> DOI:10.1094/PDIS-08-10-0607

UC Berkeley Forest Pathology and Mycology Lab, 2020. SODmap., UC Berkeley Forest Pathology and Mycology Lab. <https://www.sodmap.org>

US Forest Service Northeastern Area, 2016. 2015 Forest Health Highlights: Pennsylvania., 1-11. https://www.fs.fed.us/foresthealth/fhm/fhh/fhh_15/PA_FHH_2015.pdf

US Forest Service/Animal Plant Health Inspection Service/National Association of State Foresters/National Plant Board, 2011. National Framework for Managing Sudden Oak Death caused by *Phytophthora ramorum* in Forests and Wildlands., 1-14. http://www.suddenoakdeath.org/wp-content/uploads/2012/08/SOD_National_Framework.final_.July2012dated.2011.pdf

USDA-APHIS, 2016. Plant Health., USA: United States Department of Agriculture, Animal and Plant Health Inspection Service. <https://www.aphis.usda.gov/aphis/ourfocus/planthealth>

Vélez M L, Manna L I, Tarabini M, Gomez F, Elliott M, Hedley P E, Cock P, Greslebin A, 2020. *Phytophthora austrocedri* in Argentina and co-inhabiting phytophthoras: roles of anthropogenic and abiotic factors in species distribution and diversity. Forests. 11 (11), DOI:10.3390/f11111223

Vettrano A M, Hüberli D, Garbelotto M, 2008. *Phytophthora ramorum* infection of coast live oak leaves in Californian forests and its capacity to sporulate in vitro. Australasian Plant Pathology. 37 (1), 72-73. DOI:10.1071/AP07085

Vettrano A M, Hüberli D, Swain S, Bienapfl J C, Smith A, Garbelotto M, 2006. First report of infection of maiden-hair fern (*Adiantum jordanii* and *A. aleuticum*) by *Phytophthora ramorum* in California. Plant Disease. 90 (3), 379. DOI:10.1094/PD-90-0379B

Vettraineo A M, Hüberli D, Swain S, Smith A, Garbelotto M, 2006a. A new report of *Phytophthora ramorum* on *Rhamnus purshiana* in Northern California. *Plant Disease*. 90 (2), 246. DOI:10.1094/PD-90-0246C

Virginia Department of Agriculture and Consumer Services, 2022. communication to CABI., Richmond, Virginia, USA: Virginia Department of Agriculture and Consumer Services.

Washington State Department of Agriculture, 2022. NPPO communication to CABI., Olympia, Washington, USA: Washington State Department of Agriculture.

WDNR/USFS, 2017. Forest Health Highlights in Washington—2016., Washington Department of Natural Resources (WDNR) Department of Agriculture, Forest Service (USFS). 37 pp.

Werres S, Marwitz R, 1997. (Triebsterben an Rhododendron: Unbekannte Phytophthora). In: *Deutscher Gartenbau*, 21 1166-1168.

Werres S, Marwitz R, Man in't Veld W A, Cock A W A M de, Bonants P J M, Weerd M de, Themann K, Ilieva E, Baayen R P, 2001. *Phytophthora ramorum* sp. nov., a new pathogen on *Rhododendron* and *Viburnum*. *Mycological Research*. 105 (10), 1155-1165. DOI:10.1016/S0953-7562(08)61986-3

Werres S, Merlier D de, 2003. First detection of *Phytophthora ramorum* mating type A2 in Europe. *Plant Disease*. 87 (10), 1266. DOI:10.1094/PDIS.2003.87.10.1266C

WSDA, 2016. Annual Report - Sudden Oak Death (SOD) - *Phytophthora ramorum*., State of Washington, Department of Agriculture. 6 pp.

Yakabe L E, MacDonald J D, 2010. Soil treatments for the potential elimination of *Phytophthora ramorum* in ornamental nursery beds. *Plant Disease*. 94 (3), 320-324. DOI:10.1094/PDIS-94-3-0320

Žerjav M, Munda A, Lane C R, Barnes A V, Hughes K J D, 2004. First report of *Phytophthora ramorum* on container-grown plants of *rhododendron* and *viburnum* in Slovenia. *Plant Pathology*. 53 (4), 523. DOI:10.1111/j.1365-3059.2004.01023.x

Links to Websites

Website	URL	Comment
Global register of Introduced and Invasive species (GRIIS)	http://griis.org/	Data source for updated system data added to species habitat list.

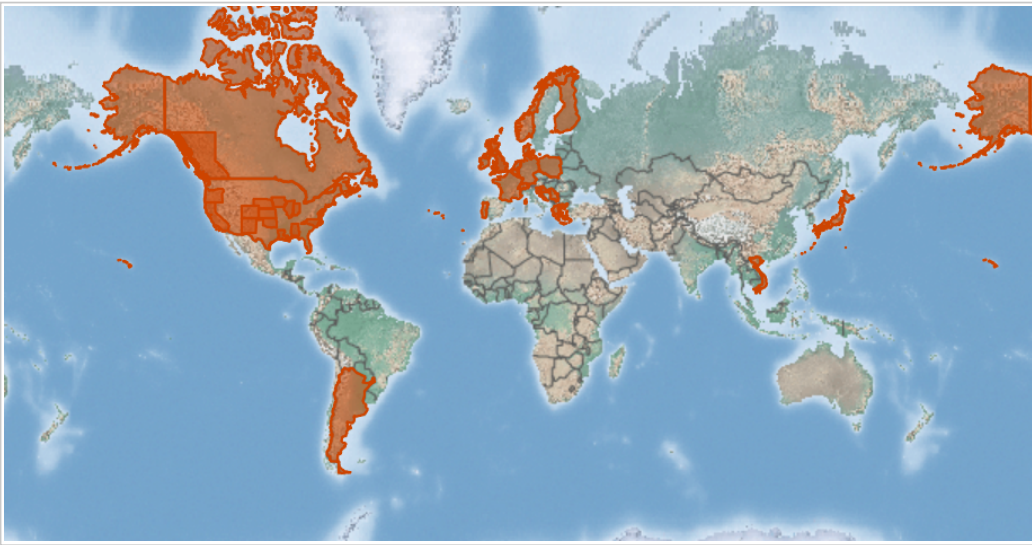
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CABI, 2022. *Phytophthora ramorum*. In: Invasive Species Compendium. Wallingford, UK: CAB International. <https://www.cabi.org/isc>

Map Legends - World

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CABI, 2022. *Phytophthora ramorum*. In: Invasive Species Compendium. Wallingford, UK: CAB International. <https://www.cabi.org/isc>

Map Legends - Africa

○ CABI Summary Data



CABI, 2022. *Phytophthora ramorum*. In: Invasive Species Compendium. Wallingford, UK: CAB International. <https://www.cabi.org/isc>

Map Legends - Asia

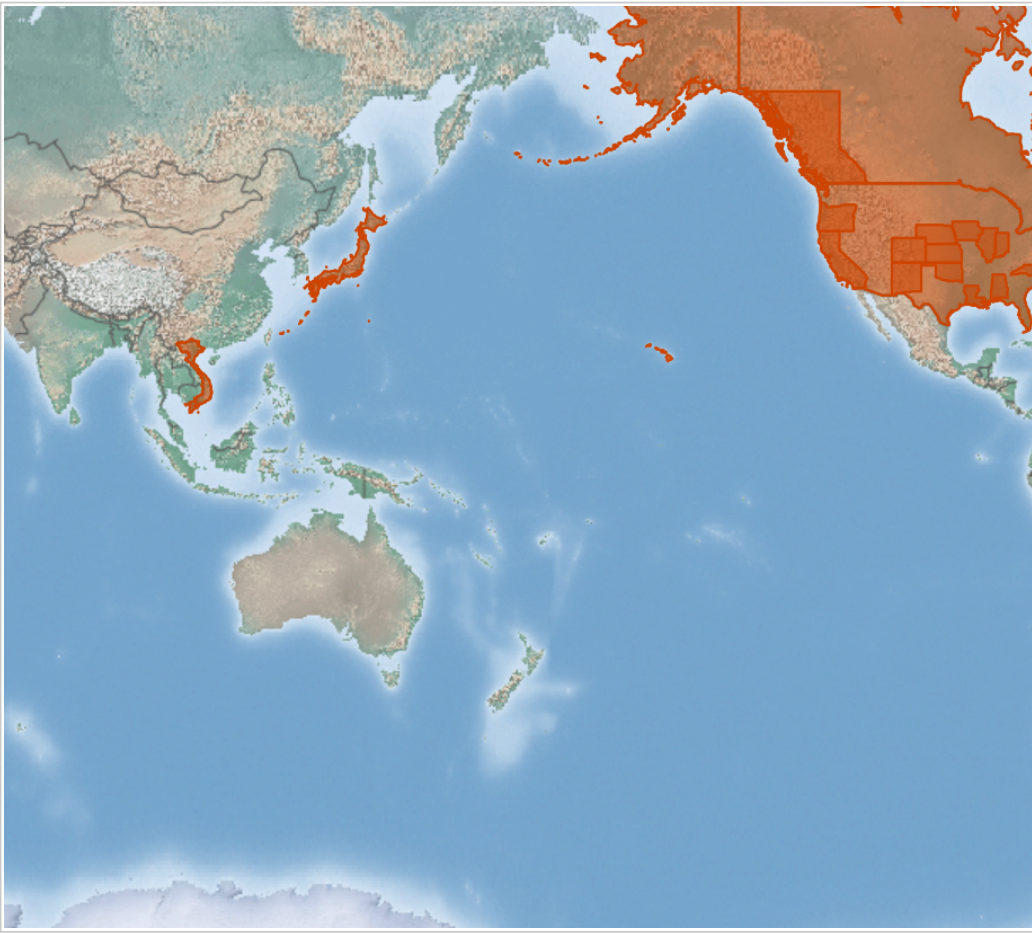
○ CABI Summary Data



CABI, 2022. *Phytophthora ramorum*. In: Invasive Species Compendium. Wallingford, UK: CAB International. <https://www.cabi.org/isc>

Map Legends - Europe

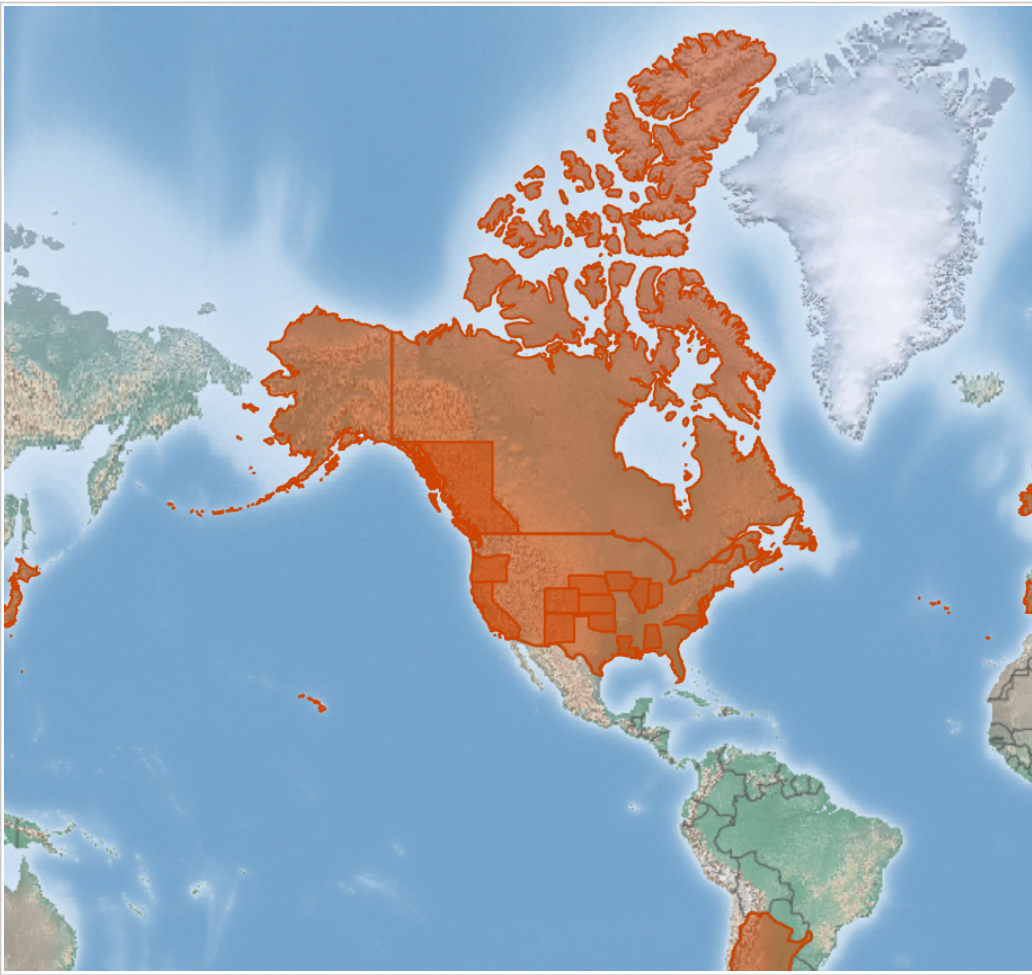
○ CABI Summary Data



CABI, 2022. *Phytophthora ramorum*. In: Invasive Species Compendium. Wallingford, UK: CAB International. <https://www.cabi.org/isc>

Map Legends - Pacific

○ CABI Summary Data



CABI, 2022. *Phytophthora ramorum*. In: Invasive Species Compendium. Wallingford, UK: CAB International. <https://www.cabi.org/isc>

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CABI, 2022. *Phytophthora ramorum*. In: Invasive Species Compendium. Wallingford, UK: CAB International. <https://www.cabi.org/isc>

Map Legends - Central America

○ CABI Summary Data



CABI, 2022. *Phytophthora ramorum*. In: Invasive Species Compendium. Wallingford, UK: CAB International. <https://www.cabi.org/isc>

Map Legends - South America

○ CABI Summary Data

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