

Phytophthora plurivora

System: Terrestrial

Kingdom	Phylum	Class	Order	Family
Chromista	Oomycota	Peronosporae	Peronosporales	Peronosporaceae

Common name

Synonym

Similar species

Summary

This species was described in 2009 and it has an uncertain origin. It is thought to potentially originate from South-East Asia and is considered as alien in Europe and North America. The oomycete is a very aggressive pathogen with a wide range of plant hosts. It has been implicated in the severe decline of multiple species throughout Europe and in North America, such as Oak and Beech. Its common presence in nurseries is thought to indicate an important route of introduction and is another impact of the species.



[view this species on IUCN Red List](#)

Species Description

Phytophthora plurivora is a fungus-like pathogen capable of infecting a very wide range of plant hosts. This oomycete was described in 2009 by Jung & Burgess as having the following characteristics: Its sporangia are typically borne terminally on unbranched sporangiophores, with the overall range of sporangial dimensions reported as 27.5–80.5 × 16.7–69.6µm. They are non-caducous, semipapillate or sometimes bi- or tripapillate, or bilobed. They usually form a conspicuous basal plug that protrudes into the empty sporangium. The shape of the sporangia is very variable, being ovoid, limoniform, obpyriform, ellipsoid or a distorted shape. Sporangia with unusual features are commonly found. These features can be lateral attachment of the sporangiophore, markedly curved apices, a widening of the sporangiophore towards the base of the sporangium or a short hyphal extension. The zoospores are discharged through an exit pore 5 to 10µm wide. Their shape ranges from limoniform to reniform when motile, and they become spherical, with a diameter of around 10µm, on encystment. The gametangia are readily produced in single culture. Oogonia are borne terminally, have smooth walls and are globose or subglobose. Older oogonia have walls that usually turn golden-yellow or golden-brown. These have a diameter of around 28.5µm. Oospores are usually globose and have a diameter of around 1.5µm. The antheridia are obovoid, club-shaped or irregular in shape, and sometimes have one or more fingerlike projections. They are almost exclusively paragynous and usually attach close to the oogonial stalk. Colonies grown on V8A or MEA produce limited aerial mycelium in the center and radiate to slightly chrysanthemum growth patterns. If grown on PDA, they have markedly more aerial mycelium than on other media. Colonies can produce globose, subglobose or appressoria-like hyphal swellings and dense, brush-like or coralloid clusters of lateral hyphae. The optimum growth temperature is 25°C, and the maximum temperature for growth is 32°C. At 25°C, the radial growth rates range from 8.0 to 8.4 mm/d. Lastly, this species is usually identified through sequencing of its ITS region, cox1 and beta-tubulin gene regions (Jung & Burgess 2009).



Notes

Taxonomy This species was previously considered as part of the *P. citricola* complex. It was described as its own species in 2009, and much of the literature referring to *P. citricola* before then has been considered as referring to *P. plurivora* (Jung & Burgess, 2009). **Spread** This species is very common in ornamental nurseries. They are an important route for its global spread. In nurseries, the pathogen can survive in water runoffs and reservoirs, plant debris in containers and in asymptomatic plants (Junker et al., 2016). The pathogen can spread via water if introduced into a river basin from nursery stock (Zamora-Ballesteros et al., 2017). **Interactions** Elevated CO₂ levels have been shown to stimulate the activity and hence increase the impact of the species. This means that *P. plurivora* could become even more aggressive in the near future (Tkaczyk et al., 2014). Additionally, it has been shown that infected *Quercus rubra* leaves have increased levels of nitrogen and water content, which enhances the performance of *L. dispar* larvae feeding on them. This faster development of larvae means that they are exposed to natural enemies for a shorter period of time, increasing their impact as pests (Milanovic et al., 2015).

Lifecycle Stages

Oospores in the soil can germinate in warm temperatures and in the presence of water to produce sporangia. Mature sporangia release biflagellate zoospores, which are motile and can direct themselves to roots through chemotaxis. Once at a host root, they can germinate to produce hyphae, which grow into the plant cells. The pathogen spreads in this way through the host, until it forms sporangia in the root surface that can release more zoospores. Alternatively, it can form oospores that can persist under unfavorable conditions in the soil, even though they don't form chlamydospores (Duares, 2015).

Habitat Description

This pathogen has a very wide host range. It has been known to infect 147 plant taxa, both dicotyledons and conifers (Jung et al., 2016). Among these are *Acer platanoides*, *A. hippocastanum*, *A. glutinosa*, *A. incana*, *B. péndula*, *Carpinus betulus*, *F. sylvatica*, *P. aibes*, *P. sylvestris*, *Q. petraea*, *Q. robur*, *T. cordata*, *Viburnum lentago*, *Vaccinium myrtillus*, *V. uliginosum*, and *V. angustifolium* (Blomquist, 2016; Rytönen et al., 2012). It's intolerant to pH levels below 3.5 and can frequently be found in silt loam and sandy loam soils with pH above 3.66 (Jankowiak et al., 2014; Jung et al., 2000). The vertical limit of its distribution in the Bavarian Alps was recorded as 870m a.s.l. (Jung & Burgess 2009).

Reproduction

P. plurivora is a homothallic species, meaning that it doesn't outcross but can sexually reproduce through self-fertilization to produce oospores. It only has one mating type (Schoebel et al., 2014). The oospores can persist in the soil. It can also reproduce asexually through motile zoospores released from sporangia. These disperse in the water and can infect host roots.

General Impacts

Phytophthora plurivora is a major pathogen throughout Europe, as it can infect multiple taxa with high economic value. It also has impacts in North America and South-East Asian nurseries and plantations. Infections are very commonly found in nurseries, which causes economic loss through the mortality of trees. It's often isolated in nurseries from blighted ornamentals such as rhododendrons (Schoebel et al., 2014). In infected trees, the pathogen causes extensive fine root losses, bark necrosis, dieback, and thinning of foliage. Leaves can become abnormally small and yellowish. Necrosis in the inner bark can be seen as tarry or rusty spots on the bark, starting from the stem base. Death can occur within one or two years, or in some cases a few months if the plants are weak or young (Jung et al., 2005; Jung & Burgess, 2009). While these are symptoms common to the *Phytophthora* genus, *P. plurivora* has been described as one of the more aggressive members of the genus. Infected hosts become predisposed to damage by droughts and secondary pests such as *C. fraxinea* (Jung & Burgess 2009; Orlikowski et al., 2011). This pathogen has been involved in multiple devastating declines of forests across Europe and now in North America. European beech (*Fagus sylvatica*) stands in Europe and the USA have been showing increasing occurrences of symptomatic trees (Jung et al., 2005). It is also present extensively in European Oak stands (Jankowiak et al., 2014) and is thought to be a major contributor to the decline of alder (Zamora-Ballesteros et al., 2017). Because of its wide host range and aggressive symptoms, it has been referred to as the most threatening *Phytophthora* species (Duares, 2015).

Management Info

Because eliminating this pathogen once it's present is nearly impossible, management is usually centered around phytosanitary guidelines in nurseries (Blomquist, 2016). Infections occur mostly through spores in soil or zoospores in irrigation water, so these are good targets for preventing spread. Because plants can be asymptomatic even if infected, guidelines usually advise regular surveys of potential sources, such as puddles and other water sources. The pathogen has previously been managed with a number of fungicides, but resistance to some of these, such as metalaxyl, has developed (Joseph & Coffey, 1984; Hung et al., 2015). There are fungicides that have been developed specifically to prevent growth of *Phytophthora* species, such as mefenoxam and derivatives of phosphoric acid (Jung et al., 2005). Phosphites are an effective control agent that has proven to prevent mortality in infected plants, but it doesn't prevent the production of zoospores that can spread the disease further (Duares, 2015). Aluminium, calcium, and sodium tris-O-ethyl phosphonates have been shown to inhibit sporangia development (Coffery & Joseph, 1985). Research on using *Chaetomium* spp. for biocontrol has shown that these species can slow the growth of multiple *Phytophthora* (Hung et al., 2015).

Pathway

P. plurivora is very commonly found in nurseries throughout all of Europe. Genetic analyses have determined that gene flow is unidirectional from Europe to the USA, suggesting that the pathogen arrived to North America through the plant trade.

Principal source: Durães, S. (2015). Pathogenicity tests of *Phytophthora alni* and *Phytophthora plurivora* in *Fraxinus excelsior* and *Alnus glutinosa* seedlings. Jung, T., & Burgess, T. I. (2009). Re-evaluation of *Phytophthora citricola* isolates from multiple woody hosts in Europe and North America reveals a new species, *Phytophthora plurivora* sp. nov. *Persoonia*, 22, 95. Jung, T., Hudler, G. W., Jensen-Tracy, S. L., Griffiths, H. M., Fleischmann, F., & Osswald, W. (2005). Involvement of *Phytophthora* species in the decline of European beech in Europe and the USA. *Mycologist*, 19(4), 159-166. Jung, T., Orlikowski, L., Henricot, B., Abad-Campos, P., Aday, A. G., Aguín Casal, O., ... & Corcobado, T. (2016). Widespread *Phytophthora* infestations in European nurseries put forest, semi-natural and horticultural ecosystems at high risk of *Phytophthora* diseases. *Forest Pathology*, 46(2), 134-163. Schoebel CN, Stewart J, Gruenwald NJ, Rigling D, Prospero S (2014) Population History and Pathways of Spread of the Plant Pathogen *Phytophthora plurivora*. *PLoS ONE* 9(1): e85368. doi:10.1371/journal.pone.0085368

Compiler:

Review:

Publication date:

ALIEN RANGE

[1] AUSTRALIA	[1] AUSTRIA
[1] BELGIUM	[3] CHINA
[1] CZECH REPUBLIC	[1] DENMARK
[1] FINLAND	[1] FRANCE
[1] GERMANY	[1] HUNGARY
[1] INDIA	[2] IRELAND
[1] ITALY	[1] NEPAL
[1] NETHERLANDS	[1] NORWAY
[1] POLAND	[1] SERBIA
[1] SLOVENIA	[3] SPAIN
[1] SWEDEN	[1] SWITZERLAND
[1] SYRIAN ARAB REPUBLIC	[1] TAIWAN
[1] THAILAND	[1] TURKEY
[1] UNITED KINGDOM	[4] UNITED STATES

Red List assessed species 1: LC = 1;

[Fagus sylvatica](#) LC

BIBLIOGRAPHY

41 references found for **Phytophthora plurivora**

Management information

Dalio RJD, Fleischmann F, Humez M, Osswald W (2014) Phosphite Protects *Fagus sylvatica* Seedlings towards *Phytophthora plurivora* via Local Toxicity, Priming and Facilitation of Pathogen Recognition. *PLoS ONE* 9(1): e87860. doi:10.1371/journal.pone.0087860

Grunwald, N. (2014) Knowing your *Phytophthora*. *Digger*. 33-35

Jung, T., Orlikowski, L., Henricot, B., Abad-Campos, P., Aday, A. G., Aguín Casal, O., ... & Corcobado, T. (2016). Widespread *Phytophthora* infestations in European nurseries put forest, semi-natural and horticultural ecosystems at high risk of *Phytophthora* diseases. *Forest Pathology*, 46(2), 134-163.

Mrázková, M., Černý, K., Tomšovský, M., & Strnadová, V. (2011). *Phytophthora plurivora* T. Jung & TI Burgess and other *Phytophthora* species causing important diseases of ericaceous plants in the Czech Republic. *Plant Protection Science*, 47(1), 13-19.

Nechwatal, J., Hahn, J., Schönborn, A., & Schmitz, G. (2011). A twig blight of understorey European beech (*Fagus sylvatica*) caused by soilborne *Phytophthora* spp. *Forest Pathology*, 41(6), 493-500.

General information

Blomquist, M. (2017). Invasive *Phytophthora* species affecting broadleaved tree species in urban and landscape settings in Southern Sweden.

Coffey, M. D., & Joseph, M. C. (1985). Effects of phosphorous acid and fosetyl-Al on the life cycle of *Phytophthora cinnamomi* and *P. citricola*. *Phytopathology*, 75(9), 1042-1046.

Durães, S. (2015). Pathogenicity tests of *Phytophthora alni* and *Phytophthora plurivora* in *Fraxinus excelsior* and *Alnus glutinosa* seedlings. Hung, P. M., Wattanachai, P., Kasem, S., & Poaim, S. (2015). Biological Control of *Phytophthora palmivora* Causing Root Rot of Pomelo Using *Chaetomium* spp. *Mycobiology*, 43(1), 63-70.

Jankowiak, R., Stępniewska, H., Bilański, P., & Kolařík, M. (2014). Occurrence of *Phytophthora plurivora* and other *Phytophthora* species in oak forests of southern Poland and their association with site conditions and the health status of trees. *Folia microbiologica*, 59(6), 531-542.

Joseph, M. C., & Coffey, M. D. (1984). Development of laboratory resistance to metalaxyl in *Phytophthora citricola*. *Phytopathology*, 74(12), 1411-1414.

Jung, T., Blaschke, H., & Oßwald, W. (2000). Involvement of soilborne *Phytophthora* species in Central European oak decline and the effect of site factors on the disease. *Plant Pathology*, 49(6), 706-718.

Jung, T., & Burgess, T. I. (2009). Re-evaluation of *Phytophthora citricola* isolates from multiple woody hosts in Europe and North America reveals a new species, *Phytophthora plurivora* sp. nov. *Persoonia*, 22, 95.

Jung T. & Burgess T.I. (2018) *Phytophthora plurivora* in Liljeblad J. Dyntaxa. Svensk taxonomisk databas. Version 1.2. ArtDatabanken. Checklist dataset <https://doi.org/10.15468/j43wfc> accessed via GBIF.org on 2018-07-31.

Jung, T., Hudler, G. W., Jensen-Tracy, S. L., Griffiths, H. M., Fleischmann, F., & Osswald, W. (2005). Involvement of *Phytophthora* species in the decline of European beech in Europe and the USA. *Mycologist*, 19(4), 159-166.

Junker, C., Goff, P., Wagner, S., & Werres, S. (2016). Occurrence of *Phytophthora* Species in Commercial Nursery Production. *Plant Health Progress*, 17(2), 64.

Kirk P.M. (2018). *Species Fungorum* (version Oct 2017). In: Roskov Y., Orrell T., Nicolson D., Bailly N., Kirk P.M., Bourgoin T., DeWalt R.E., Decock W., De Wever A., Nieukerken E. van, Zarucchi J., Penev L., eds. (2018). *Species 2000 & ITIS Catalogue of Life*, 31st July 2018. Digital resource at www.catalogueoflife.org/col. *Species 2000: Naturalis*, Leiden, the Netherlands. ISSN 2405-8858.

- MILANOVIĆ, S., LAZAREVIĆ, J., KARADŽIĆ, D., MILENKOVIĆ, I., JANKOVSKÝ, L., Vuleta, A., & Solla, A. (2015). Belowground infections of the invasive *Phytophthora plurivora* pathogen enhance the suitability of red oak leaves to the generalist herbivore *Lymantria dispar*. *Ecological Entomology*, 40(4), 479-482.
- Orlikowski, L. B., Ptaszek, M., Rodziewicz, A., Nechwatal, J., Thinggaard, K., & Jung, T. (2011). *Phytophthora* root and collar rot of mature Fraxinus excelsior in forest stands in Poland and Denmark. *Forest Pathology*, 41(6), 510-519.
- Rytkönen A., A. Lilja , A. Vercauteren , S. Sirkiä , P. Parikka , M. Soukainen & J. Hantula (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, DOI: 10.1080/07060661.2012.686455
- Schoebel CN, Stewart J, Gruenwald NJ, Rigling D, Prospero S (2014) Population History and Pathways of Spread of the Plant Pathogen *Phytophthora plurivora*. *PLoS ONE* 9(1): e85368. doi:10.1371/journal.pone.0085368
- Tkaczyk, M., Sikora, K., Nowakowska, J. A., Kubiak, K., & Oszako, T. (2014). Effect of CO₂ enhancement on beech (*Fagus sylvatica* L.) seedling root rot due to *Phytophthora plurivora* and *Phytophthora cactorum*. *Folia Forestalia Polonica*, 56(3), 149-156.
- Zamora-Ballesteros, C., Haque, M. M. U., Diez, J. J., & Mart'ın-Garc'ya, J. (2017). Pathogenicity of *Phytophthora alni* complex and *P. áplurivora* in *Alnus glutinosa* seedlings. *Forest Pathology*, 47(2), e12299.
- Bienapfl, J. C., & Balci, Y. (2014). Movement of *Phytophthora* spp. in Maryland's nursery trade. *Plant Disease*, 98(1), 134-144.
- Burgess, T. I., Webster, J. L., Ciampini, J. A., White, D., Hardy, G. E. S., & Stukely, M. J. (2009). Re-evaluation of *Phytophthora* species isolated during 30 years of vegetation health surveys in Western Australia using molecular techniques. *Plant Disease*, 93(3), 215-223.
- Haque, M. M., Mart'ın-Alvarez, P., Lomba, J. M., Mart'ın-Garc'ya, J., & Diez, J. J. (2014, March). First Report of *Phytophthora plurivora* Causing Collar Rot on Common Alder in Spain. Retrieved August 1, 2018, from <https://apsjournals.apsnet.org/doi/10.1094/PDIS-07-13-0784-PDN>
- Huai, W. X., Tian, G., Hansen, E. M., Zhao, W. X., Goheen, E. M., Gr'ınwald, N. J., & Cheng, C. (2013). Identification of *P. hytophthora* species baited and isolated from forest soil and streams in northwestern Yunnan province, China. *Forest Pathology*, 43(2), 87-103.
- Jung, T., Chang, T. T., Bakonyi, J., Seress, D., P'erez-Sierra, A., Yang, X., ... & Maia, C. (2017). Diversity of *Phytophthora* species in natural ecosystems of Taiwan and association with disease symptoms. *Plant pathology*, 66(2), 194-211.
- Milenković, I., Keča, N., Karadžić, D., Nowakowska, J. A., Borys, M., Sikora, K., & Oszako, T. (2012). Incidence of *Phytophthora* species in beech stands in Serbia.
- Milenković, I., Keča, N., Karadžić, D., Radulović, Z., Nowakowska, J. A., Oszako, T., ... & Jung, T. (2018). Isolation and Pathogenicity of *Phytophthora* Species from Poplar Plantations in Serbia. *Forests* (19994907), 9(6).
- Mrazkova, M., ČERNÝ, K., TOMŠOVSKÝ, M., Strnadova, V., GREGOROVÁ, B., Holub, V., ... & Hejna, M. (2013). Occurrence of *Phytophthora multivora* and *Phytophthora plurivora* in the Czech Republic. *Soil & Water Research*, 8(4).
- O'Hanlon, R., McCracken, A.R. and Cooke, L.R. 2016 Diversity and ecology of *Phytophthora* species on the island of Ireland. *Biology and Environment: Proceedings of the Royal Irish Academy* 2016. DOI: 10.3318/BIOE.2016.03
- Phytophthora* in Forests & Natural Ecosystems. (2014) 7th meeting IUFRO Working Party 7.02.09
- Reeser, P., Sutton, W., & Hansen, E. (2011). *Phytophthora* species in tanoak trees, canopy-drip, soil, and streams in the sudden oak death epidemic area of south-western Oregon, USA. *New Zealand Journal of Forestry Science* 41S: S65-S73, 41, S65-S73.
- Reeser P. W., Sutton W., Everett M. Hansen, Philippe Remigi & Gerry C. Adams (2011) *Phytophthora* species in forest streams in Oregon and Alaska, *Mycologia*, 103:1, 22-35, DOI: 10.3852/10-013
- Rytkönen A., Arja Lilja , Sabine Werres , Seija Sirkiä & Jarkko Hantula (2013) Infectivity, survival and pathology of Finnish strains of *Phytophthora plurivora* and *Ph. pini* in Norway spruce, *Scandinavian Journal of Forest Research*, 28:4, 307-318, DOI: 10.1080/02827581.2012.756926
- Szabó, I., Lakatos, F., & Sipos, G. (2013). Occurrence of soilborne *Phytophthora* species in declining broadleaf forests in Hungary. *European journal of plant pathology*, 137(1), 159-168.
- van Kuik, F. (2013). Inventarisatie van nieuwe *Phytophthora*soorten in de teelt van boomkwekerijgewassen, in planten, grond en water. Wageningen
- Vettraino, A. M., Barzanti, G. P., Bianco, M. C., Ragazzi, A., Capretti, P., Paoletti, E., ... & Vannini, A. (2002). Occurrence of *Phytophthora* species in oak stands in Italy and their association with declining oak trees. *Forest Pathology*, 32(1), 19-28.
- Waterhouse, G. M. (1957). *Phytophthora citricola* Sawada (Syn. *P. cactorum* var. *aplanata* Chester). *Transactions of the British Mycological Society*, 40(3), 349-IN2.
- Weiland, J. E., Nelson, A. H., & Hudler, G. W. (2010). Aggressiveness of *Phytophthora cactorum*, *P. citricola* I, and *P. plurivora* from European beech. *Plant disease*, 94(8), 1009-1014.