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A Synopsis of *Phytophthora* with Accurate Scientific Names, Host Range, and Geographic Distribution

Erica T. Cline, Research Associate, **David F. Farr**, Research Scientist, and **Amy Y. Rossman**, Research Scientist, Systematic Mycology & Microbiology Laboratory, USDA Agricultural Research Service, 10300 Baltimore Avenue, Beltsville, MD 20705-2350

Corresponding author: Amy Y. Rossman. Amy.Rossman@ars.usda.gov

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Abstract

The genus *Phytophthora* includes species causing diseases such as late blight of potatoes, *Phytophthora infestans*, and sudden oak death and ramorum blight, *P. ramorum*. Because of the importance of diseases caused by *Phytophthora*, there is a need to have rapid access to the literature using their scientific names. The literature has been reviewed for all names in *Phytophthora* in order to provide the scientific name of each accepted species with authors and synonyms as well as the plant host range and worldwide geographic distribution. Within the genus *Phytophthora*, there are 87 accepted species and six infraspecific taxa. After compiling all available reports of *Phytophthora*, it was determined that 39 species and six infraspecific taxa, or about one-half of the accepted species, are not known to occur in the United States. The accurate scientific names of accepted species of *Phytophthora* are listed in two tables based on their presence or absence in the United States. Each species name is hyperlinked to databases that provide full synonymy and references documenting the host range and geographic distribution information. These data are continuously updated as new literature is published. Having rapid access to information about species of *Phytophthora* is critical for protecting the United States from the introduction of these potentially devastating pathogens.

The genus *Phytophthora* includes species causing diseases such as late blight of potatoes, *Phytophthora infestans*, and sudden oak death and ramorum blight, *P. ramorum*, which can inflict considerable damage on their hosts. The Irish potato famine in the 1840s caused by *P. infestans* resulted in millions of deaths and triggered a significant ethnic migration (1). The full consequences of the introduction of *Phytophthora ramorum* to the western United States remain to be determined, but the financial impact is already staggering (2).

The recent advent of sudden oak death in Europe and western North America has sparked a resurgence of taxonomic interest in *Phytophthora*. Species of the genus *Phytophthora* were thoroughly and ably reviewed by Erwin & Ribeiro in 1996 (1), who included 59 species with five varieties. Since that publication, however, 28 new species of *Phytophthora* or about one-third of the known taxa have been described along with a number of other taxonomic changes. As of December 2007, seven new species have been proposed but not yet formally described. The significant economic impact of diseases caused by *Phytophthora* spp., many of them recently described, has reinforced the need for an up-to-date synopsis of *Phytophthora*.

Here we present a listing of the accepted species and infraspecific taxa currently included in *Phytophthora* based on the available taxonomic and plant pathology literature. For each species the published literature is summarized including the accepted scientific name with authors as well as a summary of the plant host range and worldwide geographic distribution. The authors of scientific names are abbreviated according to the recommendation of Brummitt & Powell (3), now considered the standard for all organisms with nomenclature governed by the International Code of Botanical Nomenclature. Each name is hyperlinked to a more detailed account available at the website of the USDA Agricultural Research Service Systematic Mycology & Microbiology Laboratory (4). For each species data are provided that include the accepted scientific name with authors, synonyms, substrate affected, disease characteristics, plant host range, worldwide geographic distribution, and important recent literature, along with source literature and specimens that document this information. These databases are continuously updated as new literature is published, thus the hyperlinks allow the user to obtain recent information about each species of *Phytophthora*. In this paper we present a synopsis of these data as two tables including the scientific name with authors and a summary of host and geographic distribution. One table includes taxa that do not occur in the United States (Table 1) while the other lists taxa that occur in the United States (Table 2). In addition seven provisional names, four invalidly published names, and one potential name in *Phytophthora* are listed in Table 3. Many of the accepted species of *Phytophthora* have synonyms that are not listed in these tables but are included at the website. Some older reports were made using names now considered synonyms; thus, the ability to search using all synonymous names is critical in accurately determining the full host range and geographic distribution for a species. Access to updated information is especially important as surveys for *Phytophthora* provide new reports of species not previously known in the United States and throughout the world.

Currently, there are 87 accepted species and six infraspecific taxa in the genus *Phytophthora*. An additional seventy names in *Phytophthora* are treated as synonyms, 15 are referred to other genera, and at least 12 names have been proposed in the literature but have not been validly published. At present 47 taxa of *Phytophthora* or about half of the described taxa have not been reported in the United States. These include 40 species, one hybrid species, two subspecies, three varieties, and one *forma specialis* (Table 1). With increased surveys for *Phytophthora*, new records are being reported such as the two species, *P. inundata* and *P. quercina*, previously unknown in the United States reported to occur here in 2007 or the recent discovery of *P. kernoviae* in New Zealand by Ramsfield et al. (5).

Table 1. *Phytophthora* not reported in the United States.

Scientific name	Hosts	Geographic distribution
Phytophthora alni Brasier & S.A. Kirk 2004 subsp. alni	<i>Alnus</i> spp. (Betulaceae)	Europe
Phytophthora alni subsp. multiformis Brasier & S.A. Kirk 2004	<i>Alnus</i> spp. (Betulaceae)	Europe (Germany, the Netherlands, UK)
Phytophthora alni subsp. uniformis Brasier & S.A. Kirk 2004	<i>Alnus</i> spp. (Betulaceae)	Europe
Phytophthora alticola Maseko, Coutinho & M.J.	<i>Eucalyptus badjensis</i> (Myrtaceae)	South Africa

Wingf. 2007		
<i>Phytophthora austrocedrae</i> Greslebin & Hansen 2007	<i>Austrocedrus chilensis</i> (Cupressaceae)	South America (Argentina)
<i>Phytophthora boehmeriae</i> Sawada 1927	<i>Citrus</i> spp. (Rutaceae) and various other families	Africa (South Africa), Asia, Australia and Papua New Guinea, Europe (Greece), South America (Argentina)
<i>Phytophthora botryosa</i> Chee 1969	<i>Colocasia</i> (Araceae), <i>Hevea</i> (Euphorbiaceae); when inoculated, <i>Theobroma cacao</i> (Malvaceae)	Asia (China, Malaysia, Thailand, Andaman Islands, Vietnam)
<i>Phytophthora ×cactorum-nicotianae</i> Man in 't Veld et al. 1998	Six genera in six families, including <i>Cyclamen</i> , <i>Eriobotrya</i> , <i>Lavandula</i> , <i>Lewisia</i> , <i>Primula</i> , <i>Spathiphyllum</i>	Europe (the Netherlands in hydroponic greenhouses), Asia (Taiwan)
<i>Phytophthora cajani</i> K.M. Amin, Baldev & F.J. Williams 1978	<i>Cajanus cajani</i> (Fabaceae)	Asia (India)
<i>Phytophthora canavaliae</i> Hara 1932	<i>Canavalia ensiformis</i> (Fabaceae)	Asia (Japan)
<i>Phytophthora captiosa</i> M.A. Dick & Dobbie 2006	<i>Eucalyptus botryoides</i> , <i>E. saligna</i> (Myrtaceae)	New Zealand
<i>Phytophthora cinnamomi</i> var. <i>parvispora</i> Kröber & Marwitz 1993	<i>Beaucarnea</i> sp. (Agavaceae)	Europe (Germany)
<i>Phytophthora cinnamomi</i> var. <i>robiniae</i> H.H. Ho 2002	<i>Robinia pseudoacacia</i> (Fabaceae)	Asia (China)
<i>Phytophthora clandestina</i> P.A. Taylor, Pascoe & F.C. Greenh. 1985	<i>Medicago</i> spp., <i>Trifolium subterraneum</i> , (Fabaceae)	Australia
<i>Phytophthora colocasiae</i> Rabenh. 1900	<i>Colocasia esculenta</i> (taro) and other Araceae; also six genera in five other families	Africa (Ethiopia, East Africa, Fernando Po), Asia, Caribbean (Dominican Republic), North America (USA: CA, NC, HI), Pacific Islands, South America (Brazil, Argentina)
<i>Phytophthora cyperi-bulbosi</i> Seethal. & K. Ramakr. 1953	<i>Cyperus bulbosus</i> (Cyperaceae)	Asia (India)
<i>Phytophthora fallax</i> M.A. Dick & Dobbie 2006	<i>Eucalyptus botryoides</i> , <i>E. saligna</i> (Myrtaceae)	New Zealand
<i>Phytophthora frigida</i> Maseko, Coutinho & M.J. Wingf. 2007	<i>Eucalyptus smithii</i> (Myrtaceae)	South Africa
<i>Phytophthora humicola</i> W.H. Ko & Ann 1985	Natural host unknown, isolated from <i>Citrus</i>	Asia (Taiwan)

	orchard (Rutaceae); when inoculated, <i>Cucumis sativus</i> (Cucurbitaceae) and <i>Malus domestica</i> (Rosaceae)	
<i>Phytophthora idaei</i> D.M. Kenn. 1995	<i>Rubus idaeus</i> (Rosaceae)	Europe (UK)
<i>Phytophthora ipomoeae</i> Flier & Grünwald 2002	<i>Ipomoea</i> <i>longipedunculata</i> , <i>I.</i> <i>purpurea</i> (Convolvulaceae)	North America (Mexico)
<i>Phytophthora iranica</i> Ershad 1971	Solanaceae; when inoculated, <i>Beta vulgaris</i> (Chenopodiaceae)	Asia (Iran)
<i>Phytophthora italica</i> Cacciola, Magnano & Belisario 1996	<i>Myrtus communis</i> (Myrtaceae)	Europe (Italy)
<i>Phytophthora japonica</i> G.M. Waterh. 1974	<i>Oryza sativa</i> (Poaceae)	Asia (Japan)
<i>Phytophthora kernoviae</i> Brasier, Beales & S.A. Kirk 2005	<i>Fagus sylvatica</i> , <i>Quercus</i> <i>robur</i> (Fagaceae), <i>Liriodendron tulipifera</i> (Magnoliaceae), <i>Rhododendron ponticum</i> (Ericaceae)	Europe (UK); New Zealand
<i>Phytophthora leersiae</i> Sawada ex H.H. Ho & H.S. Chang 1992	<i>Leersia hexandra</i> (Poaceae)	Asia (China, Taiwan)
<i>Phytophthora lepironiae</i> Sawada 1919	<i>Lepironia</i> spp. (Cyperaceae)	Asia (China, Japan, Korea, Taiwan)
<i>Phytophthora macrochlamydospora</i> J.A.G. Irwin 1991	<i>Glycine max</i> (Fabaceae)	Australia
<i>Phytophthora megakarya</i> Brasier & M.J. Griffin 1979	<i>Irvingia</i> sp. (Irvingiaceae) <i>Theobroma cacao</i> (Malvaceae),	West Africa
<i>Phytophthora melonis</i> Katsura 1976	<i>Citrullus lanatus</i> , <i>Cucumis sativus</i> , <i>Trichosanthes dioica</i> (Cucurbitaceae), <i>Pistacia</i> <i>vera</i> (Anacardiaceae)	Asia (China, India, Iran, Japan, Korea, Taiwan)
<i>Phytophthora mexicana</i> Hotson & Hartge 1923	<i>Lycopersicon esculentum</i> (Solanaceae)	North America (Mexico), possibly introduced from the Netherlands (1)
<i>Phytophthora mirabilis</i> Galindo & H.R. Hohl 1986	<i>Mirabilis jalapa</i> (Nyctaginaceae)	North America (Mexico)
<i>Phytophthora multivesiculata</i> Ilieva, Man in 't Veld, W. Veenb.-Rijks &	<i>Cymbidium</i> sp. (Orchidaceae)	Europe (the Netherlands)

R. Pieters 1998		
<i>Phytophthora oryzo-bladis</i> J.S. Wang & J.Y. Lu ex H.H. Ho 2001	<i>Oryza sativa</i> (Poaceae)	Asia (China)
<i>Phytophthora palmivora</i> var. <i>heterocystica</i> Babacauh 1983	<i>Theobroma cacao</i> (Malvaceae)	Africa (Ivory Coast); may not be distinct from <i>P. palmivora</i>
<i>Phytophthora pistaciae</i> Mirab. 2001	<i>Pistacia vera</i> (Anacardiaceae)	Asia (Iran)
<i>Phytophthora polonica</i> Belbahri, Moralejo & Lefort 2007	Isolated from soil associated with <i>Alnus glutinosa</i>	Poland
<i>Phytophthora polygoni</i> Sawada 1922	<i>Polygonum</i> spp., <i>Rumex dentatus</i> (Polygonaceae)	Asia (China, Taiwan)
<i>Phytophthora porri</i> Foister 1931	<i>Allium</i> spp. (Liliaceae), five other genera in five families	Africa (South Africa), Asia (Japan), Australia, Europe, North America (Canada). The report from USA: WI is actually <i>Phytophthora brassicae</i> .
<i>Phytophthora primulae</i> J.A. Tomlinson 1952	<i>Primula</i> spp. (Primulaceae)	Europe (Denmark, Germany, UK), New Zealand
<i>Phytophthora psychrophila</i> T. Jung & E.M. Hansen 2002	<i>Ilex aquifolium</i> (Aquifoliaceae), <i>Quercus</i> spp. (Fagaceae) when inoculated	Europe (France, Germany, UK)
<i>Phytophthora quininea</i> Crand. 1947	<i>Cinchona</i> spp. (Rubiaceae)	Central America (Guatemala), Caribbean Islands (Puerto Rico), South America (Bolivia, Peru)
<i>Phytophthora tentaculata</i> Kröber & Marwitz 1993	<i>Chrysanthemum</i> spp., <i>Santolina</i> (Asteraceae), <i>Verbena</i> (Verbenaceae)	Europe (Spain, Germany)
<i>Phytophthora uliginosa</i> T. Jung & E.M. Hansen 2002	<i>Quercus robur</i> , <i>Quercus petraea</i> (Fagaceae)	Europe (Poland, Germany)
<i>Phytophthora verrucosa</i> Alcock & Foister 1940	Four families including <i>Lycopersicon esculentum</i> (Solanaceae)	Europe (UK)
<i>Phytophthora vignae</i> Purss 1957	<i>Cajanus cajan</i> , <i>Vigna</i> spp. (Fabaceae); when inoculated, <i>Malus domestica</i> (Rosaceae) and <i>Solanum tuberosum</i> (Solanaceae)	Asia (China, Hong Kong, India, Japan, Sri Lanka, Taiwan), Australia
<i>Phytophthora vignae</i> f. sp. <i>adzukicola</i> S. Tsuchiya, Yanagawa & Ogoshi 1986	<i>Phaseolus radiatus</i> var. <i>aurea</i> , <i>Vigna angularis</i> (Fabaceae)	Asia (Japan)

The synopsis of *Phytophthora* not known to occur in the United States provides a framework to guide more extensive investigations of the biology and geographic distribution of these important organisms especially for those charged with preventing their entry into the United States. Which of these species pose a threat to the United States as invasive species? One might assume that species most threatening are those that occur in temperate regions on perennial hosts such as the recently described taxa on trees in the Betulaceae, i.e., *P. alni* and its subspecies, those having a broad host range such as *P. kernoviae* on Ericaceae, Fagaceae, and Magnoliaceae, or those on perennial crops such as *P. idaei* on *Rubus idaeus*. Species that are known to occur close to US borders such as *P. mexicana* on *Lycopersicon esculenta* also pose a significant threat.

The species of *Phytophthora* already known to occur in the United States are listed in Table 2. Many of these species such as *P. cinnamomi* and *P. cryptogea* are cosmopolitan reported on a wide range of host plants. Others occur on only a restricted number of hosts such as *P. ilicis* on *Ilex* spp. or have been reported once in the US such as *P. hibernalis* on *Citrus* reported only from California or *P. heveae* reported on a wide range of hosts, primarily tropical ones, but also known from North Carolina and Tennessee in the US. A few species of *Phytophthora* are known only from Hawaii, specifically *P. katsurae* reported throughout the tropics on diverse woody plants and *P. meadii* reported in Asia and Australia on various plant families. Known previously only from Europe, *Phytophthora quercina* was recently isolated from soil under declining oaks in Missouri (6) as was *P. inundata* from soil in California (7).

Table 2. *Phytophthora* reported in the United States.

Scientific name	Hosts	Geographic distribution
<i>Phytophthora brassicae</i> DeCock & Man in't Veld 2002	<i>Brassica oleracea</i> and <i>B. sinenses</i> (Brassicaceae)	Europe (Germany, UK); North America (USA: WI)
<i>Phytophthora cactorum</i> (Lebert & Cohn) J. Schröt. 1886	154 genera in 54 families	Cosmopolitan
<i>Phytophthora cambivora</i> (Petri) Buisman 1927	30 genera in 19 families	Cosmopolitan
<i>Phytophthora capsici</i> Leonian 1922	<i>P. capsici</i> sensu lato infects 51 genera in 28 families, including <i>Capsicum annuum</i> , <i>Lycopersicon esculentum</i> and other Solanaceae. Aragaki & Uchida (9) refer isolates from non- <i>Capsicum</i> hosts to <i>P. tropicalis</i>	Cosmopolitan. Tropical species may now be considered <i>P. tropicalis</i>
<i>Phytophthora cinnamomi</i> Rands 1922 var. <i>cinnamomi</i>	266 genera in 90 families, commonly hardwood trees	Cosmopolitan
<i>Phytophthora citricola</i> Sawada 1927	75 genera in 38 families	Cosmopolitan

<i>Phytophthora citrophthora</i> (R.E. Sm. & E.H. Sm.) Leonian 1906	88 genera in 51 families	Cosmopolitan
<i>Phytophthora cryptogea</i> Pethybr. & Laff. 1919	141 genera in 49 families	Cosmopolitan
<i>Phytophthora cyperi</i> (Ideta) Ito 1935	<i>Cyperus</i> spp. (Cyperaceae), <i>Digitaria ciliaris</i> (Poaceae)	Africa (Sudan), Asia, Europe (UK), North America (USA: SC, TX)
<i>Phytophthora drechsleri</i> Tucker 1931	113 genera in 40 families	Cosmopolitan
<i>Phytophthora erythroseptica</i> Pethybr. 1913	Principal hosts Solanaceae, 15 genera in 10 other families	Cosmopolitan
<i>Phytophthora europaea</i> E.M. Hansen & T. Jung 2002	<i>Quercus</i> spp. (Fagaceae)	Europe (France, Germany), North America (USA)
<i>Phytophthora foliorum</i> Donahoo & Lamour 2006	<i>Rhododendron</i> sp. (Ericaceae)	North America (USA: CA, TN)
<i>Phytophthora fragariae</i> Hickman 1940 var. <i>fragariae</i>	<i>Fragaria xananassa</i> and <i>Rubus ursinus</i> var. <i>longanobaccus</i> (Rosaceae); when inoculated, other Rosaceae, Chenopodiaceae, and Solanaceae on (1)	Asia, Australia, New Zealand, Europe, North America (Canada, USA)
<i>Phytophthora gonapodyides</i> (H.E. Petersen) Buisman 1927	13 genera in 11 families, including <i>Malus</i> spp. (Rosaceae), also on Pinaceae seedlings including <i>Abies</i> , <i>Pseudotsuga menziesii</i> , and <i>Tsuga mertensiana</i>	Australia, New Zealand, Europe (Denmark), North America (USA), South America (Chile)
<i>Phytophthora hedraiaandra</i> De Cock & Man in 't Veld 2004	<i>Rhododendron</i> (Ericaceae), <i>Viburnum</i> (Adoxaceae),	Europe (the Netherlands, Slovakia), North America (USA: MN)
<i>Phytophthora heveae</i> A. Thomps. 1929	12 genera in 11 families including <i>Cocos nucifera</i> (Arecaceae), <i>Hevea</i> (Euphorbiaceae) and <i>Rhododendron</i> (Ericaceae)	Asia, Australasia, North America (USA: NC, TN), South America (Brazil)
<i>Phytophthora hibernalis</i> Carne 1925	<i>Citrus</i> spp. (Rutaceae), also 11 genera in 9 other families	Africa (South Africa); Asia (Israel); Australasia; Europe; North America (USA: CA, OR); Central America, Caribbean Islands; South America (Argentina, Brazil, Venezuela)
<i>Phytophthora ilicis</i>	<i>Ilex</i> spp. (Aquifoliaceae)	Europe (UK), North America

Buddenhagen & R.A. Young 1957		(Canada, USA)
<i>Phytophthora infestans</i> (Mont.) de Bary 1876	Principal hosts Solanaceae, also on 15 genera in ten other families	Cosmopolitan
<i>Phytophthora inflata</i> Caroselli & Tucker 1949	<i>Ulmus</i> spp. (Ulmaceae), also on <i>Rhododendron</i> , <i>Sambucus</i> and <i>Syringa</i>	Europe (England), North America (Canada, USA)
<i>Phytophthora insolita</i> Ann & W.H. Ko 1981	<i>Rhododendron</i> (Ericaceae); when inoculated, on fruits of <i>Cucumis sativus</i> (Cucurbitaceae) and <i>Malus domestica</i> (Rosaceae)	Asia (Taiwan), North America (USA: OH)
<i>Phytophthora inundata</i> Brasier et al. 2003	Various families, including <i>Aesculus hippocastanum</i> (Sapindaceae), <i>Olea</i> (Oleaceae), <i>Salix</i> (Salicaceae), and <i>Vitis</i> (Vitaceae)	Europe (Denmark, France, Spain, UK), South America, recently reported in USA (CA)
<i>Phytophthora katsurae</i> W.H. Ko & H.S. Chang 1979	<i>Castanea crenata</i> (Fagaceae), <i>Cocos nucifera</i> (Arecaceae), <i>Theobroma cacao</i> (Malvaceae)	Africa (Ivory Coast), Asia (Japan, Korea, Taiwan), Caribbean (Jamaica), Pacific Islands (USA: HI), Papua New Guinea
<i>Phytophthora lateralis</i> Tucker & Milbrath 1942	<i>Chamaecyparis lawsoniana</i> (Cupressaceae), rarely, <i>Taxus brevifolia</i> (Taxaceae); when inoculated, hosts in other families	Europe (France), North America (Canada, USA). Reports from New Zealand are doubtful.
<i>Phytophthora meadii</i> McRae 1918	Various families including <i>Hevea</i> spp. (Euphorbiaceae)	Asia, Australia, Pacific Islands (USA: HI)
<i>Phytophthora medicaginis</i> E.M. Hansen & D.P. Maxwell 1991	<i>Cicer arietinum</i> , <i>Medicago sativa</i> , <i>Onobrychis viciifolia</i> (Fabaceae), <i>Prunus mahaleb</i> (Rosaceae)	Cosmopolitan
<i>Phytophthora megasperma</i> Drechsler 1931	Fabaceae and many other families; isolates previously referred to as <i>P. megasperma</i> are now considered to be three distinct species (10, 11)	Cosmopolitan
<i>Phytophthora nemorosa</i> E.M. Hansen & Reeser 2003	Various families, including <i>Lithocarpus densiflorus</i> , <i>Quercus agrifolia</i> (Fagaceae)	North America (USA: CA, OR)
<i>Phytophthora nicotianae</i> Breda de Haan 1896	255 genera in 90 families	Cosmopolitan
<i>Phytophthora palmivora</i> (E.J. Butler) E.J. Butler 1919 var. <i>palmivora</i>	160 genera in 60 families	Cosmopolitan

<i>Phytophthora phaseoli</i> Thaxt. 1889	<i>Phaseolus lunatus</i> , <i>P. vulgaris</i> (Fabaceae), other families after inoculation (1)	Africa (Congo, Zaire), Asia (Philippines, Sri Lanka, USSR), Europe (Italy, Romania), North America (Mexico, USA), Central America and Caribbean Islands, South America (Brazil)
<i>Phytophthora pseudosyringae</i> T. Jung & Delatour 2003	<i>Alnus glutinosa</i> , <i>Fagus sylvatica</i> , <i>Quercus</i> spp. , and other hardwood species	Germany, Spain, North America (USA: CA)
<i>Phytophthora pseudotsugae</i> Hamm & E.M. Hansen 1983	<i>Pseudotsuga menziesii</i> (Pinaceae)	North America (USA: OR, WA)
<i>Phytophthora quercina</i> T. Jung 1999	<i>Quercus</i> spp. (Fagaceae)	Asia (Turkey), Europe (Germany, Hungary, Italy); recently isolated from soil under oak in North America (USA: MO) (4)
<i>Phytophthora ramorum</i> Werres, De Cock & Man in 't Veld 2001	26 genera in 17 families, including <i>Camellia</i> , <i>Rhododendron</i> (Ericaceae) and <i>Quercus</i> (Fagaceae)	Europe, North America (Canada, USA: CA, OR, WA)
<i>Phytophthora richardiae</i> Buisman 1927	<i>Asparagus</i> (Asparagaceae), <i>Daucus carota</i> (Apiaceae), <i>Lycopersicon esculentum</i> (Solanaceae), <i>Robinia</i> (Fabaceae), and <i>Zantedeschia</i> (Araceae)	Asia, Australasia, Australia, Europe, North America (USA)
<i>Phytophthora rubi</i> (W.F. Wilcox & J.M. Duncan) Man in 't Veld 2007	<i>Rubus idaeus</i> var. <i>idaeus</i> (Rosaceae)	Cosmopolitan
<i>Phytophthora siskiyouensis</i> Reeser & E.M. Hansen 2007 (12)	Isolated from soil and water using <i>Lithocarpus densiflorus</i> (tanoak) (Fagaceae) and <i>Rhododendron</i> spp. (Ericaceae) as leaf baits; also reported from <i>Alnus</i> .	North America (USA: CA, OR); Australia
<i>Phytophthora sojae</i> Kaufm. & Gerd. 1958	<i>Glycine max</i> , <i>Lupinus</i> (Fabaceae); also reported from six other genera in five families	Australia, New Zealand, Asia (China, Korea), North America (Canada, USA), South America (Brazil, Chile)
<i>Phytophthora syringae</i> (Berk.) Kleb. 1909	29 genera in 14 families, including <i>Syringa vulgaris</i> (Oleaceae)	Africa (Morocco, South Africa); Asia (Korea) Australasia; Europe; North America (Canada, USA); South America (Argentina, Brazil, Peru)
<i>Phytophthora trifolii</i> E.M. Hansen & D.P. Maxwell 1991	<i>Trifolium</i> (Fabaceae)	North America (USA: MS)

<i>Phytophthora tropicalis</i> Aragaki & J.Y. Uchida 2001	14 genera in 12 families	Pacific Islands (USA: HI), North America (USA: VA, Europe (the Netherlands, Italy), before 2001 reported as <i>Phytophthora capsici</i> , thus geographic distribution unclear
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Table 3. Provisional and invalid *Phytophthora* names.

Name	Status	Host and/or substrate	Location
<i>Phytophthora andina</i> Kroon et al. 2004 (11)	Provisional name	<i>Solanum</i> spp. (Solanaceae)	South America
" <i>Phytophthora asparagi</i> " Chimento et al. 2005 (13)	Provisional name	<i>Agave</i> sp. (Agavaceae), <i>Asparagus</i> sp. (Asparagaceae),	Cosmopolitan
" <i>Phytophthora bisheria</i> " Blair et al. 2006 (14)	Provisional name	<i>Fragaria × ananasa</i> , <i>Rosa</i> sp., <i>Rubus idaeus</i> (Rosaceae)	Australia, Europe (the Netherlands), North America (USA: NC)
<i>Phytophthora eriugena</i> Clancy & Kavanagh, nom. inval. 1979	Invalidly published, no Latin diagnosis	<i>Chamaecyparis lawsoniana</i> (Cupressaceae)	Europe (Ireland, known only from the type)
<i>Phytophthora erythroseptica</i> var. <i>psi</i> Bywater & Hickman, nom. inval. 1959	Invalidly published, no type specimen designated	<i>Pisum sativum</i> (Fabaceae)	Europe (England)
" <i>Phytophthora glovera</i> " Abad, pers. comm.	Provisional name	<i>Nicotiana tabacum</i> (Solanaceae)	South America (Brazil)
<i>Phytophthora irritabilis</i> Mantri & K.B. Deshp., nom. inval. 1968	Invalidly published, no type specimen designated	<i>Phaseolus vulgaris</i> (Fabaceae)	Asia (India)
" <i>Phytophthora kelmania</i> " Abad et al. 2006 (15)	Provisional name	<i>Abies</i> spp., <i>Picea</i> spp. (Pinaceae), <i>Gerbera</i> sp. (Asteraceae), <i>Coleus</i> sp. (Lamiaceae)	Europe (Spain), North America (USA: NC)
<i>Peronophythora litchi</i> Blair et al. 2006 (14)	May belong in <i>Phytophthora</i>	<i>Litchi</i> sp. (Sapindaceae)	Asia, Europe (the Netherlands)
" <i>Phytophthora niederhauseri</i> " Abad et al. 2006 (15)	Provisional name	Various genera in multiple families	Australia, Europe (Spain), North America (USA: NC)
" <i>Phytophthora persoonii</i> " Abad et	Provisional name	<i>Nicotiana tabacum</i> (Solanaceae)	North America (USA: NC)

al. 2006 (15)			
" <i>Phytophthora rubra</i> " Mantri & K.B. Deshp., nom. inval. 1968	Invalidly published, no type specimen designated	<i>Phaseolus vulgaris</i> (Fabaceae)	Asia (India)

Data synthesized in this document and presented through the hyperlinks are complete as of 20 December 2007 and will be updated on-line as new data are published. The authors welcome input and suggestions for missing or erroneous data and will make changes to the databases as necessary. With the intense scrutiny that the genus *Phytophthora* is receiving, changes are inevitable in the distribution of species, discovery of new taxa, and revision of species concepts as currently conceived. Of special note is the progress made in refining the species concepts within *Phytophthora* especially with the application of molecular systematic tools. Species concepts have changed to reflect their phylogeny and data for some species based on the literature is not accurate. For example, in molecular analyses *Phytophthora undulata* (H.E. Petersen) M.W. Dick 1989 clusters within the genus *Pythium* (8), and this species should be rereferred to by original name *Pythium undulatum* H.E. Petersen 1910. Although for some species of *Phytophthora* accurate identifications can be made based on morphology, increasingly identification requires sequencing of specific gene regions and "blasting" against databases of known sequences such as that available at the *Phytophthora* [database](#) at Pennsylvania State University.

This publication is intended to focus attention on those species of *Phytophthora* not yet present in the United States in the effort to safeguard US agriculture and protect native ecosystems. Accurate information about scientific names, geographic distribution, and plant host range provides the basis for tracking the movement and effective protection from introduction of invasive plant pathogens.

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