

# Briefing Paper: *Phytophthora alni* subsp. *uniformis*, a first finding in North America

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## Finding:

A variant of *Phytophthora alni* (*P. alni* subsp. *uniformis*) was found in Alaska during riparian *Phytophthora* surveys and confirmed in November 2007 by Dr. Gerard Adams, Michigan State University.

The Alaska *Phytophthora* DNA will be sent to the Quality Assurance Lab at Mississippi State, Susan Diehl, for independent confirmation. The USDA APHIS-PPQ Plant Safeguarding and Pest Identification, National Identification Services in Beltsville, Maryland will also assist with further confirmation. Dr. Everett Hansen, Oregon State University, will assist with confirmation of morphological identification.

## Alder *Phytophthora* disease in Europe and variants of the pathogen

*Phytophthora alni* is an emergent hybrid pathogen of alder (*Alnus* spp.) with three variants (Brasier et al. 2004, Ioos et al. 2005, Ioos et al. 2007). The variants appear to range in their virulence and pathogenicity on European alders; our understanding of this is evolving (Brasier and Kirk 2001, Santini et al. 2003, Ioos et al. 2006). *Phytophthora alni* subsp. *alni* (PAA) appears to be the most aggressive and pathogenic to European alder species; this variant has not been found in North America. The other two variants, *P. alni* subsp. *uniformis* (PAU) and *P. alni* subsp. *multiformis* (PAM) appear significantly less aggressive than PAA, though still considered pathogenic (Brasier and Kirk 2001, Brasier et al. 2004, Ioos et al. 2006). We stress that only the PAU variant has been found in Alaska.

In Europe, alder *Phytophthora* is well documented as a lethal root and collar disease of alder in many countries including the UK, France, Germany, Austria, Hungary, Italy, and The Netherlands (Gibbs et al. 1999, Streito and Gibbs 1999, Santini et al. 2001, Nagy et al. 2003, Gibbs et al. 2003, NAPPO 2006, North American Forestry Commission 2007). The PAA variant is considered the primary agent killing alders in Europe and is the most frequent subspecies in Europe at this time (Brasier 2003). We emphasize that this variant has not been found in North America.

The PAU and PAM variants are not well understood for their role in causing alder mortality, though both are considered pathogenic. The PAU variant is the one now detected twice in Alaska. PAU and PAM have been isolated across Europe, though far less frequently than PAA (Brasier 2003, Nagy et al. 2003). Additionally, PAU and PAM have proven to be significantly less aggressive on alder bark than PAA (Brasier and Kirk 2001). PAU is often found in soil, asymptomatic plants, and areas where PAA does not occur (Santini et al. 2003, Ioos et al. 2006). One hypothesis suggests that PAU and PAM might have existed for a long time on or in the vicinity of alder before the recent emergence of large-scale death of alder in Europe (Ioos et al. 2006). Thus the occurrence of PAU or PAM in the past might not have been noticed because of the lack of conspicuous symptoms or death of alder.

## Significance of this finding

*Phytophthora alni*, especially PAA, appears to pose significant phytosanitary concerns for those countries where the pathogen does not yet occur (NAPPO 2006, North American Forestry Commission 2007). With extensive stands of alder across North America and the presumption that *P. alni* does not presently occur in the United States, the introduction of this pathogen, particularly PAA, has been considered highly undesirable.

The finding of *P. alni* subsp. *uniformis* in two remote, unmanaged locations in Alaska hundreds of miles distant from one another is both surprising and perplexing. To date, no collar or root symptoms of *P. alni* have been noted in Alaska or Colorado. Root examinations in Alaska and Colorado have revealed no evidence of root disease in alder with dieback; inspection for other symptoms of *Phytophthora* disease has been negative. Previous attempts to isolate *Phytophthora* species from diseased alder in Colorado gave negative results.

Perhaps PAU has co-existed benignly in Alaska with alder and has not been noted due to the lack of surveys such as those conducted in 2007. A pathogen considered to be morphologically and genetically similar to PAA was recently reported from Minnesota, possibly suggesting that *Phytophthora alni* variants may be widespread but uncommon in North America (Schwingle et al. 2007).

## 2007 *Phytophthora* surveys in Alaska and Colorado

For the last several years, USFS forest health specialists Lori Trummer in Alaska and James Worrall in Colorado have been observing and studying widespread, severe dieback and mortality of thinleaf alder, *Alnus incana* subsp. *tenuifolia*. Evidence strongly indicates that the damage is associated with Cytospora canker, caused by *Valsa melanodiscus*, and no symptoms or other evidence of *Phytophthora* disease has been found to date. However, because of concern about the possibility of cryptic invasion by the European alder *Phytophthora*, together with growing efforts to survey for *Phytophthora ramorum*, a survey for alder *Phytophthora* in Alaska and Colorado was conducted in 2007 by Dr. Gerard Adams.

Funding for the surveys was provided from 1) Forest Health Technology Enterprise Team (FHTET) in conjunction with a risk-mapping project for alder *Phytophthora* in North America, with the contract arranged by USFS Region 2, Colorado Forest Health Management staff, and 2) USFS Region 10, Alaska Forest Health Protection program.

## Details of the discovery of *P. alni* subsp. *uniformis* in Alaska

In the summer of 2007 Dr. Adams spent about a month each in Alaska and Colorado, intensively trapping, collecting and data gathering for alder *Phytophthora* in plots established or areas identified by Lori Trummer and James Worrall.

*Phytophthora* species were baited and trapped from roots, soils, and water sources using rhododendron leaves and nucleopore filtering. Thirty sites were sampled in Alaska and 39 in Colorado (Figure 1). Thus far, most cultures turned out to be *P. gonapodyides* and *P. megasperma*, considered common inhabitants of western forests.

Two isolates from rhizosphere soil under alders, at 1) Cooper Landing, Kenai Peninsula and 2) Panguingue Creek, north of Denali National Park and the town of Healy, had DNA sequence of the ITS region consistent with *P. alni* subsp. *uniformis* and *P. cambivora* and a RAS-protein

gene sequence was homologous with *P. alni* subsp. *uniformis* and *P. alni* subsp. *alni*. Finally SCAR-based analyses, developed to discriminate among the three *P. alni* variants, confirmed that both isolates were subsp. *uniformis*. The SCAR analyses included redundant control checks that confirm neither isolate is subsp. *alni* or subsp. *multiformis*. Thus, the analyses firmly establish that the DNA of the isolates is *P. alni* subsp. *uniformis*. More isolates from Alaska, and all the samples from Colorado, remain to be examined.

The two isolates identified as PAU occur approximately 250 miles apart, with one south of the Alaska Range in south-central Alaska and one north of the Alaska Range in interior Alaska. South-central and interior Alaska are generally considered distinct climatic and geographic regions; there is no water connection between the two PAU locations. The two waterways where PAU was isolated each flow into separate but major rivers in the state. On the Kenai Peninsula, the Cooper Landing watershed flows into the Kenai River, ending in the Pacific Ocean at Cook Inlet. The Panguingue Creek flow can be traced into the Nenana, Tanana, and Yukon Rivers, ending at the Norton Sound on the Bering Sea. Alder is a key component of all these watersheds.

### **Previous *Phytophthora* surveys in Alaska**

Few surveys for *Phytophthora* have been undertaken in Alaska, and none in south-central and interior Alaska where the current findings are based. In the 1980's *Phytophthora* surveys were initiated in southeast Alaska while investigating the causes of decline and mortality of Alaska yellow-cedar (Hansen et al. 1988). *Phytophthora drechsleri* was isolated from soil samples and streams, though was not proven to be pathogenic to Alaska yellow-cedar (Hansen et al. 1988). Since that time there have been surveys by APHIS and the Forest Service for *Phytophthora ramorum*, and to date, this organism has not been found in Alaska (P. Hennon, USFS Pathologist, Alaska, pers. comm.).

### **Hosts of *Phytophthora alni***

Since being found in the UK, alder *Phytophthora* has only been reported under natural conditions from *Alnus* species, primarily *A. glutinosa*, though also including *A. incana* and *A. cordata* (Gibbs et al. 1999, Brasier et al. 2004). Comparisons of the relative susceptibility of the three European alder species indicate that *A. glutinosa* is most susceptible to the disease, while *A. incana* is the most resistant (Webber et al. 2004).

Four alder species occur in Alaska (*A. incana* subsp. *tenuifolia*, *A. crispa*, *A. sinuata*, *A. rubra*) (Viereck and Little 1972). All Alaskan alder species are considered susceptible to alder *Phytophthora*.

Greenhouse inoculation trials with alder *Phytophthora* and seedlings of walnut (*Juglans regia*) and chestnut (*Castanea sativa*), suggested these trees may be susceptible to the pathogen (Santini et al. 2003). More recently, Santini et al. (2006) showed that seedlings of wild cherry (*Prunus avium*) are susceptible to *P. alni* in greenhouse inoculations. The common hardwood species in Alaska, birch (*Betula* spp.) and poplar (*Populus* spp.), have not been tested as hosts; their susceptibility is unknown.

## Current and Future Studies

There are many unanswered questions, particularly on the origin of PAU in Alaska and the ability of this variant to cause disease. Further testing of the isolates is underway to independently confirm this finding. Additional samples from Alaska and Colorado remain to be processed. Monitoring of the confirmed sites and further testing for *Phytophthora* in Alaska and Colorado will continue in 2008, including continued isolations and field examination for evidence of disease caused by *Phytophthora* species. Further study is needed to determine how or whether this organism was introduced in Alaska, and whether this organism is causing disease on alders in Alaska or Colorado.

APHIS, USFS, and University staff will continue to collaborate with collecting and disseminating information related to this finding.

This briefing paper was developed with a multitude of resources found in the references. Our understanding of *P. alni* and all of the known variants is rapidly shifting and evolving. As such, we fully expect that both new discoveries will be made and new literature will be published that will add to our growing knowledge of the alder *Phytophthora*.

A wide array of Forest Service, APHIS, and University personnel are involved in the *P. alni* finding in North America. Contacts for key personnel include:

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Figure 1. 2007 *Phytophthora* survey locations in Alaska

