

*Aphanomyces astaci* [简体中文](#) [正體中文](#)

**System:** Freshwater

Kingdom	Phylum	Class	Order	Family
Fungi	Myxomycota	Phycomycota	Saprolegniales	Saprolegniaceae

**Common name** Wasserschimmel (German), crayfish plague (English)

**Synonym**

**Similar species** *Aphanomyces invadans*, *Aphanomyces meridionalis*, *Aphanomyces piscicida*, *Aphanomyces stellatus*

**Summary** *Aphanomyces astaci* commonly referred to as crayfish plague is an oomycete or water mould that infects only crayfish species. It is endemic of North America and is carried by North American crayfish species; signal crayfish *Pacifastacus leniusculus*, *Procambarus clarkii* and *Orconectes limosus*. *A. astaci* was introduced into Europe through imports of North American species of crayfish. Native European crayfish populations are not resistant to this oomycete. It has since devastated native crayfish stocks throughout the continent.



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

## Species Description

Black melanized spots may be indicative of the presence of the crayfish plague (Persson and Söderhäll, 1983; Vey *et al.* 1983; Diéguez-Urbeondo and Söderhäll, 1993; Nylund and Westman, 2000). Identification of *A. astaci* requires microscopic examination of the affected tissues (Cerenius *et al.* 1987). Behavioural abnormalities, such as the phenomenon of 'walking on stilts', in which infected crayfish stand on the tips of their walking legs, is not necessarily indicative of an infected specimen.

Research shows that chitinase is expressed at a high level during vegetative growth of the crayfish pathogen (Andersson and Cerenius, 2002). Andersson and Cerenius (2002) state that "The pattern of chitinase expression is one of very few qualitative physiological characteristics known which can distinguish *A. astaci* from other parasitic and saprophytic species and may thus be of practical use for identification." Oidtmann *et al.* (2002) developed a method which allows identification of *A. astaci* by means of PCR and restriction enzyme analysis from pure fungal cultures. Recently, Oidtmann *et al.* (2004) developed a molecular method for diagnosis of *A. astaci* in clinical samples based on internal transcribed sequences of the ribosomal DNA.

## Notes

Ways of transmission only involves movements of chronic carriers, i.e. North American crayfish, or infected crayfish (Söderhäll and Cerenius, 1999). The chances of transmission by other means such as items that have been in contact with contaminated water, fish or birds are very low and can only occur during the short period of survival of the *Aphanomyces* spores, i.e. a few days.

## Habitat Description

*Aphanomyces astaci* is an oomycete or water mould, which only parasitises freshwater crayfish (Unestam, 1969). Co-evolution might have led to different (ecological) genetic variants (Diéguez-Uribeondo *et al.* 1995). At least three different species of North American crayfish have been shown to carry this water mould in their cuticle: *Pacifastacus leniusculus* (Söderhäll *et al.* 1981; Smith and Söderhäll, 1986), *Orconectes limosus* (Vey *et al.* 1987), and *Procambarus clarkii* (Diéguez-Uribeondo and Söderhäll, 1993, Diéguez-Uribeondo *et al.* 1995). These crayfish are known to be responsible for the transmission of crayfish plague, *A. astaci*, to the European species of crayfish: noble crayfish (see [Astacus astacus in IUCN Red List of Threatened Species](#)), white-clawed crayfish (see [Austropotamobius pallipes in IUCN Red List of Threatened Species](#)), and *A. leptodactylus* (Huang *et al.* 1994, Lilley *et al.* 1997; Vennestrom *et al.* 1998; Oidtmann *et al.* 1999; Diéguez-Uribeondo and Söderhäll, 1999).

## Reproduction

*Aphanomyces astaci* belongs to the order Saprolegniales. Reproduction among the Saprolegniales can be asexual and sexual. The order Saprolegniales is characterised by the production of biflagellate zoospores during asexual reproduction. Genera of saprolegnian fungi are distinguished by their asexual reproductive apparatus, features of zoosporangium production and the mode of zoospore release (Jong *et al.* 1991). *Aphanomyces* species are characterised by zoosporangia of the same diameter-like vegetative hyphae. The spores encyst at the sporangium tip after leaving the zoosporangium and form primary spore aggregates (the spore balls). From these, the secondary free-swimming zoospores emerge, which are the infective stage of the oomycete. Oidtmann *et al.* (2002) states that, "*A. astaci* is an exception in the genus *Aphanomyces* in that it does not reproduce sexually. But as sexual reproduction can be induced only inconsistently in other *Aphanomyces* sp. in culture, the absence of sexual structures is not a reliable indication of *A. astaci*."

## General Impacts

The infection process usually starts on the soft unsclerotised cuticle under the abdomen (Unestam, 1973). Hyphae grow in the soft, non-calcified parts of the cuticle. The mycelia grow rapidly through the cuticle and reach the internal body cavity, which, in European crayfish species, results in crayfish death within 6-10 days (Unestam and Weiss, 1970; Unestam, 1972; Alderman *et al.* 1987). However, in North American species the oomycete elicits a strong defence reaction immediately upon penetration of the cuticle (Unestam and Weiss, 1970). Hyphae extend into the water and produce motile zoospores which infect other crayfish. The first sign of crayfish plague mortality may be the presence of crayfish at large during daylight hours (crayfish are normally nocturnal), some of which may show evident loss of coordination in their movements and easily fall over on their backs and are unable to right themselves. Often, however, unless waters are carefully observed, the first recognition that there is a problem will be the presence of large numbers of dead crayfish in a river or lake (Alderman *et al.* 1987).

*A. astaci* has devastated European crayfish populations causing substantial economic losses to previously valuable fisheries (Diéguez-Uribeondo *et al.* 1997; Alonso *et al.* 2000; Westman and Savolainen, 2001). Resistant North American crayfish species have been introduced in an attempt to revive crayfish fisheries but research now shows that these species are having detrimental impacts on the remaining native crayfish species (Holdich, 1996; Diéguez-Uribeondo *et al.* 1997; Josefsson, 1999, *et al.* 2000). Because of the increased distribution of *A. astaci*, it poses a significant risk to plague free countries and continents (CEFAS, UNDATED).

## Management Info

For details on preventative measures, chemical, physical, cultural and biological control options, please see [management information](#).

**Principal source:** Oidtmann *et al.* 2002. *Identification of the crayfish plague, Aphanomyces astaci, by polymerase chain reaction and restriction enzyme analysis* and CEFAS, UNDATED *Crayfish Plague: Summary Final Report*.



# GLOBAL INVASIVE SPECIES DATABASE

FULL ACCOUNT FOR: *Aphanomyces astaci*

**Compiler:** National Biological Information Infrastructure (NBII) & IUCN/SSC Invasive Species Specialist Group (ISSG)

**Review:** Javier Dieguez Uribeondo. CSIC Real Jardin Botanico, Spain

**Publication date:** 2006-03-23

## ALIEN RANGE

[1] AUSTRIA	[2] BELGIUM
[1] CANADA	[4] FINLAND
[1] FRANCE	[1] GERMANY
[1] GREECE	[4] IRELAND
[2] ITALY	[1] LATVIA
[1] LITHUANIA	[1] MACEDONIA, THE FORMER YUGOSLAV REPUBLIC OF
[5] NORWAY	[2] POLAND
[1] PORTUGAL	[1] RUSSIAN FEDERATION
[1] SPAIN	[1] SWEDEN
[1] SWITZERLAND	[1] TURKEY
[2] UNITED KINGDOM	[1] UNITED STATES

**Red List assessed species 7: EN = 3; DD = 3; LC = 1;**

[Astacoides betsileoensis](#) **EN**

[Astacus leptodactylus](#) **LC**

[Austropotamobius torrentium](#) **DD**

[Cambaroides schrenckii](#) **DD**

[Astacoides caldwelli](#) **EN**

[Austropotamobius pallipes](#) **EN**

[Cambaroides dauricus](#) **DD**

## BIBLIOGRAPHY

**32 references found for *Aphanomyces astaci***

### Management information

- Andersson, M., and L. Cerenius. 2002. *Analysis of chitinase expression in the crayfish plague fungus Aphanomyces astaci*. Diseases of Aquatic Organisms 51(2):139-147
- Bangyeekhun, E., L. Cerenius, and K. Soderhall. 2001. *Molecular cloning and characterization of two serine proteinase genes from the crayfish plague fungus, Aphanomyces astaci*. Journal of Invertebrate Pathology 77(3):206-216.
- Bernardo, J. M., M. Ilheu, and A. M. Costa. 1997. *Distribution, population structure and conservation of Austropotamobius pallipes in Portugal*. Bulletin Francais de la Peche et de la Pisciculture 347:617-624.
- CEFAS (Centre for Environment, Fisheries & Aquaculture Science). UNDATED. *Crayfish Plague: Summary Final Rreport*.
- Cerenius, L., S. Rufelt, and K. Soderhall. 1992. *Effects of ampropylfos ((RS)-1-aminopropylphosphonic acid) on zoospore formation, repeated zoospore emergence and oospore formation in Aphanomyces spp.* Pesticide Science 36(3):189-194.
- Demers, A., and J. D. Reynolds. 2002. *A survey of the white-clawed crayfish, Austropotamobius pallipes (Lereboullet), and of water quality in two catchments of eastern Ireland*. Bulletin Francais de la Peche et de la Pisciculture 367:729-740.
- Dieguez-Uribeondo, J., and K. Soderhall. 1993. *Procambarus clarkii Girard as a vector for the crayfish plague fungus, Aphanomyces astaci Schikora*. Aquaculture & Fisheries Management 24(6):761-765.
- Dieguez-Uribeondo, J., and L. Cerenius. 1998. *The inhibition of extracellular proteinases from Aphanomyces spp. by three different proteinase inhibitors from crayfish blood*. Mycological Research 102(7):820-824.
- Dieguez-Uribeondo, K., A. Rueda, E. Castien, and K. C. Bascones. 1997. *A plan of restoration in Navarra for the native freshwater crayfish species of Spain, Austropotamobius pallipes*. Bulletin Francais de la Peche et de la Pisciculture 347:625-637.
- Erkamo, E., J. Kirjavainen, and J. Tulonen. 1992. *Catching as a management method for crayfish*. Finnish Fisheries Research 14(0):77-83.
- Lilley, J. H., and V. Inglis. 1997. *Comparative effects of various antibiotics, fungicides and disinfectants on Aphanomyces invaderis and other saprolegniaceous fungi* Aquaculture Research 28(6):461-469.
- Matthews, M., and J. D. Reynolds. 1990. *Laboratory investigations of the pathogenicity of Aphanomyces astaci for Irish freshwater crayfish*. Hydrobiologia 203(3):121-126.
- Momot, W. T. 1992. *Stocking and exploitation as management methods for European crayfish*. Finnish Fisheries Research 14(0):145-148.
- Oidtman, B., L. Cerenius, I. Schmid, R. Hoffmann, and K. Soederhaell. 1999. *Crayfish plague epizootics in Germany-Classification of two German isolates of the crayfish plague fungus Aphanomyces astaci by random amplification of polymorphic DNA*. Diseases of Aquatic Organisms 35(3):235-238.
- Pockl, M. and Pekney, R. 2002. *Interaction between native and Alien Species of Crayfish in Austria: Case Studies [Abstract]*, Bulletin Francais de la Peche et de la Pisciculture 367:763 - 776.

**Summary:** History of introduction and distribution of *P. leniusculus* in Austria.



# GLOBAL INVASIVE SPECIES DATABASE

FULL ACCOUNT FOR: *Aphanomyces astaci*

---

- Rantamaki, J., L. Cerenius, and K. Soderhall. 1992. *Prevention of transmission of the crayfish plague fungus Aphanomyces astaci to the freshwater crayfish astacus-astacus by treatment with magnesium chloride*. Aquaculture 104(1-2):11-18.
- Royo, L., P. Girones, G. de Blas, U. Dieguez, and M. Muzquiz. 2002. *Impact of age on susceptibility to aphanomycosis diseases in signal crayfish Pacifastacus leniusculus (Dana, 1852)*. Boletin Instituto Espanol de Oceanografia 18(1-4): 195-198.
- Taugbol, T., J. Skurdal, and T. Hastein. 1992. *Crayfish plague and management strategies in Norway*. Biological Conservation 63(1):75-82.

## General information

[Bower, S.M. 2002. Synopsis of Infectious Diseases and Parasites of Commercially Exploited Shellfish: Crayfish Plague \(Fungus Disease\). Fisheries and Oceans Canada - Pacific Region.](#)

**Summary:** Available from: [http://www.pac.dfo-mpo.gc.ca/sci/shelldis/pages/cpfdcy\\_e.htm](http://www.pac.dfo-mpo.gc.ca/sci/shelldis/pages/cpfdcy_e.htm) [Accessed 19 December 2004]

Cerenius, L., and K. Soderhall. 1992. *Crayfish diseases and crayfish as vectors for important diseases*. Finnish Fisheries Research 14(0):125-133.

Czczuga, B. 1994. *Aquatic fungi of twelve Augustow Lakes with reference to the chemistry of the environment*. Acta Mycologica 29(2): 217-227.

Gonzalez, J., J. D. Celada, J. M. Carral, T. E. Llamazares, and V. R. Gaudioso. 1992. *The Freshwater Crayfish Crustacea decapoda Astacidae in Leon Province Spain 1989 Inventory*. Boletin de la Real Sociedad Espanola de Historia Natural Seccion Biologica 88(1-4):139-145.

Holdich, D. M. 2003. *Ecology of the White-clawed Crayfish*. Conserving Natura 2000 Rivers Ecology Series No. 1.

[ITIS \(Integrated Taxonomic Information System\), 2004. Online Database Aphanomyces astaci](#)

**Summary:** An online database that provides taxonomic information, common names, synonyms and geographical jurisdiction of a species. In addition links are provided to retrieve biological records and collection information from the Global Biodiversity Information Facility (GBIF) Data Portal and bioscience articles from BioOne journals.

Available from: [http://www.itis.gov/servlet/SingleRpt/SingleRpt?search\\_topic=TSN&search\\_value=13861](http://www.itis.gov/servlet/SingleRpt/SingleRpt?search_topic=TSN&search_value=13861) [Accessed December 31 2004]

Josefsson, M. 1999. *Introduced organisms in Swedish freshwater environment*. Fauna Och Flora (Stockholm) 94(2):75-84.

Lilley, J. H., L. Cerenius, and K. Soderhall. 1997. *RAPD evidence for the origin of crayfish plague outbreaks in Britain*. Aquaculture 157(3-4):181-185.

Matthews, M., and J. D. Reynolds. 1992. *Ecological Impact of Crayfish Plague in Ireland*. Hydrobiologia 234(1):1-6.

Nylund, V., and K. Westman. 2000. *The prevalence of crayfish plague (Aphanomyces astaci) in two signal crayfish (Pacifastacus leniusculus) populations in Finland*. Journal of Crustacean Biology 20(4):777-785.

Oidtmann, B., E. Heitz, D. Rogers, and R. Hoffmann. 2002. *Transmission of crayfish plague*. Diseases of Aquatic Organisms 52(2): 159-167.

Oidtmann, B., S. Bausewein, L. Holzle, R. Hoffman, and M. Wittenbrink. 2002. *Identification of the crayfish plague fungus Aphanomyces astaci by polymerase chain reaction and restriction enzyme analysis*. Veterinary Microbiology 85(2):183-194.

Rahe, R., and E. Soyulu. 1989. *Identification of the pathogenic fungus causing destruction to Turkish crayfish stocks Astacus leptodactylus*. Journal of Invertebrate Pathology 54(1):10-15.

Westman, K., and R. Savolainen. 2001. *Long term study of competition between two co-occurring crayfish species, the native Astacus astacus L. and the introduced Pacifastacus leniusculus Dana, in a Finnish lake*. Bulletin Francais de la Peche et de la Pisciculture 361:613-627.