**Batrachochytrium dendrobatidis**

**Common name**: chytrid frog fungi (English), Chytrid-Pilz (German), chytridiomycosis (English), frog chytrid fungus (English)

**Synonym**

**Similar species**

**Summary**

Batrachochytrium dendrobatidis is a non-hyphal parasitic chytrid fungus that has been associated with population declines in endemic amphibian species in upland montane rain forests in Australia and Panama. It causes cutaneous mycosis (fungal infection of the skin), or more specifically chytridiomycosis, in wild and captive amphibians. First described in 1998, the fungus is the only chytrid known to parasitise vertebrates. *B. dendrobatidis* can remain viable in the environment (especially aquatic environments) for weeks on its own, and may persist in latent infections.

*view this species on IUCN Red List*
Species Description

**Fungal Morphology:** *Batrachochytrium dendrobatidis* is a zoosporic chytrid fungus that causes chytridiomycosis (a fungal infection of the skin) in amphibians and grows solely within keratinised cells. Diagnosis is by identification of characteristic intracellular flask-shaped sporangia (spore containing bodies) and septate thalli. The fungus grows in the superficial keratinised layers of the epidermis (known as the stratum corneum and stratum granulosum). The normal thickness of the stratum corneum is between 2µm to 5µm, but a heavy infection by the chytrid parasite may cause it to thicken to up to 60 µm. The fungus also infects the mouthparts of tadpoles (which are keratinised) but does not infect the epidermis of tadpoles (which lacks keratin).

The fungus produces inoperculate, smooth-walled zoosporangia (zoospore containing bodies), which are spherical to subspherical in shape. Each zoosporangium (10µm to 40µm in diameter) produces a single discharge tube, which penetrates (and protrudes out of) the skin. Eventually the plug that blocks the release of immature zoospores is shed and the mature zoospores are released. The zoospores (0.7µm to 6µm in diameter) are elongate to ovoid in shape. Each possesses a single posterior flagellum, rendering it motile in water (Mazzoni et al. 2003; Daszak et al. 1999; Berger, et al. 1998; Berger et al. 1998, Berger, Speare and Hyatt, 2000, in Daszak et al. 1999; Speare et al. 2001; Weldon et al. 2003).


Pathogenesis of chytridiomycosis: Authors of a recent study, Voyles et al. (2009) have found that *B. dendrobatidis*, causes such severe electrolyte imbalances that the frog’s heart stops. The skin of amphibians maintain proper osmotic balance inside the animal and regulate respiration. The authors found that the skin of infected frogs was less adept at transporting sodium and chloride ions. Sodium and potassium concentrations in the blood of infected frogs dropped, more so as the infection intensified and the animals’hearts began to beat irregularly and ultimately stopped.

**Notes**

Salamanders can act as host reservoirs of chytrid infection in frogs, and vice versa (Davidson et al. 2003).
Lifecycle Stages

*Batrachochytrium dendrobatidis* has two life stages: a spherical reproductive sessile zoosporangium and a motile zoospore. The motile zoospore directs itself and attaches to the keratinised outer layers of its host. It then absorbs its tail and buries itself below the surface of the skin. It matures into a zoosporangia with rhizoids within about four days and produces and releases up to 300 zoospores into the external environment (via a discharge tube). The cycle is initiated again once a suitable substrate (in the same or a different host) is found. The presence of the fungus in the keratinised mouthparts of frog tadpoles (without actually killing them) supports the role of larvae as reservoirs for the pathogen. (The larvae of amphibian species may survive for as long as 3 years before metamorphosing.) Syntopic salamanders and frogs may also act as reciprocal pathogen reservoirs for chytrid infections. It has been suggested that *B. dendrobatidis* may not be an obligate amphibian parasite, possibly living in other non-amphibian hosts or even sapropytically (off dead tissue) (Michigan Frog Survey, 2003; Speare et al. 2001; Daszak et al. 1999; Davidson et al. 2003).

As of yet, no resting structures (either asexual or sexual) have been identified for *B. dendrobatidis*. The fact that sexual reproduction in chytrid fungi has been associated with the production of resistant, thick-walled resting spores has lead to the hypothesis that the production of airborne spores explains the widespread distribution of *B. dendrobatidis* in relatively pristine areas. However recent research has found evidence that shows that the population structure of *B. dendrobatidis* is largely clonal, supporting the hypothesis that the fungus lacks a sexual stage (as is the case for many chytrid fungi). This suggests that dispersal by human (or perhaps other long distance travellers, such as birds), rather than natural causes, are more likely to be the cause of the pathogen's entry into pristine areas (Morehouse et al. 2003; Berger et al. 1999, Daszak et al. 1999, in Morehouse et al. 2003).

Habitat Description

Chytridiomycosis has now been reported from 38 amphibian species in 12 families, including ranid and hylid frogs, bufonid toads, and plethodontid salamanders. Although chytridiomycosis is found in a range of species and habitats (including African frogs in lowland regions in Africa) it has caused population declines of amphibians species confined to montane rain forests (Weldon et al. 2004; Daszak et al. 1999). The fungus prefers lower temperatures which may explain the high precedence of the fungus in high elevations in the tropics. In culture conditions optimum growth occurred at 23°C, with slower growth occurring at 28°C and (reversible) cessation of growth occurring at 29°C (Longcore, Pessier, Nichols, 1999, in Daszak et al. 1999).

Reproduction

*Batrachochytrium dendrobatidis* is diploid and primarily reproduces asexually (and clonally) by producing aquatic uniflagellated zoospores in a zoosporangium (Johnson and Speare, 2003).

Nutrition

Its occurrence solely in keratinised tissues suggests that it uses amphibian keratin as a nutrient. *Batrachochytrium dendrobatidis* will grow for at least one generation on cleaned epidermal keratin or on amphibians that have died of the infection. The fungus may also be cultured in vitro on tryptone agar without the addition of keratin or its derivatives (Daszak et al. 1999; Longcore, Pessier and Nichols, 1999, Pessier et al. 1999, in Daszak et al. 1999).
General Impacts

Batrachochytrium dendrobatidis has been found to affect at least 93 amphibian species from the orders Anura (frogs and toads) and Caudata (salamanders) in all the continents except Asia. It is thought to be one of the main causes of the global decline in frog populations since the 1960s, and the dramatic population crashes from the 1970s onwards (Parris and Beaudoin, 2004). The chytrid fungus kills frogs within 10 to 18 days (Michigan Frog Survey, 2003), although it is not known how. It may be physical, affecting respiration by altering the frog’s skin, or the fungus may give off a toxin (Michigan Frog Survey, 2003). Tadpoles are not affected, although the fungus may infect the keratinised mouthparts (Berger et al. 1999).

For a summary on the impacts of B. dendrobatidis please follow this link impacts. Key findings of the The Global Amphibian Assessment has revealed that one-third (32%) of the world’s amphibian species are threatened, representing 1,896 species. Threats include viral diseases, habitat loss, drought, pollution, and hunting for food. The biggest single threat appears to be B. dendrobatidis.

A search on the database using "diseases" as a keyword in "all" habitat types, biogeographic realm and countries results in a list of 547 species impacted by diseases (IUCN, Conservation International, and NatureServe. 2006).

Management Info

Preventative measures: Knowledge of the infectiveness and spread of Batrachochytrium dendrobatidis is relevant to all control strategies, particularly in the development of preventative measures. The infective unit of the fungus is the zoospore. Infection by the fungus (and thus spread of the disease) requires water because the zoospore does not tolerate dehydration. B. dendrobatidis remains viable for up to 3 weeks in tap water, up to 4 weeks in deionised water and even longer in lake water. Infection by an extremely small inoculum (100 zoospores) is sufficient to cause a fatal infection (Berger et al. in Speare et al. 2001; Johnson and Speare, 2003; Berger, Speare and Hyatt, 2000, in Daszak et al. 1999).

Please see main preventative management strategies for a summary under the following headings: improving diagnostics and knowledge of epidemiology, developing trade and quarantine regulations, raising awareness and control options.

The Amphibian Conservation Action Plan (ACAP) is designed to provide guidance for implementing amphibian conservation and research initiatives at all scales from global down to local. Chapter 4 outlines action steps relating to the detection and control of chytridiomycosis.


Daszak et al. 1999. Emerging Infectious Diseases and Amphibian Population Declines

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Review: Matthew J. Parris Assistant Professor, Department of Biology University of Memphis USA

Publication date: 2006-08-14

ALIEN RANGE


Red List assessed species 512: EX = 8; CR = 196; EN = 126; VU = 63; NT = 29; DD = 36; LC = 54;

- Adelotus brevis NT
- Agalychnis moreletti CR
- Alytes cisternasi NT
- Aplastodiscus callipygius LC
- Aromobates alboguttatus EN
- Aromobates nocturnus CR
- Atelopus angelito CR
- Atelopus arthuri CR
- Atelopus bomolochos CR
- Atelopus carauta CR
- Atelopus carrikeri CR
- Atelopus chiriquiensis CR
- Atelopus chrysocorallus CR
- Atelopus cruciger CR
- Atelopus ebenoides CR
- Atelopus episkeithos CR
- Atelopus eusebianus CR
- Atelopus famelicus CR
- Atelopus flavescens VU
- Atelopus galactogaster CR
- Atelopus guanaju CR
- Atelopus halihelos CR
- Atelopus laetissimus CR
- Atelopus longibrachius EN
- Atelopus lozanoi CR
- Atelopus mandingue CR
- Atelopus minutulus CR
- Atelopus monohernandezii CR
- Agalychnis annae EN
- Allobates offeioides VU
- Anaxyrus canorus EN
- Aplastodiscus fluminex DD
- Aromobates leopardalis CR
- Atelopus andinus CR
- Atelopus arsycue CR
- Atelopus balios CR
- Atelopus boulengeri CR
- Atelopus carbonerensis CR
- Atelopus certus EN
- Atelopus chocoensis CR
- Atelopus coynei CR
- Atelopus dimorphus EN
- Atelopus elegans CR
- Atelopus erythropus CR
- Atelopus exiguus CR
- Atelopus farci CR
- Atelopus franciscus VU
- Atelopus glyphus CR
- Atelopus guitarraensis CR
- Atelopus ignescens EX
- Atelopus limosus EN
- Atelopus longirostris EX
- Atelopus lynch CR
- Atelopus mindoensis CR
- Atelopus mittermeieri EN
- Atelopus mucubajensis CR

[Accessed 18 December 2022]
GLOBAL INVASIVE SPECIES DATABASE
FULL ACCOUNT FOR: *Batrachochytrium dendrobatidis*

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GLOBAL INVASIVE SPECIES DATABASE

FULL ACCOUNT FOR: *Batrachochytrium dendrobatidis*

- *Plectrohyla ameibothalame* DD
- *Plectrohyla avia* CR
- *Plectrohyla calthula* CR
- *Plectrohyla celata* CR
- *Plectrohyla charadricola* EN
- *Plectrohyla chrysopleura* CR
- *Plectrohyla cyanomma* CR
- *Plectrohyla dasypus* CR
- *Plectrohyla exquisita* CR
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- *Plectrohyla hazelae* CR
- *Plectrohyla lacertosa* EN
- *Plectrohyla mykter* EN
- *Plectrohyla penither* EN
- *Plectrohyla psiloderma* EN
- *Plectrohyla quechi* CR
- *Plectrohyla sabrina* CR
- *Plectrohyla siopela* CR
- *Plectrohyla teuchestes* CR
- *Pleurodema marmoratum* LC
- *Pristimantis anolis* DD
- *Pristimantis calcarulatus* VU
- *Pristimantis caryophyllaceus* NT
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- *Pristimantis diogenes* VU
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- *Pristimantis ginesi* EN
- *Pristimantis ignicolor* EN
- *Pristimantis jorgevelosai* EN
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- *Pristimantis lymani* LC
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- *Pristimantis sanguineus* NT
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- *Psychophyta dendrophasma* CR
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- *Psychophyta leonhardschultzei* EN

[Accessed 18 December 2022]
GLOBAL INVASIVE SPECIES DATABASE
FULL ACCOUNT FOR: Batrachochytrium dendrobatidis

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Ptychohyla salvadorensis EN
Ptychohyla spinipollex EN
Rana muscosa EN
Ranitomeya abdita CR
Rhaebo haematiticus LC
Rhinella amabilis CR
Rhinoderma darwini VU
Scinax albicans LC
Silverstoneia nubicola NT
Strabomantis cheirolepidus VU
Strabomantis zygodactylus LC
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Taudactylus lieni NT
Taudactylus rheophilus CR
Telmatobius atacamensis CR
Telmatobius bolivianus NT
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Telmatobius ignavus EN
Telmatobius jelskii NT
Telmatobius latirostris EN
Telmatobius mayoloi EN
Telmatobius neger CR
Telmatobius peruvianus VU
Telmatobius pinguiculus DD
Telmatobius platycephalus EN
Telmatobius scrochii EN
Telmatobius simonsi NT
Telmatobius thompsoni EN
Telmatobius truebae EN
Telmatobius verrucosus VU
Telmatobius yuracare VU
Thoropa lutzi EN
Thoropa petropolitana VU

Ptychohyla panchoi EN
Ptychohyla sanctaecrucis CR
Ptychohyla zophodes DD
Rana sierrae EN
Rhaecophorus margaritifer LC
Rheobatrachus vitellinus EX
Rhinella chrysophora EN
Rhinoderma rufum CR
Scinax heyeri DD
Smilisca cyanosticta NT
Strabomantis nesus VU
Taudactylus acutirostris CR
Taudactylus eungellensis CR
Taudactylus pleione CR
Telmatobius arequipensis VU
Telmatobius atahualpa DD
Telmatobius brevipes EN
Telmatobius carrillae VU
Telmatobius cirrhacilis CR
Telmatobius contrerasi DD
Telmatobius dankoi DD
Telmatobius edaphonastes EN
Telmatobius hauthali VU
Telmatobius hypseocephalus EN
Telmatobius intermedius DD
Telmatobius laticeps EN
Telmatobius marmoratus VU
Telmatobius necopinus EN
Telmatobius pefauri CR
Telmatobius philippii DD
Telmatobius pisanoi EN
Telmatobius schreiteri EN
Telmatobius sibircus EN
Telmatobius stephani EN
Telmatobius timens DD
Telmatobius vellardi CR
Telmatobius vilamensis DD
Telmatobius zapahuirensis CR
Thoropa miliaris LC
Thoropa saxatilis NT

BIBLIOGRAPHY
55 references found for Batrachochytrium dendrobatidis

Management information

GLOBAL INVASIVE SPECIES DATABASE
FULL ACCOUNT FOR: Batrachochytrium dendrobatidis


This document gives details on the global distribution of the chytrid fungus, and was last updated in April 2004.


Summary: This paper outlines techniques for identifying the chytrid fungus.


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Summary: This paper outlines techniques for identifying the chytrid fungus.


Summary: This paper outlines techniques for identifying the chytrid fungus.
General information


Summary: Available from: http://www.pnas.org/cgi/content/full/95/15/9031 [Accessed 7 Dec 2004]


Summary: This paper discusses the role of disease in amphibian decline, and the immunological response.


Johnson, Pieter T.J., 2006. Amphibian diversity: Decimation by disease. Published online before print February 21, 2006, 10.1073/pnas.060293103

Summary: Available from: http://www.pnas.org/cgi/content/full/103/9/3011 [Accessed 14 August 2006]


Norman, R. Undated. Chytrid fungus disease in New Zealand, Massey University Institute of Veterinary, Animal and Biomedical Sciences.

Summary: Article outlining the first case of chytrid fungus in New Zealand.


Summary: B. dendrobatidis differentially affects genotypes between two species of hybridizing leopard frogs (Rana). Hybrid genotypes are more susceptible to infection, and suffer greater reductions in growth and development from the fungus.


Summary: B. dendrobatidis alters the outcome of natural predator - prey dynamics in a larval amphibian - predator system.


Summary: B. dendrobatidis impacts on Hyla larvae may be somewhat ameliorated in a heavy metal (Cu) aquatic environment. Thus, pathogenic effects may be a result of interactions with other aquatic contaminants.


Summary: This paper documents that B. dendrobatidis induces competitive effects in the larval environment between a toad (Bufo) and treefrog (Hyla) species.


Summary: This paper outlines the role of antimicrobial peptides in deterring chytrid infection.

Speare R, Berger L. Chytridiomycosis in amphibians in Australia.


Summary: The pathogen Batrachochytrium dendrobatidis (Bd), which causes the skin disease chytridiomycosis, is one of the few highly virulent fungi in vertebrates and has been implicated in worldwide amphibian declines. However, the mechanism by which Bd causes death has not been determined. We show that Bd infection is associated with pathophysiological changes that lead to mortality in green tree frogs (Litoria caerulea). In diseased individuals, electrolyte transport across the epidermis was inhibited by >50%, plasma sodium and potassium concentrations were respectively reduced by ~20% and ~50%, and asystolic cardiac arrest resulted in death. Because the skin is critical in maintaining amphibian homeostasis, disruption to cutaneous function may be the mechanism by which Bd produces morbidity and mortality across a wide range of phylogenetically distant amphibian taxa


Summary: This article gives details about the first case of chytrid fungus in New Zealand, including possible means of introduction and spread.


Summary: A discussion of the factors involved in the population declines of amphibians in Latin America.