**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](http://www.iucngisd.org/gisd/species.php?sc=123)
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).


To view histological sections of infected skin of *Bufo haematiticus* and *Atelopus varius* (showing the sporangia and discharge tubes of the fungus) please see: [Daszak *et al.* 1999. Emerging Infectious Diseases and Amphibian Population Declines.](http://www.iucngisd.org/gisd/species.php?sc=123)


Click here to see information about Symptoms of the disease caused by *Batrachochytrium dendrobatidis*.

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). In

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 hyliid 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 occuring at 28°C and (reversible) cessation of growth occuring 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](http://www.iucngisd.org/gisd/species.php?sc=123).

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](http://www.iucngisd.org/gisd/species.php?sc=123) 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)](http://www.iucngisd.org/gisd/species.php?sc=123) 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.

**Principal source:** Berger *et al.* 1999. Chytrid fungi and amphibian declines: Overview, Implications and Future Directions.


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

**Compiler:** National Biological Information Infrastructure (NBII) & IUCN/SSC Invasive Species Specialist Group (ISSG) with support from the Terrestrial and Freshwater Biodiversity Information System (TFBIS) Programme [Copyright statement](http://www.iucngisd.org/gisd/species.php?sc=123)
Review: Matthew J. Parris Assistant Professor, Department of Biology University of Memphis USA

Publication date: 2006-08-14

ALIEN RANGE

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

- Adelotus brevis NT
- Agalychnis moreletii CR
- Alytes cisternasii 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 epikeisthos CR
- Atelopus eusebianus CR
- Atelopus famelicus CR
- Atelopus flavescens VU
- Atelopus galactogaster CR
- Atelopus guanaju CR
- Atelopus halihelos CR
- Atelopus laetissimus CR
- Atelopus longibrachii EN
- Atelopus lozanoi CR
- Atelopus mandingues CR
- Atelopus minutulus CR
- Atelopus monohernandezii CR
- Agalychnis annae EN
- Allobates oflersioides VU
- Anaxyrus canorus EN
- Aplastodiscus flumineus DD
- Aromobates leopoldialis CR
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- Atelopus boulengeri CR
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- Atelopus certus EN
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- Atelopus dimorphus EN
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- 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 11 March 2020]
GLOBAL INVASIVE SPECIES DATABASE
FULL ACCOUNT FOR: Batrachochytrium dendrobatidis

Atelopus muisca CR
Atelopus nanay CR
Atelopus nicefori CR
Atelopus oxapampae EN
Atelopus pachydermus CR
Atelopus patazensis CR
Atelopus peruensis CR
Atelopus petiriuizi CR
Atelopus pinangoi CR
Atelopus pulcher CR
Atelopus reticulatus CR
Atelopus seminiferus CR
Atelopus sermai CR
Atelopus siranus DD
Atelopus soriani CR
Atelopus spurrelli VU
Atelopus tamaense CR
Atelopus varius CR
Atelopus zeteki CR
Bokermannohyla claresignata DD
Bolitoglossa conanti EN
Bolitoglossa dolfelini NT
Bolitoglossa pesrubra VU
Bolitoglossa sooyorum EN
Bombina pachypus EN
Bromeliohyla dendroscarta CR
Centrolene audax EN
Centrolene buckleyi VU
Centrolene gemmatum CR
Centrolene lynch EN
Centrolene peristictum VU
Centrolene scirtetes DD
Charadrahyla neplia VU
Chiromantis cracens EN
Craugastor anciano CR
Craugastor angelicus CR
Craugastor berkenbuschii NT
Craugastor catalinae CR
Craugastor chrysozetes EX
Craugastor daryi EN
Craugastor emleni CR
Craugastor escoces EX
Craugastor fleischmanni CR
Craugastor guerrerensis CR
Craugastor laevissimus EN
Craugastor lineatus CR
Craugastor merendonensis CR
Atelopus nahumae CR
Atelopus nepiozomus CR
Atelopus onorei CR
Atelopus oxyrhythrus CR
Atelopus palmaus DD
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Atelopus petersi CR
Atelopus pictiventris CR
Atelopus planispina CR
Atelopus quimbaya CR
Atelopus sanjosei DD
Atelopus senex CR
Atelopus simulatus CR
Atelopus sonsonensis CR
Atelopus spumarius VU
Atelopus subornatus CR
Atelopus tricolor VU
Atelopus walkeri CR
Bokermannohyla circumdata LC
Bokermannohyla hylax LC
Bolitoglossa copia DD
Bolitoglossa magnifica EN
Bolitoglossa sombra VU
Bolitoglossa subpalmata EN
Bromeliohyla bromiaca EN
Bufo bufo LC
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Centrolene geckoideum VU
Centrolene heloderma CR
Centrolene medemi DD
Centrolene pipilatum EN
Charadrahyla altipotens CR
Charadrahyla trux CR
Charadrahyla truxulens EN
Craugastor andi CR
Craugastor azueroensis EN
Craugastor brochii VU
Craugastor charadrina EN
Craugastor cruzi CR
Craugastor emcelae CR
Craugastor epochthidius CR
Craugastor fluctuans CR
Craugastor inachus EN
Craugastor laticeps NT
Craugastor melanostictus LC
Craugastor mexicanus LC

FULL ACCOUNT FOR: Batrachochytrium dendrobatidis

Craugastor milesi CR
Craugastor olanchano CR
Craugastor pechorum EN
Craugastor podiciferus NT
Craugastor punctariolus EN
Craugastor rhyacobatrachus EN
Craugastor rugulosus LC
Craugastor sabrinus EN
Craugastor sandersonii EN
Craugastor tabasaare CR
Craugastor trachydermus CR
Crinia pseudinsignifera LC
Crossodactylus gaudichaudi LC
Cycloramphus ohausi DD
Duellmanohyla chamulai EN
Duellmanohyla lythrodos EN
Duellmanohyla schmidtorum VU
Duellmanohyla uranochrao CR
Ecomiophyla rabborum CR
Eleutherodactylus cooki VU
Eleutherodactylus hedricki EN
Eleutherodactylus karlschmidtii CR
Eleutherodactylus orcutti CR
Eleutherodactylus portoricensis EN
Eleutherodactylus ruhae EN
Eleutherodactylus semipalmatus CR
Eleutherodactylus turquinensis CR
Eleutherodactylus wightmanae EN
Euproctus platycephalus EN
Exerodonta melanomma VU
Gastrotheca cornuta EN
Gastrotheca guentheri VU
Gastrotheca orophylax EN
Gastrotheca piperata LC
Gastrotheca pseustes EN
Gastrotheca splendens EN
Heleioporus australiacus VU
Hyalinobatrachium fleischmanni LC
Hyloxalus anthracinus CR
Hyalinobatrachium guairarepanense EN
Hylarana chalconota LC
Hylodes dactylocinus DD
Hylodes meridionalis LC
Hylodes phylloides LC
Hyliscirtus armatus LC
Hyliscirtus cobyla RC
Hyliscirtus pantosticulus EN
Hyliscirtus pyleodicaylites CR
Hyliscirtus torricolisa VU

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<td>Pristimantis caprifer</td>
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<td>Pseudacris triseriata</td>
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<td>Ptychohyla crassa</td>
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<td>Ptychohyla eurystanote</td>
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<td>Ptychohyla leonhardschulzei</td>
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GLOBAL INVASIVE SPECIES DATABASE
FULL ACCOUNT FOR: Batrachochytrium dendrobatidis

Ptychohyla macrotympanum CR
Ptychohyla salvadorensis EN
Ptychohyla spinioloves EN
Rana muscosa EN
Ranitomeya abdita CR
Rheo haematiticus LC
Rhinella amabilis CR
Rhinoderma darwinii VU
Scinax albicans LC
Silverstonea nubicola NT
Strabomantis cheirolethys VU
Strabomantis zygodactylus LC
Taudactylus diurnus EX
Taudactylus liemi NT
Taudactylus rheophilus CR
Telmatobius atacamensis CR
Telmatobius bolivianus NT
Telmatobius brevirostris EN
Telmatobius cielorum EN
Telmatobius colanensis EN
Telmatobius culeus CR
Telmatobius degener EN
Telmatobius gigan CR
Telmatobius holcini VU
Telmatobius ignavus EN
Telmatobius jelskii NT
Telmatobius latirostris EN
Telmatobius mayoloi EN
Telmatobius niger CR
Telmatobius peruvians VU
Telmatobius pinguiulus DD
Telmatobius platyccephalus EN
Telmatobius scrochyi EN
Telmatobius simonsi NT
Telmatobius thompsoni EN
Telmatobius truebae EN
Telmatobius verrucosus VU
Telmatobius yuracare VU
Thoropa lutzi EN
Thoropa petropolitana VU

BIBLIOGRAPHY
55 references found for Batrachochytrium dendrobatidis

Management information


Summary: 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. Available from: http://www.amphibians.org/newsletter/ACAP.pdf [Accessed 9 June 2008]


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.


methods cohort, amphibians are identified which are infected with B. dendrobatidis. These animals were then subjected to a range of stressors, including those normally encountered in the field, such as cold temperatures, high altitudes, and exposure to predators. The results showed that B. dendrobatidis infection can significantly reduce amphibian fitness, which may contribute to the decline in amphibian populations worldwide.


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 pathological 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.