**Batrachochytrium dendrobatidis**  

【简体中文】

**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 a scanning electron micrograph of infected skin of a wild frog (*Litoria lesueuri*) please see: Daszak et al. 1999. Emerging Infectious Diseases and Amphibian Population Declines.

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.

To view a histological section of severely infected skin of a wild frog (*Litoria caerulea*) please see: Berger et al. 1998. Chytridiomycosis causes amphibian mortality.

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 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 amphibian 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.

**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*

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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 moreletii CR
Alytes cisternasii NT
Aplastodiscus callipygius LC
Aromobates alboguttatus EN
Aromobates nocturnus CR
Atelopus angelito
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 longibrachius EN
Atelopus lozanoi CR
Atelopus mandingues CR
Atelopus minutulus CR
Atelopus monohernandezii CR

Agalychnis annae EN
Allobates olfersioides VU
Anaxyrus canorus EN
Aplastodiscus flumineus DD
Aromobates leopoldis CR
Atelopus andinus CR
Atelopus arsyecue 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 lynchis EX
Atelopus mindoensis CR
Atelopus mittermeieri EN
Atelopus mucubajiensis CR
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 petirui zi CR
Atelopus pinangoi CR
Atelopus pulcher CR
Atelopus reticulatus CR
Atelopus seminiferus CR
Atelopus serrai CR
Atelopus siranus DD
Atelopus soriano CR
Atelopus spurrellii VU
Atelopus tamaense CR
Atelopus varius CR
Atelopus zeteki CR
Bokermannohyla claresignata DD
Bolitoglossa conanti EN
Bolitoglossa dolleini NT
Bolitoglossa pesrubra VU
Bolitoglossa sooyorum EN
Bombina pachypus EN
Bromeliohyla dendroscarta CR
Centrolene audax EN
Centrolene buckleyi VU
Centrolene gemmatum CR
Centrolene lynchii EN
Centrolene peristictum VU
Centrolene scirtetes DD
Charadrahyla nephila VU
Chiropterotriton cracens EN
Craugastor anciano CR
Craugastor angelicus CR
Craugastor berkenbuschii NT
Craugastor catalinae CR
Craugastor chrysozetetes 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 oxyrhynchus CR
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Atelopus spumarius VU
Atelopus subornatus CR
Atelopus tricolor VU
Atelopus walkeri CR
Bokermannohyla circumpedata LC
Bokermannohyla hylax LC
Bolitoglossa copia DD
Bolitoglossa magna fina EN
Bolitoglossa sombra VU
Bolitoglossa subsalpinosa EN
Bromeliohyla bromeliacia EN
Bufo bufo LC
Centrolene ballux CR
Centrolene geckoideum VU
Centrolene heloderma CR
Centrolene mederi DD
Centrolene pipilatum EN
Charadrahyla altipotens CR
Charadrahyla trux CR
Chiropterotriton multidentatus EN
Craugastor andi CR
Craugastor azueroensis EN
Craugastor brochi VU
Craugastor charandra EN
Craugastor cruzi CR
Craugastor emcelae CR
Craugastor epochthidius CR
Craugastor fecundus CR
Craugastor greggi CR
Craugastor inachus EN
Craugastor laticeps NT
Craugastor melanostictus LC
Craugastor mexicanus LC
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**GLOBAL INVASIVE SPECIES DATABASE**

**FULL ACCOUNT FOR:** *Batrachochytrium dendrobatidis*

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<td>Pristimantis caprifer</td>
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<tr>
<td>Pristimantis chaleucus</td>
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<td>Pristimantis diaphonus</td>
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<td>Pristimantis duellmani</td>
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<td>Pristimantis gracilis</td>
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<td>Pristimantis lichenoides</td>
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<td>Pristimantis molybrignus</td>
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<td>Pristimantis penelopus</td>
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<tr>
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<tr>
<td>Pristimantis sanctaemartae</td>
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<td>Pristimantis savagei</td>
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<td>Pristimantis scolodiscus</td>
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<td>Pristimantis sulculus</td>
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<td>Pristimantis uranobates</td>
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<td>Pristimantis verecundus</td>
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<td>Pristimantis zophus</td>
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<tr>
<td>Pseudacris triseriata</td>
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<tr>
<td>Pseudophryne corroboree</td>
<td>CR</td>
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<tr>
<td>Ptychohyla</td>
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<tr>
<td>Ptychohyla dendrophastrum</td>
<td>CR</td>
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<tr>
<td>Ptychohyla euthysanota</td>
<td>NT</td>
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<tr>
<td>Ptychohyla leonhardschultzei</td>
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</tbody>
</table>

GLOBAL INVASIVE SPECIES DATABASE
FULL ACCOUNT FOR: Batrachochytrium dendrobatidis

Ptychohyla macrotympanum CR
Ptychohyla salvadorensis EN
Ptychohyla spinipollex EN
Rana muscosa EN
Ranitomeya abdita CR
Rhaebo haematticus LC
Rhinella amabilis CR
Rhinoderma darwinii VU
Scinax albicans LC
Silverstoneia nubica NT
Strabomantis cheiroplethus VU
Strabomantis zygodactylus LC
Taudactylus diurnus EX
Taudactylus liemi NT
Taudactylus rheophilus CR
Telmatobius atacamensis CR
Telmatobius bolivianus NT
Telmatobius breviostris EN
Telmatobius ceiorum EN
Telmatobius colanensis EN
Telmatobius culeus CR
Telmatobius degener EN
Telmatobius gigan CR
Telmatobius hockingi VU
Telmatobius ignavus EN
Telmatobius jelskii NT
Telmatobius latirostris EN
Telmatobius mayoloi EN
Telmatobius niger CR
Telmatobius peruvianus VU
Telmatobius pinguiulus DD
Telmatobius platycephalus EN
Telmatobius scrochi 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 sanctaeccruciis CR
Ptychohyla zophodes DD
Rana sierrae EN
Rhacophorus margaritifers LC
Rheobatrachus vitellinus EX
Rhinella chrysophora EN
Rhinodema rufum CR
Scinax heyeri DD
Smilisca cyanosticta NT
Strabomantis nectarus VU
Taudactylus acutirostris CR
Taudactylus eungellensis CR
Taudactylus pleione CR
Telmatobius arequipensis VU
Telmatobius atahualpa DD
Telmatobius brevipes EN
Telmatobius carrillae VU
Telmatobius cirrhacelis CR
Telmatobius contrerasi DD
Telmatobius dankoi DD
Telmatobius edaphonastes EN
Telmatobius hauthali VU
Telmatobius hypselocephalus EN
Telmatobius intermedius DD
Telmatobius laticeps EN
Telmatobius marmoratus VU
Telmatobius necopinus EN
Telmatobius pefauri CR
Telmatobius philippi DD
Telmatobius pisanoi EN
Telmatobius schreiteri EN
Telmatobius sibiricus 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

[Accessed 01 August 2019]


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.


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


General information


Summary: Available from: http://www.pnas.org/cgi/content/full/95/16/9031 [Accessed 7 Dec 2004]


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


Daszak, P., Andrew, A Cunningham and Hyatt, D Alex., 2003. Infectious disease and amphibian population declines. Diversity and Distributions 9, 141?150


Summary: The Global Amphibian Assessment (GAA) is the first-ever comprehensive assessment of the conservation status of the world's 5,918 known species of frogs, toads, salamanders, and caecilians. This website presents results of the assessments, including IUCN Red List threat category, range map, ecology, distribution, and why did populations of Archey's frog Leiopelma archeyi crash over 1996?2001? Biological Conservation 120 (2004) 189-199

Johnson, Pieter T. J., 2006. Amphibian diversity: Decimation by disease. Published online before print February 21, 2006, 10.1073/pnas.0600293103

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


Summary: This article gives details about the first reports of chytrid fungus in Archey's frog.


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.

[Accessed 01 August 2019]

FULL ACCOUNT FOR: Batrachochytrium dendrobatidis
Summary: A discussion of the factors involved in the population declines of amphibians in Latin America.