Chytridiomycosis (amphibian chytrid fungus disease)

Chytridiomycosis is an infectious disease that affects amphibians worldwide. It is caused by the chytrid fungus (Batrachochytrium dendrobatidis)*, a fungus capable of causing sporadic deaths in some amphibian populations and 100% mortality in others. The disease has been implicated in the mass die-offs and species extinctions of frogs in the past 15 years, but its origin and its true impact on populations remain uncertain and are under investigation.*

History

First discovered in dead and dying frogs in Queensland in 1993, chytridiomycosis is a highly infectious disease of amphibians, caused by the amphibian chytrid fungus *Batrachochytrium dendrobatidis*. Research since then has shown that the fungus is widespread across Australia and has been present in the country since at least 1978. It is also found in Africa, the Americas, Europe, New Zealand and Oceania.

In Australia, Panama and New Zealand, the fungus initially seemed to have suddenly 'appeared' and expanded its range at the same time as frog numbers declined. However, it may be that the fungus occurs naturally and has only been identified recently because it has become more virulent or more prevalent in the environment, or because host populations have become less resistant to the disease. The fungus has been detected in four areas of Australia — the east coast, Adelaide, south-west Western Australia and the Kimberley — and is probably present elsewhere.

Ecology

Chytrid fungi typically live in water or soil, although some are parasites of plants and insects. They reproduce asexually and have spores that 'swim' through the water. Only the amphibian chytrid fungus is known to infect vertebrate species. Individual frogs are thought to contract the disease when their skin comes into contact with water that contains spores from infected animals.

Much is still unknown about the fungus and the disease in the wild, including reasons for the death of hosts, how the fungus survives in the absence of amphibian populations, and how it spreads. Interactions between the fungus and environmental factors are known to be important. For example, Australian upland frog populations have suffered the greatest number of declines and extinctions, leading to the suggestion that environmental stress, perhaps from global warming or increased exposure to ultraviolet radiation, may be reducing resistance to infection. However, such interactions between the fungus and other factors are not well understood.

Fletcher's frog Lechriodus fletcheri*, which occurs throughout New South Wales and eastern Queensland, has been recorded as being infected with chytrid fungus. Photo: H B Hines*

Impact

The fungus invades the surface layers of the frog's skin, causing damage to the keratin layer. It is not yet known exactly how this kills the frog. The fungus may release toxins that are absorbed through the skin, or — given that frogs drink and breathe through their skins — it may directly affect water uptake and respiration.

In some frog populations, the disease causes only some animals to die; in others, it can cause 100% mortality. Surviving individuals are thought to be carriers. Some species are highly susceptible and die quickly; others seem to be less susceptible. There is no known treatment once the fungus is contracted.

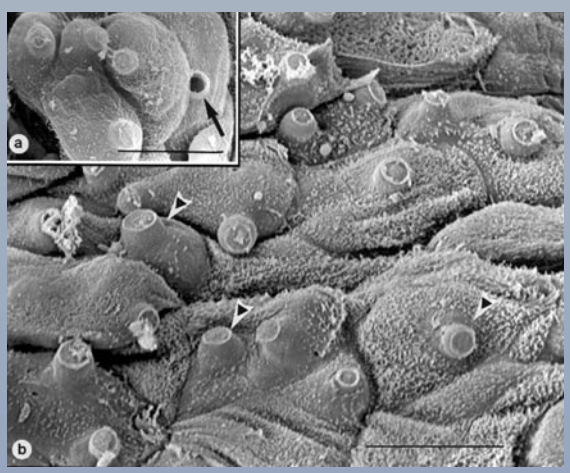
Although the fungus has caused the death of a number of individual Australian frogs, it is not clear whether it is the primary cause of population declines. For example, the disease has been known to be active for at least 15 years in some south-west Western Australia species, such as the orange-bellied frog *Geocrinia vitellina* and the western green and golden bell frog *Litoria moorei*, without impact on their populations.

Symptoms of the terminal stages of chytridiomycosis include the half-closed eyes and generally depressed attitude seen in this frog, and an accumulation of cast-off skin (the greyish crescent shape near the top rear end of the frog). Photo: Lee Berger

Nonetheless, some researchers have blamed chytrid infection for the extinction of the sharp-snouted day frog *Taudactylus acutirostris*, and have linked it to the decline of at least four other species (waterfall frog *Litoria nannotis*, common mistfrog *Litoria rheocola*, spotted tree frog *Litoria spenceri* and lace-eyed tree frog *Nycitmystes dayi*).

Control

As chytridiomycosis has only recently been diagnosed, little is known about how to control it, although it is clear that control should involve effective diagnosis and monitoring. A threat abatement plan being developed is likely to recommend extending and reinforcing current quarantine and handling protocols; controlling human movement and release of amphibians between areas; ensuring that the disease is identified wherever it occurs; and phasing out imports of amphibians. Identifying and managing environmental factors that make amphibians more likely to develop chytridiomycosis may also help in controlling the threat of this disease.



The surface of the epithelium (outer layer of skin) of a frog with chytridiomycosis shows discharge tubes of spores of the fungus Batrachochytrium dendrobatidis *emerging from the surface. Photo: Lee Berger and Alex Hyatt*

Research

Scientists from the CSIRO are testing antifungal drugs in the hope of finding one that is effective against chytrid infection. They will collect tadpoles from the wild, treat them with the antifungal drug and keep them in a fungus-free environment until they metamorphose. The researchers will then release and monitor the young frogs at the site where they were collected as tadpoles.

In the meantime, scientists are making sure that their activities do not help to spread the fungus, and governments are imposing strict quarantine rules on amphibian movements into Australia and between states.

Research is continuing into the origin and spread of the fungus, its impact on frog populations and environmental factors that may make animals more susceptible to the disease.

How the Australian Government is dealing with a national problem

Infection of amphibians with chytrid fungus resulting in chytridiomycosis is listed as a key threatening process under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (the EPBC Act). Under the EPBC Act, the Australian Government in consultation with the states and territories is developing the *Threat Abatement Plan for Infection of Amphibians with Chytrid Fungus Resulting in Chytridiomycosis*, which aims to reduce the impact of chytridiomycosis on native frog species.

The threat abatement plan will establish a framework that will enable the best use to be made of any resources made available for chytridiomycosis management. The Australian Government will continue to work with the states and territories in dealing with this national problem.

More information about the threat abatement plan can be found at http://www.deh.gov.au/biodiversity/threatened/tap/chytrid

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