

# SALAMANDER CHYTRIDIOMYCOSIS

Other names: salamander chytrid disease, B sal

## CAUSE

Salamander chytridiomycosis is an infectious disease caused by the fungus *Batrachochytrium salamandrivorans*. The fungus is a close relative of *B. dendrobatidis*, which was described more than two decades ago and is responsible for the decline or extinction of over 200 species of frogs and toads. Salamander chytridiomycosis, and the fungus that causes it, were only recently discovered. The first cases occurred in The Netherlands, as outbreaks in native fire salamanders, *Salamandra salamandra*. Further work discovered that the fungus is present in Thailand, Vietnam and Japan, and can infect native Eastern Asian salamanders without causing significant disease. Evidence suggests that the fungus was introduced to Europe in the last decade or so, probably through imported exotic salamanders that can act as carriers. Once introduced the fungus is capable of surviving in the environment, amongst the leaf litter and in small water bodies, even in the absence of salamanders. It thrives at temperatures between 10-15°C, with some growth in temperatures as low as 5°C and death at 25°C. *B. salamandrivorans* has not, so far, been reported in North America.

## SIGNIFICANCE

The disease is not present in North America, but an introduction of the fungus into native salamander populations could have devastating effects. In Europe, the fire salamander population where the disease was first discovered is at the brink of extirpation, with over 96% mortality recorded during outbreaks. Little is known about the susceptibility of most North American salamanders but, based on experimental trials, at least two species, the Eastern newt (*Notophthalmus viridescens*) and the rough-skinned newt (*Taricha granulosa*), are highly susceptible to the fungus and could experience similar high mortalities. If *B. salamandrivorans* is introduced into North America, it will likely become permanently established and, based on experience with frog chytridiomycosis, impossible to eradicate.

## SPECIES AFFECTED

Based on experimental infections conducted on selected species of each of the three amphibian orders, *B. salamandrivorans* seems incapable of establishing an infection in the skin of frogs (order Anura) and caecilians (order Caecilian), while it is deadly to the majority of species of salamanders and newts in which experimental infections have been performed. Three species of Asian salamanders have been proposed as potential reservoirs: the blue-tailed fire-bellied newt (*Cynops cyanurus*), Japanese newt (*Cynops pyrrhogaster*) and Tam Dao salamander (*Paramesotriton deloustali*).

## DISTRIBUTION

Salamander chytrid appears to be native to Eastern Asia, where it infects salamanders native to Thailand, Vietnam and Japan without causing significant disease. It was recently found in wild salamanders in The Netherlands, and has since spread to populations in neighbouring Belgium.

## TRANSMISSION

Chytrid fungi can be transmitted through contact with water or organic matter (mud, leaf litter, etc.), or by direct contact with an infected salamander. The fungus produces motile zoospores, capable not only of surviving in water and moist environments, but also of short distance dispersal through active swimming. Because the fungus and its infectious zoospores can survive in the absence of an infected host, transmission from an outbreak site to adjacent areas can occur both through dispersal of infected salamanders and through human activities, such as movement of soil, water or even fishing bait.

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## CLINICAL SIGNS

Like the frog chytrid fungus, *B. salamandrivorans* infects only the skin, never going into deeper tissues. In the skin it causes reddening and ulceration, often followed by secondary bacterial infection. Skin lesions are not always obvious, however. In some cases all that is observed is severe lethargy, sometimes weight loss, followed by a quick death.

## DIAGNOSIS

Infection (presence of the fungus in a host) and disease (ill effects on the host) are not the same thing. Some species of salamanders, the Asian carriers for instance, can be infected but do not develop disease. To diagnose chytridiomycosis it is necessary to confirm the concurrent presence of skin lesions and fungus, and this is done through microscopic examination of tissues fixed in either formalin (10%) or ethanol (70%). Molecular confirmation of the fungus in either asymptomatic carriers or sick salamanders can be done with a PCR test, usually from a skin swab.

## TREATMENT

Research specific to treatment of *B. salamandrivorans* has only begun, and it has shown that controlling temperature may be a viable way to treat infected salamanders in captivity. Based on what is known of the frog chytrid infection, several antifungal drugs could prove effective against the salamander chytrid fungus in captive individuals. Treatment of wild salamanders would be impractical and, most likely, ineffective.

## MANAGEMENT AND PREVENTION

As with frog chytrid fungus, salamander chytridiomycosis could be spread during anthropogenic activities. Boots, clothes, and all field equipment should be cleaned with a 10% bleach-water mixture before moving between sites. Wild amphibians should not be moved between habitats, and captive amphibians should not be released into the environment or used as fishing bait. All newly acquired captive amphibians should be initially quarantined from other amphibians until it has been confirmed that they are disease free.

Salamander chytridiomycosis is not yet a reportable disease but, as it is exotic to North America and its introduction may have severe consequences on native populations, suspicious deaths of salamanders both in the wild and in captivity should be investigated.

## SUGGESTED READING

**Amphibians.org**

<http://www.amphibians.org/news/watching-extinction-happen-origins-of-the-salamander-eater/>

Martel *et al.* *Batrachochytrium salamandrivorans* sp. nov. causes lethal chytridiomycosis in amphibians. PNAS Sep 17; 110(38): 15325–15329 doi: 10.1073/pnas.1307356110



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