



## BSAL CHYTRIDIOMYCOSIS

*Rough skinned newt (Taricha granulosa). The rough skinned newt is a native North American newt that is susceptible to Bsal chytridiomycosis.*

*Photo credit: © 2009 Aaron Schusteff. This fact sheet has been updated on 04/20/2020.*

MARCH 2022

### CAUSE

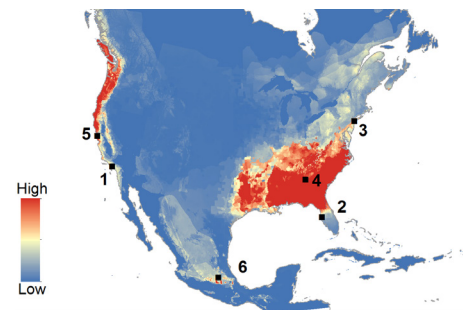
*Batrachochytrium salamandrivorans* (Bsal) is an infectious fungus that causes the skin disease Bsal chytridiomycosis in some amphibians. The fungus is a close relative of *B. dendrobatidis*, which was described more than two decades ago and is thought to have contributed to the decline or extinction of over 500 species of frogs, toads and is known to infect about half of all frogs, toads, and salamanders tested. Bsal chytridiomycosis, and the fungus that causes it (Bsal), were recently discovered in 2013. The first cases occurred in the Netherlands with outbreaks in native fire salamanders, *Salamandra salamandra* that resulted in the loss of over 96% of the population. Further work discovered that the fungus is present in Thailand, Vietnam and Japan, and can infect native Eastern Asian salamanders and at least one anuran without causing significant disease; this indicates Bsal may be native (or naturally endemic) to this region in Asia. Evidence suggests that Bsal was introduced to Europe through imported exotic salamanders from Asia that act as carriers of the fungus. Once introduced, the fungus is capable of surviving in the environment, among 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 at temperatures as low as 5°C and death at 25°C. Experimental trials to understand Bsal effects on various amphibian species is ongoing, but emerging results show some North American salamanders and frogs/toads can be infected, and for highly susceptible species, Bsal infection can be lethal.

### SIGNIFICANCE

To date, the Bsal fungus and associated disease have not been found in North America, but an introduction of the fungus into native amphibian populations could have devastating effects.

Models based on initial results of amphibian species susceptible to Bsal infection predict that the greatest risk of an introduction of Bsal into the United States is in the Pacific Coast, southern Appalachian Mountains, and mid-Atlantic regions, with the overall risk being most significant across the eastern United States.

In Europe, the fire salamander population in which the disease was first discovered is at the brink of extinction. Little is known about the susceptibility of most North American amphibians but, based on experimental trials, species such as the Eastern newt (*Notophthalmus viridescens*) and some plethodontid salamanders are highly susceptible to the fungus and could experience similar high mortalities. If Bsal were introduced into North America, it would likely become permanently established and, based on experience with *Bd chytridiomycosis*, impossible to eradicate.



*Bsal vulnerability model for North America. The red areas were identified as the highest risk for potential Bsal outbreaks based on Bsal habitat suitability, species richness, species endemism, and potential ports of entry. Image credit: Yap et al., 2015*



*(A) Skin lesions in Bsal infected S. s. bernadezi along the base of the tail, just behind the left rear foot. (B) S. s. fastuosa with lesions typical of Bsal infection (white arrow) and patches of shed skin (black arrowhead). Image credit: Pinto et al., 2015.*

continued ▶

Bsal is a Notifiable Pathogen by the OIE (the World Organization for Animal Health).

## SPECIES AFFECTED

Research is ongoing to assess amphibian species' susceptibility to Bsal infections. Early tests reported that three species of Asian salamanders could be infected but as they did not appear to be susceptible to disease, they have been proposed as potential reservoirs: the blue-tailed fire-bellied newt (*Cynops cyanurus*), Japanese newt (*Cynops pyrrhogaster*) and Tam Dao salamander (*Paramesotriton deloustali*). At this time, Bsal infections appear to be more widespread across salamander taxonomic groups, with mortality from Bsal chytridiomycosis reported in newts and some woodland salamander species during laboratory experiments, yet some anurans also can harbor infections and could be Bsal carriers.

There is no known zoonotic risk associated with Bsal.

## DISTRIBUTION

Bsal appears to be native to Eastern Asia, where it infects salamanders native to Thailand, Vietnam and Japan without causing significant disease. As of 2020, in Europe, Bsal has been detected in wild salamanders in the Netherlands, Belgium, Germany, and Spain. In addition, Bsal outbreaks in captive salamander populations have been reported in the United Kingdom, Germany, the Netherlands, and Spain.

## TRANSMISSION

Chytrid fungi, including Bsal, can be transmitted through contact with water or organic matter (mud, leaf litter, etc.), or by direct contact with an infected salamander. Similar to Bd, Bsal 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.

The importance of biosecurity implemented to minimize the anthropogenic spread of the Bsal fungus between site and individual animals cannot be overstated.

## CLINICAL SIGNS

Like Bd, the Bsal chytrid fungus infects only the skin, never going into deeper tissues. Clinical signs are similar to those seen in *Bd chytridiomycosis* and can include reddening and ulceration or blistering of skin, excessive shedding of skin, ataxia, apathy, emaciation, and ultimately death. Skin lesions are not always obvious. Disease severity is variable and may depend on climatic conditions, species infected, life stage infected, etc.

## 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 *Bsal chytridiomycosis* it is necessary to confirm the concurrent presence of disease symptoms such as skin lesions and the fungus. This is done through a combination of histologic (tissue) examination and molecular confirmation of the fungus (via PCR or qPCR), following the case definition (White et al 2016):

### Bsal present

Positive Bsal PCR or Bsal culture from an animal or swab sample without compatible gross lesions and for which histopathology was either not done or was not consistent with Bsal histopathology

### Suspect Bsal chytridiomycosis

Histopathology consistent with Bsal infection in the absence of corroborating Bsal PCR or Bsal fungal culture

### Confirmed Bsal chytridiomycosis

Histopathology consistent with Bsal infection and positive Bsal PCR or Bsal culture from skin samples or histopathology and positive Bsal PCR or Bsal culture and Bd PCR or culture negative

## TREATMENT

Research specific to treatment of Bsal chytridiomycosis has only begun, and it has shown that controlling temperature may be a viable way to treat infected amphibians in captivity. Based on what is known of the Bd infection, several antifungal drugs could prove effective against Bsal chytridiomycosis, especially in captive individuals.

## MANAGEMENT

As with Bd, Bsal could be spread during anthropogenic activities. Boots, clothes, and all field equipment should be cleaned and disinfected with appropriate cleaners/disinfectants according to product label, 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.

## SUGGESTED READING

Martel et al. 2013. Batrachochytrium salamandrivorans sp. nov. causes lethal chytridiomycosis in amphibians. *PNAS* 110(38): 15325–15329 doi: 10.1073/pnas.1307356110

[Amphibian Survival Alliance and Amphibian Specialists Group](#)

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[Bsals Europe Bsal Task Force](#)

<https://www.cabi.org/isc/datasheet/121671>

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