Salamander killer fungus report

Also in this issue:

Indonesia opposes Banggai CITES listing
Brexit and the aquarium industry
CITES CoP preview
EUS and common cichlid diseases
New OFI Secretary General
The salamander fungus: too hot to handle?

Maarten Gilbert, Project Leader, and Annemarieke Spitzen, Senior Project Leader, RAVON*, the Netherlands

A novel detected infectious disease caused by a chytrid fungus has wiped out a native population of fire salamanders in the Netherlands within a few years. It is suspected that this fungus originates from Asia and was transported to Europe via the pet trade. In this article we would like to provide information on this devastating disease, on the threat it poses to naïve species and populations, and on precautionary measures that could be taken to prevent the spread of the fungus.

Following the enigmatic 99.9% decline of the fire salamander (Salamandra salamandra) in the Netherlands, it was discovered in 2013 that the newly described fungal disease, Batrachochytrium salamandrivorans (Bsal), was the cause of this decline. Subsequent research showed that Bsal specifically affects salamanders and newts (collectively called urodelans), while frogs and toads remain unaffected. By causing superficial skin erosion, deep ulcerations and skin necrosis, Bsal eats away the skin, which is lethal for many urodelan species (Martel et al, 2013).

Bsal is closely related to another chytrid fungus, Batrachochytrium dendrobatidis (Bd), which has already caused declines and extinctions of many amphibian species all over the world (Kolby and Daszak, 2016). The fear is that Bsal will have a similar impact on urodelans. Bsal was found lethal for all North American newt species and nearly all European, North African, and Middle Eastern urodelan species tested (Martel et al, 2014).

Disease transmission and symptoms

The optimum temperature for the growth of Bsal is lower (10-15°C) than that of Bd (17-25°C), which means that Bsal is likely to pose a greater threat to salamanders and newts in temperate climate zones than Bd. The disease is highly contagious and can be easily transferred between different species of salamanders and newts. Common modes of transmission are direct contact of the animals (skin-to-skin) or contact with dispersed zoospores (Martel et al, 2013).

Urodelans infected by Bsal may develop ulcers on the skin. Depending on host susceptibility, Bsal may cause extensive mortality in salamander and newt collections. However, not all infected animals become ill and show these symptoms. Also, skin ulcers can have many other causes besides Bsal. Therefore, urodelans may carry Bsal without any symptoms and can spread Bsal unnoticed. East Asian salamanders, in particular, may be symptomless carriers of Bsal (Martel et al, 2013; 2014).

Testing for Bsal and treating an infection

To detect Bsal with high confidence in live salamanders and newts the animals need to be tested. This can be done by collecting skin swabs, which are subsequently tested for Bsal in a dedicated laboratory by PCR, a highly sensitive method which detects the DNA of Bsal. Swabs and dead animals can be examined by veterinary diagnostic laboratories trained in diagnosing Bsal (Blooi et al, 2013).

Encouragingly, Bsal can be successfully treated. This involves treatment of the skin with fungicidal compounds, prolonged incubation at increased temperatures, or a combination of both. Bsal cannot survive at temperatures higher than 25°C, so many urodelan species can be successfully treated by keeping them at 25°C for 10 days.
However, it needs to be stressed that not all species tolerate these temperatures. Also, it cannot be excluded that Bsal strains exist which tolerate higher temperatures. Consequently, it is recommended to confirm the absence of Bsal by PCR of skin swabs after treatment (Blooi et al., 2015a,b).

**Current distribution and impact**

Bsal outbreaks have currently been detected in western Germany and in Belgium, including a location close to the French border. The webpage www.ravon.nl/bsal provides an up-to-date map on the current distribution of the fungus.

It appears that Bsal is spreading across Europe and will likely have a large impact on urodelan populations (Spitzen – van der Sluijs et al., 2016). Major causes for concern are rare and range-restricted urodelan species, which may face extinction when Bsal reaches these populations.

Besides these environmental outbreaks, Bsal has also been detected in captive-held urodelans in Germany and the United Kingdom (Sabino-Pinto et al., 2015; Cunningham et al., 2015).

A sharp decline in the number of live fire salamanders has been observed in the Netherlands since 2010. In 2013, this enigmatic decline was linked to an outbreak of Bsal. Within a few years the population of fire salamanders collapsed and is now close to extinction without any signs of recovery (Spitzen – van der Sluijs et al., 2013). This pattern is seen in outbreak locations in Belgium and Germany, too, which means that the chytrid fungus has the capacity to eliminate populations of salamanders within a short period of time.

**Spread of the disease**

A large-scale infection experiment comprising many urodelan species of various families from across the world indicated the East Asian salamander species *Cynops pyrrhogaster, Cynops cyanurus,*...
and *Paramesotriton deloustali* as potential reservoirs for Bsal. These species carry Bsal with no or little adverse health effects and have likely lived in balance with Bsal for millions of years. However, many urodelan species outside East Asia lack an efficient defense when exposed to this novel pathogen (Martel *et al.*, 2014).

Human-mediated transport of East Asian salamanders outside their natural range has been implicated in the distribution of Bsal. East Asian salamanders, especially *Cynops* species, form an important part of the worldwide trade in urodelans. A major cause for concern is that Bsal may, thus, be introduced into susceptible wild urodelan populations via the trade in urodelans. Urodelan diversity is especially high in North and Central America, and Bsal could potentially have a devastating impact on urodelan communities in these regions.

To avoid the spread of Bsal when transporting urodelans, high bio-security measures need to be taken. Good practice would be to keep urodelans from the same population or collection well separated from those of other origins to prevent the spread of the fungus. The containers used to transport the salamanders need to be discarded or thoroughly cleaned and disinfected when used for more than one transportation of urodelans. Effective disinfection can be done with a 5% household bleach solution or with a 1% Virkon-S solution, followed by extensive rinsing with clean water. These disinfectants can also be used to disinfect waste water after transport. As Bsal is intolerant to desiccation, thorough drying of materials can also help prevent the spread.

**Role of the amphibian trade**

An important question is how the trade should react to the emergence of this novel pathogen. Several countries, such as the USA and Switzerland, have already prohibited the import of salamanders and newts, while, in the EU, scientists and NGOs are pleading for a ban on import of Asian salamanders. Clearly, a proactive response and a clear uniform policy towards Bsal and other invasive pathogens are needed from the animal trade.

Based on current knowledge, completely banning the trade in salamanders is not considered to be a viable short term solution. However, both the scientific community and hobbyist groups are requesting a ban for a ban in the trade of wild-caught Asian urodelans.

Calotriton arnoldi is one of the European range-restricted species susceptible to infection, which would be at high risk of extinction should Bsal spread into its habitat. PHOTO: SERGÉ BOGAERTS

O FI and RAVON (Reptile, Amphibian and Fish Conservation the Netherlands) have formulated a joint statement regarding this issue. Both parties share the ambition to stimulate a safe and sustainable trade of salamanders and newts and to prevent the spread of Bsal and other pathogens outside their indigenous range. To reach that goal it was agreed to work towards the prevention of the import and transmission of Bsal and other invasive pathogens to both captive-held and wild amphibians.

O FI has acknowledged the bio-security risks that are associated with importing animals. A science-based pre-import screening should be compulsory for all imported salamanders and newts, but the development and implementation of this could be long term. In the meantime, awareness to this relevant issue needs to be created on the side of suppliers, importers and customers.

O FI and RAVON emphasize the need to maintain high bio-security standards and have sick or dead salamanders and newts tested. They also suggest that traded animals should be treated preventively by heat treatment, and issue a call-out to provide information for the end user not to release amphibians into the wild, or to deposit waste water outside.

Until pre-import screening measures are well implemented, a (temporary) ban in the trade of Asian urodelans, which can be unnoticed and high-risk Bsal carriers, could potentially be a safe and advisable option. A well controlled, safe and sustainable trade in salamanders and newts is needed to prevent new introductions of Bsal. If well implemented, this can be beneficial for all parties.

**LITERATURE CITED AND FURTHER READING:**

A full list of the References highlighted in this article may be obtained directly from the authors: Maarten Gilbert and Annemarieke Spitzen – RAVON (Reptile, Amphibian and Fish Conservation the Netherlands); email: m.gilbert@ravon.nl; a.spitzen@ravon.nl