

A European Early Warning System for a Deadly Salamander Pathogen

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The chytrid fungus *Batrachochytrium salamandrivorans* (*Bsal*) was described in 2013 after the rapid decline of a Fire Salamander population (*Salamandra salamandra*) in the south of the Netherlands (1, 2). This population experienced a 99.9% decline over a seven-year period with no signs of recovery. Soon after the description of *Bsal* more outbreak sites with massive population crashes were discovered in Belgium, Germany and in additional sites in the Netherlands (3, 4). In most cases Fire Salamander populations were affected but Alpine Newts (*Ichthyosaura alpestris*) and Smooth Newts (*Lissotriton vulgaris*) also suffered mortalities (4, 5). In 2017 *Bsal* was also detected in Great Crested Newts (*Triturus cristatus*) and Palmate Newts (*Lissotriton helveticus*) in Germany (5) but without obvious clinical signs. *Bsal* is deadly to nearly all European urodelans and poses a massive threat to European urodelan diversity (6).

Bsal originated in Asia and likely arrived in Europe via the trade in Asian salamanders and certain Asian anurans (6-9). From these vectors, it is believed *Bsal* spilled over to European salamanders and newts, which are naive to the pathogen, and most die soon after being infected. Recently Stegen *et al.*, (2017) found that Alpine Newts with low *Bsal* infection intensity may persist with the fungus, and even clear the infection. This means that these newts can vector the fungus, as can some anuran species. *Bsal* has also been detected in populations of captive urodelans in the Germany, the Netherlands, Spain and the United Kingdom (10-14).

Legislation has anticipated on halting the spread of the fungus via trade. The USA has banned the interstate transport and import of salamanders and newts in 2016, Switzerland has banned the import as has Hungary and the EU has recently announced animal health protection measures for intra-Union trade in salamanders

in order to prevent further introduction of *Bsal* (<http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018D0320&from=NL>).

The current knowledge of the distribution of *Bsal* outside of its native range is incomplete. It might be present in more European countries than currently known. Early detection of *Bsal* induced population declines is therefore very important. Especially urodelans with small ranges and/or small population sizes are at risk. In order to stem the tide of amphibian population declines and prevent mass extinctions, the European Commission (EC) issued the tender ENV.B.3/SER/2016/0028, Mitigating a new infectious disease in salamanders to counteract the loss of European biodiversity).

GENERAL OBJECTIVES

Bsal has devastating effects on European urodelans and measures to protect them from these are of the utmost importance. The general objectives of this project can be summarized as followed:

- Delineate the current range of *Bsal* in Europe
- Create an Early Warning System which allows the rapid detection of novel *Bsal* outbreaks
- Development of an emergency action plan (short term)
- Provide proof of concepts for sustainable long-term mitigation measures

This article focusses mostly on the first and second objective. More on the [third](#) and [fourth](#) objective can be found on www.BsalEurope.com.

EARLY WARNING SYSTEM

Website: We created an online platform BsalEurope.com (Fig. 1) in order to educate the European public on *Bsal*, with the aim to detect novel *Bsal* outbreaks throughout Europe. This website replaces the previous website (<https://bsalinfoeurope.wixsite.com/eubsalmitigation2017>). The site BsalEurope provides [general information](#) on *Bsal*, from pathogen characteristics, clinical signs and hosts, to the European distribution of *Bsal*, options for treatment and prevention. The map of the current known distribution of *Bsal* in Europe will be kept up to date. In addition, several [public awareness materials](#) were created which aid in the early detection of *Bsal* outbreaks. Reporting dead- and moribund animals is very important, therefore [regional hotlines](#) and [Bsal diagnostic centres](#) are listed on BsalEurope. Comprehensive lists of [scientific and popular scientific papers](#) can also be found on the website in addition to more helpful resources. BsalEurope will be updated on a regular basis, so be sure to bookmark it!

Public awareness materials: On BsalEurope several public awareness materials can be found that were specifically created for this project: three videos and several informative leaflets. The [first](#) of the animated videos show where *Bsal* originates from, outlines its effect on European urodelans and where you can report dead- and moribund animals. The [second animation](#) outlines best practices for captive populations: biosecurity measures, quarantining of newly acquired specimens and a call to report dead- and

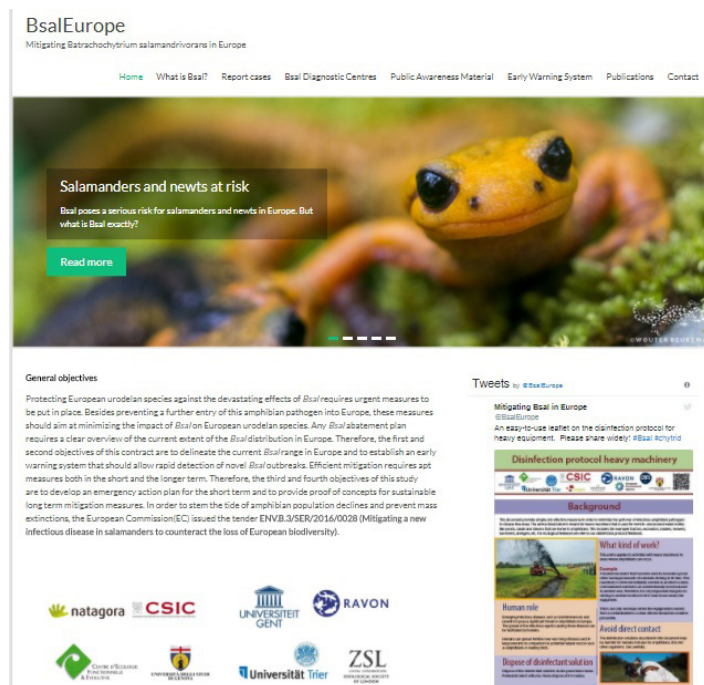


Fig. 1: Homepage of BsalEurope (www.BsalEurope.com)

moribund animals (Fig. 2). The [third video](#) stresses the importance of adherence to a field hygiene protocol in order to reduce the risk of human-mediated pathogen dispersal. Both animated clips have subtitles in 16 European languages in order to reach a large (European) audience. The clips can be found on the [YouTube Channel](#) of Reptile, Amphibian and Fish Conservation Netherlands. The other public awareness materials are three easy-to-use leaflets on [recognition of Bsal in urodelans](#) (including FAQ's for fieldwork and captive collections), disinfection protocols for [fieldwork](#) and [heavy machinery](#) (Fig. 3).

Report cases: In order to detect Bsal outbreaks and hence delineate the current range of the pathogen in Europe an Early Warning System is of the essence. If you have found a salamander or newt that is not the obvious victim of traffic or predation, then please report it to your nearest [regional hotline](#). Now, eight hotlines have been established in eight EU countries. The network of [diagnostics centres](#) in the EU currently consists of 14 laboratories in 11 countries. Ghent University centralizes all data on Bsal outbreak and monitoring.



Fig. 2: Screenshot of one of the animated videos.



Fig. 3: Example of one of the leaflets on hygiene protocols.

In addition, a European network of stakeholders that will report urodelan population declines is being developed.

When you notice suspicious deaths or sick animals, please take the following steps:

- Do not handle sick or dead amphibians with your bare hands
- Use your mobile phone or other device to take multiple photos of the animal (from all sides).
- Be sure to include photos of any obvious lesions which you notice on its body.
- Make a note of the location, date, time, number of animals which are sick or dead.
- In Europe, it is prohibited to collect wildlife (alive or dead) from the environment. Therefore, please contact the relevant hotline listed below as soon as possible for further action.

Monitoring: The detection of disease induced population declines relies heavily on long-term monitoring schemes. Several European NGO's developed programs where individual amphibian species, populations and communities are followed in long-term monitoring schemes. Long-term studies are extremely valuable to assess population trends and can act as an Early Warning System when populations are declining (especially rapid declines). Sharp declines can be a sign of the involvement of a pathogen, like *Bsal*, and follow-up research can quickly be deployed. Interested in participating in such a program? Please contact one of the regional hotlines.

Contact and follow us: An Early Warning System only works when many organisations, professionals and volunteers work together. Questions about this project can be directed to Prof. Dr. An Martel of Ghent University via email (An.Martel@ugent.be) or via the [contact form](#). The project also has it's very own Facebook- (@B.salamandrivorans) and Twitter accounts (@BsalEurope). Be sure to follow us!

Partners: This project is a collaboration of Ghent University (Belgium: Flanders), Natagora (Belgium Walloon), The Spanish National Research Council (Spain), Reptile, Amphibian and Fish Conservation Netherlands (the Netherlands), Centre d'Ecologie Fonctionnelle et Evolutive (France), Genoa University (Italy), Trier University (Germany), Zoological Society of London (United Kingdom). This tender (ENV.B.3/SER/2016/0028 (Mitigating a new infectious disease in salamanders to counteract the loss of European biodiversity) was issued by the European Commission.

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