Amphibians under threat

Frogs, toads, newts and salamanders look like hardy creatures and anyone observing a pond full of frogspawn could be forgiven for thinking their future was secure. But several emerging diseases are attacking the world's amphibians, sometimes with devastating results. Trent Garner explains how we're starting to understand the extent of the threat.

Fire salamander.

MYN / Marko Mastel / NPL

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There's no denying that the places we do fieldwork are stunning. Monte Limbara, the French Pyrenees, the Picos de Europa, the Serra de Tramuntana, the Drakensberg, all are high-elevation sites of exceptional beauty and striking biodiversity. Unfortunately, the need for these expeditions takes the edge off the views. I've yet to experience a mountain-top vista that compensates for finding hundreds of amphibian corpses in and around mountain ponds and streams. It doesn't help that in many cases these corpses are the lion's share of their generation – juvenile amphibians that should be vigorously pursuing the food they need to survive the upcoming hibernation period. Instead, many of the live ones aren't even capable of righting themselves when placed on their back.

For more than a decade, I have been part of an international team investigating the emergence of a lethal infectious disease, chytridiomycosis, in amphibians across Europe. What started in 2004 as a collaboration between the Zoological Society of London, Imperial College and the Museo Nacional de Ciencias Naturales of Madrid, has grown to a collective of researchers based at more than 20 institutions or NGOs across Europe, working with other research teams in North America, Africa, Australia and Asia. Our goal is to understand under what conditions emerging diseases threaten European amphibian biodiversity. The cause of chytridiomycosis, infection with a chytridiomycete fungus, was initially described in 1998, affecting Latin American and Australian amphibians in the wild and captivity; the previous year, amphibian mass mortality from chytridiomycosis was first seen in Europe.

Our studies have shown that *Batrachochytrium dendrobatidis*, the first chytridiomycete species known to cause the disease, is killing amphibians in at least seven EU countries, causing population decline and local extinction in some cases. Peñalara Natural Park, in the mountains near Madrid, is ground zero for European chytridiomycosis. Here, common midwife toads (*Alytes obstetricans*) have disappeared from an area where previously thousands of tadpoles could be counted at a single breeding site. Tyrrhenian painted frogs (*Discoglossus sardus*) are all but absent from places on Sardinia where infection with *B. dendrobatidis* is recorded.

But are these local conservation issues reflected across Europe? We don't yet know for certain, but our general impression is that European amphibians

Midwife toad.

Paul Hobson/NPL

Common midwife toads have disappeared from an area where previously thousands of tadpoles could be counted at a single breeding site.

are not comprehensively threatened by chytridiomycosis: we have not seen the rapid spread of infection and death that has struck Central American amphibians.

There are several reasons why this may be. First, *B. dendrobatidis* is composed of many and varied genetic lineages and only one of these, a highly virulent form, is consistently associated with amphibian mass mortality and population decline. Second, while some environmental conditions can favour the spread of the disease, others limit the likelihood, strength and severity of infection. Third, the process of infection can be limited through the food chain, as microscopic predators like rotifers feed on infectious *B. dendrobatidis* spores. Finally, some of Europe's native amphibians are naturally resistant to infection, possibly through the antimicrobial qualities of their skin or the antifungal microbes that live on them.

Based on a first look at our European survey and experimental data, we believe that only midwife toads, painted frogs and fire-bellied toads (*Alytes, Discoglossus* and *Bombina*) are highly susceptible to lethal infection with *B. dendrobatidis*. These results should be treated with caution, however, because we couldn't include all European species in our analysis and in some circumstances even species resistant to infection in the lab may fall prey to lethal chytridiomycosis in the wild. And exposure to pathogens can cause mortality even in resistant populations, because the energy invested in resisting infection is diverted away from other tasks resulting in weaker animals that don't survive; this calls into question the value of field observations for fully understanding the risks of infection. Throw in the inevitability of changing European climates, and it's clear we need to keep assessing *B. dendrobatidis* and keep working to develop mitigation strategies.

Our story doesn't end there, however. A new species – *B. salamandrivorans* – is emerging on continental Europe, this one a salamander and newt specialist that rapidly kills almost every European tailed amphibian we have tested. Right now it's affecting fire salamanders (*Salamandra salamandra*) at three locations and it's spreading, devastating populations in a matter of weeks; it may have caused the near-extinction of fire salamanders across the Netherlands. *Batrachochytrium salamandrivorans* and *B. dendrobatidis* are both found in the amphibian pet trade, which is largely unregulated and has no disease-control standards.

But an even greater threat may be emerging on the Continent. Ranaviruses have long been recognised as a danger to amphibians, reptiles and fish, and now a new strain has devastated amphibians across Iberia and at high-elevation sites in France. Newts, salamanders, toads and frogs are all susceptible at all stages of life. Even worse, there have been reports of the virus affecting terrestrial reptiles with similarly lethal effects. There is strong reason to believe we are seeing the emergence of a disease that can devastate both amphibians and reptiles.

Although both of these diseases are notifiable to the OIE, the World Organisation for Animal Health, there are no clear strategies for mitigating their impacts on biodiversity. We are currently trialling several strategies – including treating animals with antifungals, or altering amphibian skin microbiomes to enhance their antifungal capacity – with varying levels of success; some look promising for controlling chytridiomycosis, but tackling a virus that threatens terrestrial reptiles and aquatic amphibians will require an extensive, joined-up and international effort. We are working with the Global Ranavirus Consortium and other stakeholders in the hope that we can develop an effective strategy before this important part of Europe's biodiversity is diminished for ever.