

Help, I'm a frog!

An overview of the mysterious disease eradicating our beloved amphibians, and why bacteria are their knights in shining armor.
By Fiona Walter

A growing threat to our amphibian biodiversity has revealed itself in the past 2 decades¹. At the root of the large-scale die-offs of amphibian species is Chytridiomycosis, a highly infectious disease caused by the invasive fungi *Batrachochytrium dendrobatidis* (Bd)². It invades keratinous parts of amphibian skin and interferes with essential processes such as breathing or water absorption³. Fungal virulence can range from symbiosis-like living arrangements to 100% mortality, depending on the affected amphibian species and environmental conditions⁴. Here we introduce our knights in shining armor: a diverse range of bacteria living on amphibian skin with the ability to inhibit Bd growth⁵.



These two cute af frogs are endangered.

The majority of these superheroes are Proteobacteria such as *Pseudomonas*, *Serratia*, and *Janthinobacterium*⁶. Current research explores the impact environmental differences have on the bacteria; the pathogenic fungi; and the amphibian host. Altitude and thermal differences have attracted particular attention⁶⁻⁹. However, scientific technique used to manipulate these environmental conditions is limited to *in vitro* testing¹⁰ and a large difficulty lies in creating a growth media that accurately represents the nutritional environment of the symbiotic bacteria. This is particularly important as Bd gene expression is higher when in contact with amphibian skin than in standard growth media¹¹.

Bacteria's fitness regarding Bd-inhibition is lowest at temperatures of approximately 27°C^{6,7}. To establish this, Bd exposure was used to trigger expression of Bd-inhibiting genes at various temperature points^{6,7,9}. However, Bd metabolism is highest at 17-25°C^{11,12}. The relative level of Bd gene expression may have an impact on level of bacterial Bd-inhibition and therefore may be a confounding factor that has not been considered previously. An alternative to this experiment could be to expose the bacteria to dead or metabolically inactive Bd.

Bacteria found at elevations of 1500-2000m are least efficiently inhibiting Bd-growth⁶. The least amount of bacterial diversity alongside the highest amount of amphibians affected by Chytridiomycosis were also found at mid-elevations^{6,7}. Notably, within a community, the amount of bacterial species capable of Bd-inhibition impacts neither the days to death of infected amphibians⁶ nor the severity of infection⁵. These results may suggest that bacterial composition on amphibian's skin is important. Bacterial communities may share the responsibility of defending their habitat, the amphibian, from destruction. Therein, a lack of bacterial diversity at mid-elevations would contribute to decreased Bd-inhibition. Investigating proportional requirements of particular niche bacteria within the community may ascertain how supplementing bacterial communities at mid-elevations could assist in best protecting amphibians from Bd.

It is paramount to acknowledge that understanding how bacteria mitigate Bd invasion will enable us to delay or even prevent the rapid decline of our precious amphibian diversity. This may be by further exploring altitude and thermal differences, or possibly in other ways that we are yet to explore. Ecologists and Microbiologists work hard to continuously provide further insights into the mystery of the complicated relationship between (pathogenic) fungi, bacterial communities and amphibians. Whilst it is concerning to be witness to the rapid decline of amphibian diversity, we certainly have not reached the end of the road. Committed research teams continue to investigate, work, question and critique works. With the help of our multi-faceted and talented symbiotic bacteria we will continue to slowly work towards solutions that will enable us to preserve amphibian species diversity.

Note: The picture at the top was taken from [this BBC-earth article](#) with some frog facts. Give it a read.

References

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