Researchers find genes that help frogs resist fungus

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Lowland leopard frog. Image: Anna Savage

(PhysOrg.com) -- For several decades, the fungal pathogen *Batrachochytrium dendrobatidis* (Bd) has been decimating frogs, yet some populations and species have been able to resist the fatal disease, called chytridiomycosis.

Now, for the first time, researchers have identified a genetic mechanism in lowland leopard frogs that makes some frogs resistant to Bd. Although many researchers have explored environmental and pathogenic factors that contribute to chytridiomycosis, this study complements those by

specifically looking at host genetic factors that might play a role in resistance.

The researchers discovered that variation in a gene associated with a frog's ability to identify pathogens and initiate an immune response determined whether a frog resisted the disease. They also found evidence that one form of the gene that gives frogs immunity to chytridiomycosis has been positively selected in recent generations.

The findings offer hope that frogs may adapt to the disease, as long as their habitats are protected and their populations expand enough to diversify their gene pools.

"This is the first demonstration that host genetics determine susceptibility to Bd," said Anna Savage, the lead author of a paper published Sept. 26 in the Proceedings of the National Academy of Sciences, and a graduate student working in the lab of Kelly Zamudio, Cornell professor of ecology and evolutionary biology and the paper's senior author.

In this study, Savage reared lowland leopard frogs from five distinct populations in Arizona to a disease-free adulthood in the lab. She then infected them with a Bd strain that was new to all five populations. All frogs from three populations died. In the two remaining populations, seven frogs from each survived.

Lowland leopard frog killed by the fungal disease, chytridiomycosis. Image: Anna Savage

Savage then analyzed immune system major histocompatibility complex (MHC) genes, which code for a molecule that binds to foreign pathogens and initiates an immune response in the host. Specifically, Savage sequenced MHC genes that control the regions of these molecules that bind, like a lock and key, to pathogens; if the molecule and Bd bind, the frog survives.

She found 33 distinct alleles (or forms of this MHC gene), showing large variability. Almost all of the frogs that had two forms of the gene (called heterozygotes) survived, while almost all of the frogs with only one form (homozygotes) died. Since Bd has many proteins that could be recognized by different MHC molecules, having more than one form of the MHC gene may have increased the survivors' chances for binding to the pathogen. The researchers also found that one of the 33 gene variants, called allele Q, was only found among survivors.

"The study shows that allele Q is a candidate resistance allele, and more broadly, heterozygous frogs had a higher chance of survival," Savage said. She also found evidence for positive selection along the evolutionary lineage leading to allele Q, which provides hope that frogs

will evolve and adapt to Bd if habitats are maintained.

"This is one case where we have shown selection and adaptation for resistance to this particular disease. The hope is that we can detect this signal of evolved resistance to other species as well," said Zamudio.

More information: www.pnas.org/content/early/201 …/1106893108.abstract

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