

INSIDE JEB

Developing in drying ponds could leave frogs unprepared for climate change



A juvenile southern leopard frog (*Rana sphenocephala*). Photo credit: Michel Ohmer.

Dependable wet seasons are essential for the survival of many frogs, which rely on full pools in spring for their aquatic young to develop and mature. But recently, some regions have suffered unusually dry winters, threatening vital watercourses, and spring conditions are predicted to become even drier. ‘Development is a particularly sensitive period for many animals’, says Michel Ohmer, at University of Mississippi, USA, explaining that growing as a tadpole in a dwindling warm pool could affect the animal later in life. But no one knew how. As the conditions that southern leopard frog (*Rana sphenocephala*) tadpoles grow up in are predicted to change, Ohmer, Jeff Bednark and Trina Wantman (while at University of Pittsburgh, USA) headed down to Fort Polk, Louisiana, USA, to collect eggs freshly laid by the frogs to find out how the animals fared as young adults after a dry or warm start.

Recreating 18 tadpole ponds in plastic pools in Louisiana, the team covered each with cloth providing 50% shade for

shelter before introducing 40 tadpoles to their new homes and warming some to simulate future climate conditions. Then, the team recreated a drought by lowering the water rapidly in six tanks over 9 weeks until almost dry, while draining the water more slowly from six other tanks and keeping the water level unchanged in the remaining ponds. By doing so, the team created a range of conditions from future droughts to the current climate. But how did the different pond environments affect the developing youngsters?

The team measured the tadpoles’ growth and development, and it was clear that the loss of water from their tank homes caused the tadpoles to develop faster, while growing in the warmer pools drove them to develop even faster, emerging as fully formed froglets in about 10 weeks. And when the team compared the tadpoles’ size when they finally lost their tails, the youngsters in the drying tanks were always smaller than the froglets from the deeper pools. But how did the changing and warming environments impact the frogs later in life?

After transporting the froglets to Pittsburgh, Ohmer spooked the 1- to 2-month-old amphibians into jumping at different temperatures by gently prodding them, and found that the froglets that had developed in a cool, deep pond outleapt the froglets from the warmer, drier ponds, bounding 12% further at 32°C. The team also checked how well the froglets could withstand the heat, discovering that the fastest developing youngsters were unable to cope with high temperatures, regardless of the water conditions in their pools. And up to the age of 7 months, the froglets that had developed in the warmest and most rapidly drying pools were more timid and less keen to explore than the other frogs, while preferring to hang out in warmer conditions.

‘The environment tadpoles develop in can impact frogs both in the short- and long-term, leading to changes not only in how they can handle the heat, but also the temperatures they choose in their habitat’, says Ohmer. So, growing up in drying ponds could be detrimental for adult frogs as the climate continues warming. And Ohmer warns that the impacts of climate change ‘may be amplified beyond what has been predicted’, as more timid frogs that develop in dwindling pools may avoid picking up microbes that offer protection from other pathogens. However, she points out that the frogs’ preference for warmer conditions may also make them less vulnerable to fungal infections that thrive in the cold.

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Ohmer, M. E. B., Hammond, T. T., Switzer, S., Wantman, T., Bednark, J. G., Paciotta, E., Coscia, J. and Richards-Zawacki, C. L. (2023). Developmental environment has lasting effects on amphibian post-metamorphic behavior and thermal physiology. *J. Exp. Biol.* **226**, jeb244883 doi:10.1242/jeb.244883

Kathryn Knight
kathryn.knight@biologists.com