The pool frog adapts its growth to Sweden's cold temperatures

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Credit: German Orizaola

Pool frog (Pelophylax lessonae) tadpoles have the amazing ability to grow at different rates depending on changes in temperature. A new study has revealed that this species, which requires relatively warm environments for breeding, speeds up its capacity for growth in Sweden during the warmest time of the year in order to take full advantage of

short periods of high temperatures. This trait may be the key to this frog's survival in cold climates.

Two scientists from Uppsala University (Sweden) have studied the impact of temperature on the growth and development of the pool frog (Pelophylax lessonae), a species that needs relatively warm environments for reproduction and so that its larvae, or tadpoles, can properly develop.

The study published in the journal *Evolutionary Applications* explains how tadpoles from all of the regions studied in Sweden, Latvia and Poland grow at the same rate under low-temperature conditions. However, under improved conditions -i.e. higher temperatures- the tadpoles from frogs that inhabit Sweden are able to grow more quickly than those found in Central Europe (Poland and Latvia).

"Since Sweden has briefer periods of high temperatures than Poland and Latvia do, this increased growth capacity under warm conditions allows this frog to take full advantage of the short periods of high temperatures. As a result, it is able to complete its life cycle -which relies heavily on warm temperatures- at high latitudes such as in Scandinavia," Germán Orizaola, a Spanish scientist, co-author of the study and a researcher for the Department of Ecology and Genetics at Uppsala University, told SINC.

In Sweden, this species does not begin breeding until pond water temperatures reach about 16 ºC - hardly ever before mid to late May. In contrast, other species of frogs such as Rana temporaria and Rana arvalis begin reproduction much earlier (up to two months earlier), as soon as ponds start to melt.

"Considering that pond temperatures drop once autumn arrives to levels that prevent further tadpole development, the period of time that these frog larvae have for development at northern latitudes is very limited,"

asserts the researcher.

In order to conduct the study, researchers visited the area inhabited by pool frog populations around the Baltic Sea in May 2006 -the breeding period for this species- and began collecting samples in Poland. In each region, samples of frog spawn were collected from ten different females so that the population's genetic variability would be well-represented.

"Once all of the samples of frog spawn had been collected, we then returned to our laboratory at Uppsala University where the experiments were conducted. The samples of frog spawn taken from the three Swedish regions were collected in early June - the time when the species in this region begins reproduction," points out Orizaola.

Once the frog spawn samples had been taken to the laboratory, researchers carried out the experiment in two temperature-controlled rooms: one set to 19 ºC (a low temperature for this species) and the other set to 26 ºC (a high temperature). In both of these rooms the researchers then bred tadpoles from the different samples of frog spawn collected in each region.

The degree of plasticity corresponding to each characteristic studied was determined for each frog spawn sample by comparing these characteristics among siblings that were bred at the two different temperatures. A greater difference in growth and development values among tadpoles bred at different temperatures indicates greater plasticity.

Plasticity is their safeguard

The two aspects that play crucial roles in the development of amphibian larvae are duration of the larval stage and size of the juvenile frogs when metamorphosis occurs. Ideally, the most advantageous scenario is to

complete metamorphosis as quickly as possible and weighing as much as possible.

The expert adds that "the fact that tadpoles bred in Sweden can maximise their growth during the brief periods of high temperatures that characterise these latitudes is indicative of the Swedish pool frog's increased plasticity".

This ability that organisms have to develop different critical strategies (different phenotypes) in response to different environmental conditions -without needing to alter their genetic makeup- is what allows these frog larvae to survive.

This may be one of the key traits that accounts for the survival of these populations in climates that are initially unfavourable, as a species so heavily dependent on heat can hardly maintain populations at such northern latitudes such as central Sweden.

"The increased plasticity of the tadpoles from Swedish regions is demonstrated by the fact that, whereas there are no differences in growth rates at low temperatures among the three geographical areas, the Swedish larvae have the ability to grow at a much faster rate than those from Polish or Latvian regions when exposed to high temperatures," concludes the researcher.

More information: Germán Orizaola et al. Developmental plasticity increases at the northern range margin in a warm-dependent amphibian, *Evolutionary Applications* (2016). DOI: 10.1111/eva.12349

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