Team says non-genetic changes can help parents or offspring, not both

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Dr. Matthew Walsh is an assistant professor at The University of Texas at Arlington. He is seen here with an image of the *Daphnia ambigua*. Credit: UT Arlington

A new study from The University of Texas at Arlington biologists examining non-genetic changes in water flea development suggests something human parents have known for years - ensuring a future generations' success often means sacrifice.

Matthew Walsh, an assistant professor of biology, and his team looked at a phenomenon called "phenotypic plasticity" in the *Daphnia abigua*, or water flea. Phenotypic plasticity is when an organism changes its trait expressions or physical characteristics, or those of its offspring, because of external factors. In *Daphnia*, that can mean a generation speeding up its own physical maturation in response to a predator threat or speeding the maturation of its offspring.

Current theory says similar conditions will favor phenotype changes within and across generations of organisms. Walsh's experiment, which involved about 25 lineages of *Daphnia*, contradicts that thought.

"The surprising aspect of our research is, they couldn't do both," said Walsh, who is lead author on a paper published today in *Proceedings of the Royal Society B*. "They could either do something that strengthens their own fitness and their own survival or they could do something to strengthen the fitness and survival of future generations. What we're trying to find now is what makes these responses happen."

The title of the new paper is "Predator-induced phenotypic plasticity within- and across-generations: A challenge for theory?"

Co-authors on the new paper are: UT Arlington undergraduates Frank Cooley IV and Kelsey Biles; and Stephan Munch, a fisheries ecologist with the National Marine Fisheries Service in Santa Cruz, Calif.

With factors such as climate change, habitat loss and the growth of invasive species threatening biodiversity globally, scientists like Walsh are trying to understand the abilities of organisms to alter the expression of traits across multiple generations.

"Plasticity is widespread across the tree of life," Walsh said. "These non-genetic responses to environmental signals may represent a key

mechanism that allows organisms to persist in the face of ongoing climate change."

To examine patterns of plasticity within and across generations, Walsh's team exposed clones of *Daphnia* collected from six lakes in Connecticut to a variety of threatening factors at different intervals. They used water that contained kairomones, a chemical signal produced by fish that would eat the *Daphnia*, and *Daphnia* alarm cues, chemicals that other *Daphnia* emit to signal trouble.

Walsh and his co-authors found that these threats could lead to changes in development rates of the *Daphnia* that could last for two generations. Their results also consistently showed that a negative relationship existed between within generation alterations of development and trans-generational changes. In other words, the more changes within a generation almost always correlated with less change from the norm in the next generation.

Laura Gough, interim chair of the UT Arlington Department of Biology and a professor who has studied effects of climate change on plant communities, said Walsh's work has far-reaching implications.

"Dr. Walsh's research suggests that environmental cues experienced by one generation can affect growth and maturation of future generations in ways that are not explained by current theory," she said. "This elegant study highlights the need for the use of similar experiments to test important biological theories with direct implications for how organisms are affected by changes in their environment."

More information: The study is available at http://rspb.royalsocietypublishing.org/content/282/1798/20142205.