When less is more: Smaller offspring thrive in competitive environments

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The parenting debate has raged for ages in the halls of academia and in homes around the world. For the best chance of survival and fitness, should mothers coddle their offspring, giving them every advantage, or let them learn to fend for themselves?

In a recent study published in the journal *Ecology*, researchers used an innovative technique to experimentally manipulate the amount of investment provided to offspring by salamander mothers. In many organisms that lay eggs and then swim or walk away to let their offspring figure out life on their own, yolk is one of the only forms of maternal investment. To understand the way maternal investment interacts with different environments, the researchers surgically reduced embryonic yolk reserves and then followed the resulting offspring through adulthood in favorable and unfavorable conditions.

Embryos with less yolk hatched out at smaller sizes as expected, but the effects didn't end there.

"We thought that removing yolk would be bad news for the salamander larvae going into competitive environments. And we expected favorable environments would allow yolk-reduced animals to catch up," says Professor Howard Whiteman, in whose Murray State University lab this study was conducted.

However, the opposite occurred. In favorable conditions, the larvae with less yolk didn't catch up to the controls, and in the unfavorable

conditions, there was no size difference between controls and yolk-reduced animals.

"Here's where it gets crazy," says Tobias Landberg, a post-doctoral researcher and co-author on the study who is now an assistant professor of biology at Arcadia University.

"The effects of removing about 20% of yolk reserves didn't only affect hatchling size and adult body size. Amazingly, it affected the way the females, when they became mothers, invested in their own offspring!"

Females that received less yolk as embryos actually increased the number of eggs they produced when they reached maturity. This increased their fitness in unfavorable conditions compared to the control group.

"Females in many organisms are able to provide less yolk to offspring when conditions are bad. Our study shows that mothers may prepare their offspring for the environment that they themselves faced through variation in the amount of yolk that they provide," says Michael Moore, the lead author on the study and now a Ph.D. student at Case Western Reserve University. "When the offspring face those same unfavorable conditions as their mothers, their maternally-influenced traits facilitate substantially better performance."

"But when the mother's environment and the offspring environment don't match, the offspring potentially pay a big cost," Moore notes.

While the direct long-term influence that mothers can have on their offspring has been known, these findings have the potential to change the way scientists think about the energy and information that mothers provide their offspring.

"Not only are mothers providing resources to their offspring, but information about whether that environment is favorable or not. And it looks like they are matching the resources with the right information," says Professor Whiteman.

All three authors stressed that these so-called "trans-generational effects" can play a big role in many aspects of biology. How traits affect performance throughout every life stage is an important question with broad implications for developmental biology, ecology, and evolutionary biology.

"In order to understand the ultimate consequences of these maternal influences on offspring performance, the next step is really to study their integrative effects on traits across the offspring's whole life cycle and into future generations," Moore says.

Maybe those offspring who have to fend for themselves are being well-prepared for a tough, competitive life. And maybe... mom does know best.

More information: Michael P. Moore, Tobias Landberg, Howard H. Whiteman 2015. Maternal investment mediates offspring life history variation with context-dependent fitness consequences. *Ecology* 96:2499–2509. dx.doi.org/10.1890/14-1602.1

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