Crayfish get more interesting at bigger parties, study suggests

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University of Illinois researchers separate diet and behavioral specialization in invasive rusty crayfish using stable isotopes and laboratory behavioral assays. Credit: University of Illinois

In many North American lakes, a tiny clawed creature has become a big bully. The invasive rusty crayfish roams lakebeds, snapping up snails, bivalves, and water plants, cutting off food supplies for native crayfish and other animals. And when they're feeling saucy, some mount daring raids on fish eggs, reducing sport-fish populations.

It's those extra bold individuals that intrigue Eric Larson, associate professor in the Department of Natural Resources and Environmental Sciences at the University of Illinois. He and his students visit the lakes of northern Wisconsin every summer to keep track of the crabby critters. And now, in a new study, they've figured out why some lakes have bolder, more aggressive crayfish.

"Crayfish seem more behaviorally specialized in lakes where they're highly abundant, becoming more aggressive, bold, or active," Larson says. "Even if only a few of them become specialized in this way and nest-raid on recreationally important fish, those few individuals could lead to sunfish or other fish being excluded in these lakes. That's why we're looking at behavioral specialization on the level of individuals."

The study of individuals is a relatively recent phenomenon in ecology. In the past, oddball animal behaviors or personalities were usually treated as outliers or noise to be statistically smoothed in ecological datasets. Now, ecologists recognize these more specialized individuals could be disproportionately responsible for large-scale ecosystem changes and could even signal the beginnings of new species. In any case, they're worth a closer look.

Larson worked with co-author and former student Amaryllis Adey, now a doctoral student at the University of Notre Dame, to document diet and behavioral specialization at the individual level for rusty crayfish in six northern Wisconsin lakes. Importantly, they wanted to know if population size made a difference in terms of specialization.

It did.

Larson and Adey used stable carbon and nitrogen isotopes to look back at what crayfish ate over the previous several months. They found a peak in diet specialization in lakes where crayfish abundance was neither high nor low.

When crayfish are super abundant, they've long since eaten all the best food sources—snails and other easy-to-catch animal prey—and nearly every individual has to make do with the lower-quality food that's left over. In lakes where crayfish are scarce, those tasty snails are still readily available, so most individuals focus their efforts on capturing them. But in mid-abundance lakes, individual crayfish really show their flair. Some concentrate on leafy matter, while others are all about the snails.

"It's like at Thanksgiving, with more people wanting mashed potatoes than green bean casserole. When you have a small group, everyone can get some mashed potatoes. However, when the group gets larger, some people might be stuck with green beans and no potatoes," Adey says. "Similarly, when there are a lot of crayfish, they might have to switch to eating foods they don't like as much if other crayfish eat all the 'mashed potatoes' first."

As for behavior, a different pattern emerged. As crayfish became more crowded in high-abundance lakes, individual behaviors became more and more specialized.

"The crayfish do seem more behaviorally diverse—and more aggressive—in those high-abundance lakes. And that might spill over to impacts on spawning fish. It's as if they're thinking, 'Hey, there's no snails left, I'm going to raid a sunfish nest to feed on eggs or I'm going to destroy aquatic plants.' That's where those links between individual behavior and ecological impact probably come into play," Larson says.

The researchers didn't reach these conclusions by studying crayfish in the lakes. The animals are nocturnal and too small to be easily fitted with radio trackers. Instead, Larson and Adey collected them from lakes varying in crayfish abundance and brought them back to the lab.

Each individual crayfish was plunked into a tank and given a cozy PVC tube shelter. After the crayfish settled in for a day, Adey and Larson observed how active they were—essentially, how much time they spent exploring the tank vs. resting in the shelter. They also tested their boldness by looking at how quickly they grabbed various food items, with and without another crayfish behind a clear divider in the same tank. To test aggression, they "rushed" the crayfish with a wooden rod, mimicking an attacker.

"We set a 20-minute limit for the crayfish to explore a new space or to take a food item or not. Some of this was fairly interesting. We'd remove a divider and the crayfish would sprint across the arena and take a snail. But we had other crayfish, especially from our low-abundance habitats, where they didn't feel a lot of urgency from intraspecific competition. We'd remove a divider and the crayfish would just kind of hang out for 20 minutes. That is not a very exciting work day," Larson says.

But Larson and Adey are excited to document individual specialization in diet and behavior at the same time, within the same populations. No one had done that before. The finding, along with the research team's novel techniques, could help other ecologists better appreciate distinct animal personalities and the impacts of those individual differences on their environments.

The article, "Testing the relationship between intraspecific competition and individual specialization across both behavior and diet," is published in *Ecology and Evolution*.

More information: Amaryllis K. Adey et al, Testing the relationship between intraspecific competition and individual specialization across both behavior and diet, *Ecology and Evolution* (2021). DOI: 10.1002/ece3.7916