KNOWLEDGE

A previously unknown mechanism for rapid acclimation?

Santiago Salinas and Stephan Munch study local minnows to find the answer

A frog can't decide to skip the tadpole stage and then band with its fellow frogs to hunt horses. A hawk isn't going to grow gills and nest underwater. Animals, including humans, are what we are because of our genes — the blueprint that tells our cells whether to become skin, hair, horns, bones or a heart.

Animals — and plants — can change over time when a genetic variation offers an advantage. That advantage can mean better food, better shelter, a safer life and a lot more offspring.

Generally, those changes happen over the course of hundreds or even thousands of years and are considered part of evolution. On an individual level, though, the genes animals get are like a hand in poker. Even if, say, a chasm formed that separated a rhinoceros from its favorite food, it couldn't will itself to jump further than its muscular, stubby legs allowed.

Most of the time, animals rely on their DNA inheritance to provide the tools to survive through sudden changes in their environment, whether it's suddenly wetter, colder, darker or hotter. They can't generally adapt their genetic machinery to fit the environment.

But, that may not always be the case. Using a fish common to Long Island called the sheepshead minnow, researchers at Stony Brook University showed that the fish can somehow tailor its offspring's growth rate to the temperature they experienced before they reproduced.

'Quite honestly, we weren't expecting this to work out.'
— SANTIAGO SALINAS

SBU doctorate student Santiago Salinas and adjunct associate professor Stephan Munch, who is now a fisheries ecologist at the National Oceanic and Atmospheric Association, put groups of these hearty fish in water at 24-, 29- and 34 degrees Celsius.

While keeping everything else the same — the amount of food they were fed, the salinity of the water, etc. — they maintained these fish at each temperature for a month. Lo and behold, the results were clear: The young from the "hot" parents grew much faster and bigger in the hotter water, while the young from the "cold" parents grew faster than the "hot" young in the colder water.

"Quite honestly," Salinas said, "we weren't expecting this to work out."

So, what's going on? Are the parents tinkering with their genes before they reproduce? No, said Salinas and Munch. More likely, they are going through something called transgenerational plasticity, which is a form of epigenetics. In epigenetics, animals change the way their genes are expressed without changing their genes.

Specifically, the sheepshead minnows are sending a cue through their eggs about the likely temperatures they'll face.

"For climate change," offered Salinas, "it's a positive little piece of news in an otherwise pretty terrible news landscape when it comes to climate change."

A native of Argentina, Salinas himself knows something about adapting to temperature changes. He attended college in Maine, where he saw snow for the first time.

"The first big snowstorm was scary and also quite magnificent," he recalled.

A native of Madison, Wis., Salinas' wife Jessica

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Rapid acclimation

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Glynn, a human-rights lawyer, is much more familiar with colder climates.

Salinas, who plans to follow Munch out to California for his postdoctoral work after he completes his doctorate this summer, said he adapted well to the colder climate.

As for the sheepshead minnows, Munch and Salinas said they can only speculate about how the fish pass along the information about temperature through their eggs.

"There are changes in gene expression that are not because of changes in DNA," Munch said. "We don't have any of the mechanism worked out. We are looking for a partner."

At the very least, the minnows may have shown that the discussion about environmental changes needs to consider another option.

A lot of work in the last decade or so on climate change assumes that "the main response to climate change is to move to a place where the environment is still good for them. A second wave acknowledges that evolution might occur, but will it be fast enough to keep up with environmental change? Many conclusions are along the lines of 'probably not,'" said Munch.

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— Santiago Salinas

What the sheepshead minnow suggest, however, is that "potentially, there is a mechanism for rapid acclimation to climate change that we hadn't been thinking about before."