New study could reset how scientists view sex determination in painted turtle populations

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A painted turtle lays eggs. Credit: Fredric Janzen

A new study from Iowa State University scientists could flip the

established framework for how scientists believe geography influences sex determination in painted turtles on its shell.

The study, published Tuesday in the academic journal *Functional Ecology*, analyzed decades of data concerning painted turtles, a species widely distributed across North America that undergoes temperature -dependent sex determination. That means the temperatures experienced by an incubating painted turtle egg influence whether an embryo develops the physical characteristics biologists describe as male or female. Warmer temperatures tend to produce females, and cooler temperatures tend to produce males.

The study's findings defied theoretical expectations for how painted turtle populations respond to environmental variation, which could lead scientists to rethink how they look at the topic, said Anna Carter, a postdoctoral research associate in ecology, evolution and organismal biology and lead author.

Painted turtles cover a vast geographical range, from New Mexico to Canada. That means populations experience wide variation in temperatures and environmental conditions. For years, scientists emphasized "pivotal temperature," or the temperature that produces an equal number of males and females in a given population, when studying how the turtles respond to environmental variation. This framework would expect populations that live in warmer regions to have a higher pivotal temperature as well.

Previous studies found patterns related to latitude, Carter said. The closer a population was to the equator, the higher its pivotal temperature. But using a massive dataset on painted turtle populations allowed the scientists to take an unprecedented look at the relationship between latitude and pivotal temperature, and the new analysis didn't find a convincing pattern.

Instead, the researchers found wide variation in pivotal temperature within local populations, as much as 5 degrees Celsius. The finding suggests temperature sensitivity of embryonic development can vary significantly from one turtle nest to another within a single population.

"The implication of our study is that our understanding of local adaptation in this species isn't as good as we thought it was," Carter said. "It might be useful to move away from pivotal temperature as a model."

The study, however, did find patterns connecting geography to the transitional range, or the range of temperatures that produce a mix of males and females. Transitional ranges tended to be wider at lower latitudes, Carter said.

The unexpectedly wide variation in pivotal temperature within populations could suggest painted turtles are more resilient to changes in temperature than previously thought. It's possible female painted turtles can nest successfully in a multitude of environments, they said.

The study drew on a huge dataset collected over the span of decades by Fred Janzen, a professor of ecology, evolution and organismal biology, and his colleagues. Janzen said his lab has collected data on painted turtle populations on the Mississippi River near Clinton for 32 years. The data includes nesting and temperature measurements.

"I've been truly fortunate to meet folks willing to put in the time and effort to do this work," Janzen said. "It's a big ask. We're talking about year after year of each group putting together their own field crew to follow a turtle population."

For the study, the researchers modeled temperature dependent sex determination in 12 geographically distinct painted turtle populations using both field data and lab incubation experiments.

More information: Anna L. Carter et al. Breadth of the thermal response captures individual and geographic variation in temperature-dependent sex determination, *Functional Ecology* (2019). DOI: 10.1111/1365-2435.13410