Surface-going cave crickets actually more isolated than cave-dwelling cousins

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A pair of *Ceuthophilus* crickets. Credit: Photo by Jean Krejca.

People sometimes rely on the stereotype of a kid living in their parents' basement to illustrate poor socialization and isolation.

But the basement-dwellers may be connected with others in ways that those who are "out in the world" might not. And that seems to be the case for a group of cave crickets.

Recently published research by a team of scientists found that a sub-genus (a group of species) of crickets, *Ceuthophilus*, which is known to venture out of caves, show a higher degree of genetic isolation than its cousins, *Geotettix*, who live strictly inside the caves.

"The main issue is that *Ceuthophilus* leaves the cave to forage at night, whereas *Geotettix* doesn't. That led us to hypothesize that perhaps *Ceuthophilus* was better at dispersing and might not show as much genetic structure," said Jason Weckstein, PhD, associate professor in the Department of Biodiversity, Earth and Environmental Science at Drexel University's College of Arts and Science. "In fact, what we found was the *Ceuthophilus* showed deeper—older—structure than *Geotettix*."

Weckstein is the lead author on the recent publication of the study's findings in the *Journal of Biogeography* called "Comparative phylogeography of two codistributed subgenera of cave crickets." Other authors included Steve Taylor, PhD, Kevin Johnson, PhD, John Murdoch, PhD, Daniela Takiya, PhD, Jean Krejca, PhD, James Reddell and George Veni, PhD.

The crickets in the study live in a variety of caves in central Texas, from which the team collected specimens and then analyzed their DNA.

Ceuthophilus are known to be trogloxenes, meaning that they live parts of their lives in caves. Species in the *Ceuthophilus* sub-genus lay their eggs and spend the day in caves but come out to forage at night.

Geottetix, meanwhile, are troglobites, which means that they spend all of their lives deep in caves. The team wrote that *Geotettix* have almost never

been recorded on the surface outside a cave entrance.

Going into the study, the scientists believed that since the *Ceuthophilus* sometimes go to the surface that they would have more opportunity to disperse between caves. That mobility, it was believed, would make populations of *Ceuthophilus* more connected and result in less genetic variation than the subgenus *Geotettix*. This is because dispersal has the potential to allow individuals from different populations to breed with one another, which would homogenize genetic variation among these populations.

On the other hand, a lack of dispersal allows individual populations to evolve genetic differences in isolation. Previous studies of other cave-dwelling organisms pointed toward the belief that Ceuthophulus would be less genetically distinct, but the study's data conflicted with that hypothesis.

"The fact that we see deep genetic structure in the *Ceuthophilus* suggest that individuals from different cave populations are not dispersing long distances to breed with individuals in other populations," Weckstein said. "There are more groups of genetically distinct populations in *Ceuthophilus* than we would have expected."

Although the *Ceuthophilus* may be able to move around outside of a cave environment, populations seem to be isolated enough that they are not genetically homogenized and still retain distinct, population-specific genetic characteristics.

The isolation of *Ceuthophilus* could be attributed to surface structures, such as rivers or other natural barriers. Meanwhile, the fact that *Geotettix* exhibits evidence of lesser genetic isolation (and more homogeneity) could point to the potential of greater mobility in the caves beneath the surface through interconnected caverns.

In the course of the study, the team discovered a plethora of genetically distinct cricket lineages that likely correspond to undescribed species. They agreed that taxonomic work, describing new species, is critically needed for understanding and conserving this group of organisms.

"Considering these results and that most of the species in this genus were described more than 75 years ago, the taxonomy for this group is desperately out of date," said Krejca. "If the best management practices for endangered cave invertebrates are to include protection of cave cricket foraging ranges, further work is needed to describe which species occur in different areas and what the differences are in their foraging behavior, migration and habitat use."

Ultimately, more research will be needed to fully understand why *Ceuthophilus* became so genetically distinct. But what findings the study did turn up have implications for both understanding biodiversity and the endemism of both crickets and other organisms in these caves.

"Given that we found this distinct pattern of structure between caves, other cave-dwellers that haven't been studied also likely show these patterns," Weckstein said. "So this is a good proxy for studying them."

Additionally, discovering that the crickets may not be moving distances outside of the cave has implications for conservation.

"Cave crickets that go outside the cave and then return to the caves during the day are sources of nutrients for these cave communities," Weckstein explained. "If these *Ceuthophilus* cave crickets are, in fact, multiple endemic lineages then, from a conservation perspective, that has implications for the conservation of other living things in the caves. We need to treat many of these lineages as unique conservation units rather than a widespread species."

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