With discovery of roundworms, Great Salt Lake's imperiled ecosystem gets more interesting

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Exposed microbialites in the Great Salt Lake off the north end of Antelope Island. Utah biologists discovered nematodes living in these reef-life structures that cover about a fifth of the lakebed. Credit: Brian Maffly, University of Utah

Scientists have long suspected that nematodes—commonly known as roundworms—inhabit Utah's Great Salt Lake sediments, but until recently, no one had actually recovered any there.

It took a University of Utah postdoc with a hammer and loads of field experience to solve the puzzle. Along with biology professor Michael Werner, postdoctoral researcher Julie Jung announced in a study published in *Proceedings of the Royal Society B: Biological Sciences* that they had discovered thousands of tiny worms in the lake's microbialites, those reef-like structures that cover about a fifth of the lakebed.

Their initial attempts failed to find nematodes in lakebed sediments, prompting Jung to take a hammer to samples of microbialites where she struck biological pay dirt. Breaking up the carbonate structures yielded nematode specimens representing several species, resulting in a significant discovery.

Previously, only two multicellular animals have been known to inhabit the lake's highly saline waters—brine shrimp and brine flies. Now there is a third, opening several new lines of inquiry into Great Salt Lake's largely hidden web of life.

With more than 250,000 known species, nematodes comprise the world's most abundant animal phylum in both aquatic and terrestrial biospheres. They live deep in the oceans, deep underground, and in frigid, arid conditions. The nematode species Caenorhabditis elegans is used in science as a model organism whose genome has been thoroughly mapped.

The new Great Salt Lake findings represent the most saline environment where nematodes have ever been recovered, according to Werner, an assistant professor in the university's School of Biological Sciences.

"Just what is the limit of animal life? What environments can animals actually survive? That captures some imagination about looking at other planets where we might find complex multicellular life," said Werner, the senior author of the study. "If there was life also on Mars, it might have looked a little bit like the [lake's ultrasalty] North Arm right now."

But there's even more to the story. In a "crazy" side experiment, Werner's team fed bacteria from the lake to C. elegans to see what would happen if they exposed these worms to the lake's water, which is 50 times more saline than this species' usual habitat.

After 24 hours, these worms were still alive, while those nourished on the model species' usual diet were dead within five minutes.

"We didn't expect it to work, but it did," Werner explained. This suggests that bacteria can help nematodes adapt to highly saline conditions, but more research is needed to identify the mechanisms at play.

The new study builds on the prior research of Bonnie Baxter, a Westminster University biology professor who has studied Great Salt Lake halophilic microorganisms, and Brigham Young University biologist Byron Adams, a leading expert in nematodes, with whom Werner consulted when he set up his search.

"Even today we're discovering these amazing things about this lake that's been sitting on our doorstep for 170 years," Adams marveled. "It's an amazing system that Michael has worked to better understand."

Adams has discovered nematodes in some of the most extreme environments on Earth, such as Antarctica, yet was surprised Werner's team found them in the Great Salt Lake.

Researchers collect sediment samples on Great Salt Lake in search of nematodes. Credit: Michael Werner, University of Utah

"I'd looked there myself for them, but I didn't look in the same places where Michael went," Adams said. "I had initially started to work up in the North Arm, where conditions are obviously a lot more extreme, and I didn't find things there. I just didn't put in the time. I didn't put in the effort to sample more rigorously or more thoroughly."

Nematodes are Earth's most abundant animal. Werner said that 80% of all animal life on the terrestrial soil and 90% on the ocean floor are nematodes. Because these worms inhabit completely different environments across the globe, many have suspected they also inhabit the Great Salt Lake.

But as Adams learned, finding them proved the tricky part.

Werner and his colleagues began their worm-hunting surveys in the spring of 2021 when they sampled three sites in the South Arm where salt concentrations are 10 to 20%, or three to six times saltier than the ocean.

These sites were at the southern end of Fremont Island, the northern end of Antelope Island and a point midway between. Led by Jung, the team initially used kayaks to access these sites in the spring of 2021, but water levels dropped so much in a year that they had to return by mountain bike and foot to gather the samples during the summer and fall.

"At first it was just scooping up segment samples. But then once we noticed microbialites, we shoveled little chunks of them, tried to preserve the layers, and brought them back to the lab," said Jung, whom the College of Science has named one of its outstanding postdocs.

Initially, the team could not detect any worms using standard techniques, but after the researchers adopted a method called sucrose-density centrifugation they consistently recovered live nematodes from every site.

Werner's team believes the nematodes feed on the bacteria that form mats on the microbialites. The mats may also protect from the sun's ultraviolet light.

Nearly all the nematodes recovered in the South Arm came from a single family, Monhysteridae, an ancient branch of the nematode phylum known for its association with deep-sea hydrothermal vents and ability to adapt to extreme environments. Characterizing and naming the potentially new species of nematodes will be the task of additional studies.

Among the study's key discoveries was a powerful association between nematode abundance and microbialites, further demonstrating the ecological importance of these structures, each about a meter across and formed by microbes.

Understanding the formation and biota of these structures could provide important clues to the origin and ecology of early life on our planet. However, much of the lake's microbialite networks are no longer submerged, leaving them dry and exposed, thanks to the lake's low water levels.

As a result, exposed microbialite habitat and record-high salinity levels threaten both benthic zone inhabitants, such as brine flies and algae, and the upper trophic levels (i.e. waterfowl) that depend on them. Thus, there is a pressing need to understand this lynchpin community and the limits of their habitability.

Other authors include University of Utah graduate student Shelley Reich, and Tobias Loschko of the Max Planck Institute for Biology.

More information: Julie Jung et al, Newly identified nematodes from the Great Salt Lake are associated with microbialites and specially adapted to hypersaline conditions, *Proceedings of the Royal Society B: Biological Sciences* (2024). DOI: 10.1098/rspb.2023.2653

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