Eyeless Australian fish have closest relatives in Madagascar

August 29 2012

This composite image shows *Typhleotris pauliani* (top), a previously known species of Malagasy cave fish, and the newly discovered pigmented species (bottom). Credit: AMNH/J. Sparks

A team of researchers from Louisiana State University and the American Museum of Natural History has discovered that two groups of blind cave fishes on opposite sides of the Indian Ocean are each other's closest relatives. Through comprehensive DNA analysis, the researchers determined that these eyeless fishes, one group from Madagascar and the other from similar subterranean habitats in Australia, descended from a common ancestor before being separated by continental drift nearly 100 million years ago. Their study, which appears in the journal *PLOS ONE* this week, also identifies new species that add to existing biological evidence for the existence of Gondwana, a prehistoric supercontinent that was part of Pangaea and contained all of today's southern continents.

"This is the first time that a taxonomically robust study has shown that blind cave vertebrates on either side of an ocean are each other's closest relatives," said Prosanta Chakrabarty, an assistant professor and curator of fishes at Louisiana State University's Museum of Natural Science. "This is a great example of biology informing geology. Often, that's how things work. These animals have no eyes and live in isolated freshwater caves, so it is highly unlikely they could have crossed oceans to inhabit new environments."

The cave fishes, of the genus *Typhleotris* in Madagascar and Milyeringa in Australia, are small—less than 100 millimeters long—and usually lack pigment, a substance that gives an organism its color and also provides protection from the sun's ultraviolet radiation. These characteristics, coupled with a lack of eyes and enhanced sensory capabilities, allow cave fishes to survive in complete darkness. For this reason, the fishes have very restricted distributions within isolated limestone caves. It's also why the newfound genetic relationship between the trans-oceanic groups is an exciting geological find.

"The sister-group relationship between cavefishes from Madagascar and Australia is a remarkable example of Gondwanan vicariance—a geographical split dating back to the Late Cretaceous some 100 million years ago," said John Sparks, a curator in the Division of Vertebrate Zoology at the American Museum of Natural History. "The interesting thing about Madagascar's extant freshwater fish groups, with the exception of a single species, is that all exhibit relationship patterns that are in time with the Mesozoic breakup of Gondwana—some are related to groups in India/Sri Lanka, and others to groups in Australia. Only a single freshwater species has its closest relative in nearby Africa."

One of the new species discovered by the researchers, which will be named in a future publication, is a novelty among cave fishes because it is fully and darkly pigmented. The analysis the researchers conducted for

this fish's tree of life shows that it evolved from a pigment-free ancestor, indicating that some subterranean forms can "reverse" themselves for this character.

"It is generally thought that cave organisms are unable to evolve to live in other environments," Sparks said. "Our results, and the fact that we have recently discovered new cave fish species in both Madagascar and Australia belonging to these genera, are intriguing from another perspective: they show that caves are not so-called 'evolutionary dead ends.'"

Funding for the research expedition was provided by the Constantine S. Niarchos Expedition Fund, established by the Stavros Niarchos Foundation to support the research of museum curators around the globe. This particular expedition turned into more of an adventure than the group was planning—in fact, one of the new species has been given a moniker that means "big sickness" in Malagasy because of the dangers the team incurred while searching for specimens in this dry, inhospitable region of Madagascar.

"Only two specimens of the new pigmented form were recovered from the first cave we searched in Madagascar, despite the fact that we spent hours in this sinkhole," said Chakrabarty. "Even the locals hadn't been inside of it before."

Because remote locales with caving opportunities exist all over the world, the researchers are eager to pursue other opportunities for discovery.

"Conducting this research really developed my love for caving," said Chakrabarty. "You don't always find something exciting. But, when you consider how isolated many of these caves are, especially in places like Madagascar, and how unaffected they have been by the passage of time,

you know that the fish in there are going to tell a really good story."

More information: dx.plos.org/10.1371/journal.pone.0044083

Provided by American Museum of Natural History