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SCIENCE

Researchers Find Fish That Walks the Way Land Vertebrates Do

Carl Zimmer

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It's one of the most famous chapters in evolution, so familiar that it regularly inspires New Yorker cartoons: Some 375 million years ago, our ancestors emerged from the sea, evolving from swimming fish to vertebrates that walked on land.

Scientists still puzzle over exactly how the transition from sea to land took place. For the most part, they've had to rely on information gleaned from fossils of some of the intermediate species.

But now a team of researchers has found a remarkable parallel to one of evolution's signature events. In a cave in Thailand, they've discovered that a blind fish walks the way land vertebrates do.

The waterfall-climbing cave fish, Cryptotora thamicola, has even evolved many of the skeletal features that our ancestors did for walking, including a full-blown pelvis.

"It's really weird," said John R. Hutchinson, a biologist at the Royal Veterinary College at the University of London who was not involved in the

new study. “It’s a good example of how much fish diversity there’s left to be discovered.”

Drop an ordinary fish on the ground, and it will flop around helplessly: Its fins are adapted for pushing against water, not fighting gravity.

The early land vertebrates, known as tetrapods, evolved adaptations that enabled them to move efficiently over solid ground. A pelvis joined their hind limbs to their spines, for example. Their vertebrae grew flanges so that they interlocked, helping the spine hold itself stiff and straight even when being pulled down by gravity.

These adaptations led tetrapods to walk in a distinctive fashion, moving their forelegs and hind legs together in a cycle. Early tetrapods probably walked much the way salamanders do today, bending their trunk from side to side as they traveled.

All tetrapods descend from a single ancestor — a single lineage of fish that managed to spread on land. Some other fishes evolved vaguely similar ways of moving around.

On coral reefs, for example, frogfish can push off surfaces with their fins. They have a gait that looks something like a slow-motion walk. But they can manage this movement only underwater.

Other fish can move on land, although none of them use a tetrapod gait to do so. Some simply squirm, while others, like mudskippers, rely on their front fins as crutches. In Hawaii, the Nopili rock-climbing goby climbs up rock faces by using its mouth as a suction cup.

The waterfall-climbing cave fish is leaps ahead of them, it turns out. Pale and blind, the two-inch-long fish feeds on microbes and organic matter growing on the cave walls. It was discovered in 1985, deep inside a system of caves in northern Thailand, and has been found nowhere else.

While other fish in the caves enjoy a life in quiet pools, the waterfall-climbing cave fish clambers up slick rocks as water crashes over it.

On a recent expedition to the caves, Apinun Suvarnaraksha, a biologist at Maejo University in Thailand, and Daphne Soares, of the New Jersey Institute of Technology, came across the climber and took some grainy videos of it.

Back in New Jersey, Dr. Soares showed the videos to her colleague, Brooke E. Flammang, an expert on biomechanics.

“I was completely blown away,” Dr. Flammang said. Instead of flopping or crutching, the cave fish were using what looked like a full-blown tetrapod gait.

“These guys seemed to be very leisurely walking up the rock face,” Dr. Flammang said.

She wanted to study the fish more closely, but the species is rare and protected, and she could not bring any of them into her lab.

Dr. Suvarnaraksha did the next best thing. In a Thai museum collection, he found one of the few preserved specimens of the fish. He took it to a dental school and used a high-resolution CT scanner to make images of the fish.

After Dr. Suvarnaraksha emailed the images to Dr. Flammang, she was able to line up the images together to reconstruct the fish’s three-dimensional anatomy.

In many ways, the skeleton of the fish looked like what you’d see on a walking tetrapod. “I literally thought someone was playing a trick on me,” she said.

In typical fish, the pelvis is just a pair of small bones floating in the body wall. Fish use the bones only to stabilize their pelvic fins, so that they can stop themselves from rolling over.

In the waterfall-climbing cave fish, on the other hand, the pelvis is a complex of bones that is fused to the spine by elongated ribs. It's the same arrangement that tetrapods evolved, allowing them to hold themselves up with their hind legs.

Typical fish also have small vertebrae that don't overlap, allowing them to bend their bodies as they swim. But the waterfall-climbing cave fish has the same overlapping growths on their vertebrae that stiffen the spine in tetrapods.

"Functionally, it makes perfect sense, but to see it in a fish is incredibly wild," Dr. Flammang said.

In Thailand, Dr. Suvarnaraksha then went back to the caves with a video camera. He scooped two of the fish into an aquarium and made videos of them walking at different angles.

When Dr. Flammang and her colleagues analyzed the images, they confirmed their initial hunch: The fish were using their tetrapod-like bodies to walk with a tetrapod-like gait. It most closely resembles that of a salamander.

The researchers published their study on Thursday in the journal Scientific Reports.

Dr. Flammang said that the waterfall-climbing cave fish eventually might give scientists hints about how fish originally arrived on land. "The physics are the same," she said.

Scientists have found trackways in Poland dating back almost 400 million years that look as if they were made by a walking tetrapod. But the oldest tetrapod fossils found so far date only to 375 million years.

It's possible that a fish, rather than a primitive tetrapod, made those tracks by moving as the waterfall-climbing cave fish does today.

"We see these footprints in a fish today, doing something very unfishlike," Dr. Flammang said.

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