© 2022. Published by The Company of Biologists Ltd | Journal of Experimental Biology (2022) 225, jeb245130. doi:10.1242/jeb.245130

INSIDE JEB

Mangrove killifish abandon the water to catch their breath

A mangrove killifish (*Kryptolebias marmoratus*) jumping out of the water. Photo credit: Brock Fenton and Sherri Fenton.

One of the most important and remarkable steps in the evolution of animals occurred when fish emerged from the water and stepped onto land. But why would fish want to leave the water in the first place? Fish are generally not well suited to life on land, lacking important structures such as lungs and feet that allow other animals to thrive on terra firma. However, some fish have got around these problems. The mangrove killifish (*Kryptolebias marmoratus*) can survive on land for months at a time, which led Liam Tigert and Patricia Wright, both from the University of Guelph, Canada, with Andy Turko from McMaster University, Canada, to ask whether there is a cost to being a fish out of water. The researchers suspected that breathing air would make it harder for killifish to return to their aquatic lifestyle, reinforcing their desire to stay on land.

To test this, Tigert first accustomed some killifish to breathing air on land for a week and then placed them back into the water, slowly lowering the oxygen levels from 100% to 4% in the water until the killifish hopped back onto land to take a breath. The fish that spent a week out of water popped back onto land when the oxygen levels in their water had dropped to 20%, whereas killifish that had spent the whole time in the water waited until the oxygen levels were at 9% before deciding to hop out of the water; the land-accustomed killifish seemed to find it easier to breathe in air than in water. However, Tigert and colleagues were concerned that these fish might have just preferred to be on land, so they decided to find out just how low the oxygen levels in the water could get before the fish toppled over. After placing the killifish in mesh-sided containers within a larger tank, Tigert again lowered the oxygen levels in the water. When the oxygen levels got very low, the killifish that were used to breathing air toppled over earlier than the killifish that were only in the water. This suggested to Tigert that the killifish can't breathe as well in the water, raising another question: is there a point at which the oxygen is so low that it drives mangrove killifish to leave their aquatic accommodations?

The authors examined how often the killifish from normal, poorly oxygenated or very poorly oxygenated water came out of the water to breathe. At very low oxygen levels, the killifish jumped onto land more frequently, suggesting that it is easier for them to breathe in air than in water. But what effect does a terrestrial lifestyle have on the versatile fish's gills? Because one consequence of spending more time out of water is that the killifish's gills become clogged with cells, which prevent the structures from absorbing as much oxygen in water, the team looked to see whether living in poorly oxygenated water had similar consequences. The size of gill clogging masses nearly doubled when the team kept the killifish in very poorly oxygenated water.

So, when mangrove killifish spend time on land, they become worse at breathing in the water. This could leave the intrepid fish marooned on land by making it too hard for them to catch their breath underwater. This same dilemma must have troubled some ancestral fish species which sallied forth from the water and eventually became the planet's first land creature, not just a fish out of water.

10.1242/jeb.245130

Tigert, L., Wright, P. A. and Turko, A. J. (2022). Positive feedback promotes terrestrial emergence behaviour in an amphibious fish. *J. Exp. Biol.* **225**, jeb244236. doi:10.1242/jeb.244236.

Jarren Kay
jarren.kay@biologists.com