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Mangrove rivulus's strategy for being a fish out of water



Fish out of water should, by definition, be uncomfortable, but amphibious fish appear to suffer no ill effects. Whether they are dragging themselves out to catch a snack or holing up in a decaying mangrove trunk for months to wait out the dry season, tiny mangrove rivulus (*Kryptolebias marmoratus*) are at ease in and out of water. According to Pat Wright and colleagues from the University of Guelph, Canada, and the University of California, Davis, USA, the versatile fish are able to convert their skins into ad hoc lungs by increasing the number of capillaries close to the surface to absorb more oxygen from their surroundings; however, Wright also wondered whether the beached fish improve other aspects of their oxygen delivery system to compensate for a lack of water.

After transferring the adaptable creatures to damp boxes for periods ranging from a day up to a week, Wright and Tessa Blanchard measured: the point at which the oxygen carried in the fish's blood is no longer able to sustain their metabolic

rate, how well the fish maintain their metabolic rates as the amount of oxygen available to them declines and how their metabolic rate altered over time. In addition, the pair measured the amount of oxygen-carrying material in the blood and how quickly the genes that trigger blood capillary formation were activated.

Impressively, the fish increased the amount of oxygen that they were able to extract directly from the air within a day of emerging from water – in line with increasing the amount of oxygen-carrying material in the blood – and were able to maintain their metabolic rate, despite inhaling less oxygen. In addition, Andrew Whitehead and Yunwei Dong from the University of California, Davis, USA, showed that the fish activate the genes that trigger blood capillary growth in the skin within an hour of leaving the water, to supplement the blood supply to the skin.

However, it seemed to take a week for the fish to reduce their metabolic rate in order

to further eke out their energy when starving during the dry season. The animals were also able to sustain their metabolic rate while inhaling less oxygen. And when the team compared the responses of fish from different locations – Florida, Honduras and Belize – the Honduras fish acclimated more rapidly to being out of water than the fish from Belize, which Wright says ties in with their ability to survive in the air for longer.

So amphibious fish seem to tackle extended periods out of water in two stages: an initially brief period, which allows them to survive short episodes out of water, and a longer-term strategy, which allows them to endure the dry season.

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Blanchard, T. S., Whitehead, A., Dong, Y. W. and Wright, P. A. (2019). Phenotypic flexibility in respiratory traits is associated with improved aerial respiration in an amphibious fish out of water. *J. Exp. Biol.* **222**, jeb186486.

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