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INSIDE JEB

Different strategies for toxic-stink-defying mangrove rivulus mitochondria

Mangrove rivulus emerging from the water in the lab. Photo credit: Keri Martin.

Hydrogen sulphide (think rotten eggs) doesn't just smell dreadful: in addition to the unpleasant stink, the gas is toxic, corrosive and best given a wide berth. Yet some species don't have the option of moving on. Mangrove swamps are hotbeds of hydrogen sulphide production, and the mangrove rivulus fish that make their homes there have simply had to adapt to the toxic environment. Hydrogen sulphide generally targets the essential mitochondrial powerhouses that supply animal tissues with energy, so Keri Martin (Mount Allison University, Canada), Suzie Curie (Acadia University, Canada) and Nicolas Pichaud (University of Moncton, Canada) wondered how the mitochondria of different populations of mangrove rivulus have adapted to deal with the noxious fumes in their water.

The team focused on two populations of mangrove rivulus. The first, hailing from Honduras, are relatively sensitive to hydrogen sulphide, but are able to reduce their energy consumption to survive for lengthy periods when they escape the water. The second, from Belize, appear to cope better with high levels of the toxin in their water than their Honduran cousins. But first the team needed to figure out how the fish's mitochondria compared under non-stressful conditions, given their different heritages.

Analysis of the anaerobic and aerobic capacities of the liver mitochondria of both fish showed that the mitochondria of the Honduras fish consumed more oxygen and had a higher anaerobic capacity, while the mitochondria from the Belize fish did not have to depend on oxygen to the same extent and had a greater aerobic capacity. 'These differences at the cellular level could explain why Honduran fish jump sooner and can survive longer out of water than the Belize fish', says Pichaud. The team suspects that the Honduras fish's souped up anaerobic capacity allows them to survive well on land when the hydrogen sulphide levels in their tide pools becomes too high. They simply flip out of the water onto dry land and respire anaerobically, waiting it out until it is safe to return to the water. In addition, the Honduran fish's mitochondria were able to process and detoxify the gas, to provide them with some resistance to poisoning.

The mitochondria of the fish that originated from Belize, in contrast, were more efficient at generating energy aerobically when poisoned by the toxic gas, allowing them to maintain energy production when the mitochondria of other species would fail. And the resourceful fish are also able to resort to using an alternative energy source, succinate – which they may produce when respiring anaerobically – when the toxin dissipates and they can resume aerobic energy production.

So, mangrove rivulus that originated from two distinct locations have come up with alternative strategies that allow them to thrive in toxic swampy conditions, and the mini powerhouses of the cell appear to hold the key to their survival.

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Kathryn Knight
kathryn.knight@biologists.com

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