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# Cold winter fish slow down naturally rather than by depressing metabolism

Young cunner close to a pipe shelter. Photo credit: Ben Speers-Roesch.

We are all familiar with the archetypal grizzly bear, hedgehog and squirrel depressing their metabolism when snuggling down for their winter hibernation. But what about sluggish fish lurking at the bottom of icy pools? Are these so-called ‘cold-blooded’ (ectothermic) animals making an active choice to reduce their metabolism to conserve energy during winter, or are their metabolisms simply coming along for the ride as temperatures fall and they cool naturally? Cold critters run more slowly than warm ones. Unfortunately, it’s difficult to tell the difference between the two scenarios. However, animals that actively suppress their metabolic rates tend to get more sluggish than animals that passively allow the chilliness to slow them down. Wondering whether cold-blooded fish are simply allowing their metabolic rates to remain in harmony with their surroundings or are actively depressing them, Connor Reeve, Lauren Rowsey and Ben Speers-Roesch from the University of New Brunswick, Canada, collected cunner, pumpkinseed sunfish, American eels and mummichogs to find out how the chilly fish weather winter conditions.

First, the team wanted to find out when the fish switched from active lifestyles to sluggish winter existences as the temperature declined gradually to 1–2°C over a 14-day period. ‘The fish were held in their own plastic aquaria, which contained a pipe for shelter, and were video recorded continuously using an infrared-sensitive camera that can see in day and night’, says Reeve, who filmed the fish dining and pottering around their individual enclosures until it became too cold. Impressively, the mummichogs never became entirely still, even at the chilliest temperature of 1.1°C, although they gave up feeding by 3°C, and the sunfish also continued feeding and moving a little at temperatures below 7°C. However, the cunner all became inactive by 7–8°C and the eels gave up moving around by 3°C. But were the fishes actively suppressing their metabolic rates to a point where they were unable to remain active, or were their metabolic rates declining naturally as the water cooled?

Next, the team recorded the fishes’ oxygen consumption rates, which provides an estimate of their metabolic rates, and filmed the animals’ antics as they cooled 3°C each day from their usual summer temperatures (14–17°C) to ~2.5°C. Then, after allowing the fishes to adapt to the new chilly temperature for 4–6 weeks, the team rewarmed the fishes to their summer temperatures, as if experiencing a mini heatwave, while keeping track of the animals’ movements and oxygen consumptions the whole time. The team then calculated how much the fishes’ metabolic rates declined as they were chilled and rewarmed and discovered that the metabolic rates never changed by more than 3.5-fold for every 10°C temperature change, which is the minimum metabolic rate change experienced by animals that actively suppress metabolic rate to conserve energy. The metabolic rates of the cunner, pumpkinseed sunfish, American eels and mummichogs all tied in perfectly with temperature of their surroundings. They were simply going along with the metabolic flow, allowing themselves to be cooled naturally by their environment, rather than actively depressing their metabolism.

However, the team suspects that instead of being completely dormant – like American eels and cunner, which shut down entirely at low temperatures – chilly pumpkinseed sunfish and mummichogs merely become lethargic. Reeve suggests that this form of winter lethargy ‘encompasses a larger intermediate scope of activity, relative to winter dormancy or winter activity’. In fact, the team reckons that most fish residing in temperate waters tend to the lethargic end of the spectrum – rather than full-blown dormancy – as many species remain active to some extent during long chilly winters.

10.1242/jeb.244303

**Reeve, C., Rowsey, L. E. and Speers-Roesch, B.** (2022). Inactivity and the passive slowing effect of cold on resting metabolism as the primary drivers of energy savings in overwintering fishes. *J. Exp. Biol.* **225**, jeb243407. doi:10.1242/jeb.243407

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