

INSIDE JEB

Barramundi take the average to cope with high temperatures

Barramundi (*Lates calcarifer*) in a tank. Photo credit: Hanna Scheuffele.

Despite the guarded optimism of some politicians following the COP26 summit in November 2021, the planet continues to warm, leaving so-called cold-blooded animals (ectotherms) with an uncertain future. No one really knows how fishes will cope as their waters warm. ‘Lifetime fitness, such as growth and number of offspring produced, in ectothermic animals such as fish is thought to be maximised at some optimal temperature and to decrease either side of that optimum’, says Hanna Scheuffele from Deakin University, Australia – which would place animals at risk at temperatures that they are not prepared for. But Scheuffele and Timothy Clark, also from Deakin University, were curious to find out just how hard-wired fish physiology is – whether they can adjust their physiological performance window to cope with higher temperatures and whether the varying temperatures experienced by an animal over the course of the day could leave them less well prepared as the mercury rises? To answer these questions, the duo monitored the metabolism of a tropical fish, barramundi (*Lates calcarifer*), to find out how they fare over a range of temperatures.

Receiving ~450 young barramundi from a local fish farm, Scheuffele, Clark and Francesc Rubio-Gracia – visiting from the University of Girona, Spain – divided the fish into four groups held at different water temperatures: one each at 23, 29 and 35°C and the fourth on a daily temperature cycle between 23 and 35°C. ‘Juvenile barramundi are often found in highly fluctuating environments such as estuaries and coastal swamps throughout northern Australia and therefore can experience drastic daily temperature changes of $\pm 10^\circ\text{C}$ ’, says Scheuffele. After allowing the fish to adjust to their new homes for 2 weeks, Scheuffele, Clark and Rubio-Gracia began the monumental task of recording the fish’s resting metabolic rate, measuring how much oxygen each individual consumed while resting overnight at the temperature of their home tank, before recording their maximum metabolic rate when recovering from a chase around a pool. Then, the team altered the temperature to one of the two remaining temperatures and repeated the experiments, before selecting the third temperature and measuring the fish’s resting and maximum metabolic rate again.

‘We had four very busy months of measuring oxygen consumption, all the while attending to the daily needs of nearly 500 fish’, says Scheuffele, who recorded that – as expected – the fish’s metabolic rates rose when they were transferred to warmer water. However, when the team checked the performance of the fish that had lived in a variable environment, cycling between 23 and 35°C each day, the fish did not struggle as they had predicted. Instead, their lifestyles were most efficient at 29°C, which was the average temperature that they had experienced each day. ‘The average daily temperature seems to be more important than the range in daily temperature when it comes to regulating aerobic performance’, says Scheuffele.

In addition, instead of seeing a dip in the fish’s ability to keep going at 35°C, the team recorded all of the fish rising to the challenge of increasing their maximum metabolic rate in warmer conditions, even when they were used to living at 23°C. Also, varying the temperature experienced by the fish over the course of the day did not leave them better prepared for a heatwave than the fish that had lived at constant temperature.

So, when setting their metabolism, the average daily temperature that tropical barramundi experience is more important than the daily extremes they encounter, and Scheuffele is keen to find out whether the fish’s responses to constant versus variable temperatures differ at the level of the tissues in their bodies.

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