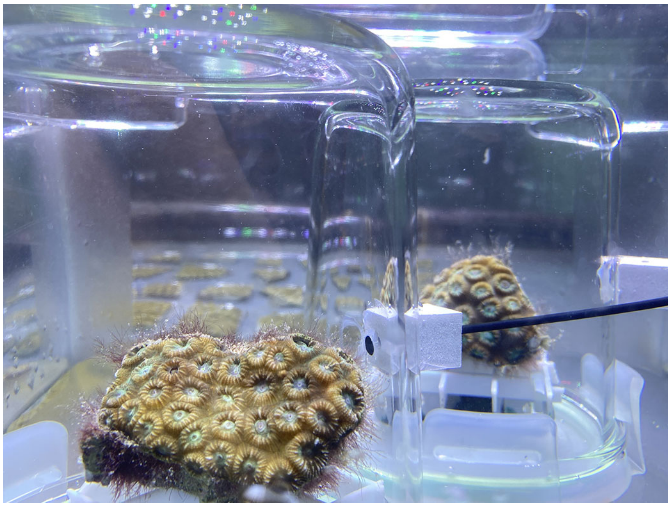
INSIDE JEB

Corals can compensate for cold if algae step up



A fragment of great star coral (*Montastraea cavernosa*) in an incubation chamber to measure metabolic rate. Photo credit: Yvonne Sawall.

Faced with the challenge of climate change, most cold-blooded (ectothermic) creatures have a choice: head up a mountain or move closer to the poles. But the altitude solution doesn't work the same for creatures in the sea; they would have to move deeper, which is tricky for corals that require light for their symbiotic algal lodgers. Their only alternative would be to migrate away from the equator. But as populations of these animals shift toward the poles, there will be additional challenges to overcome: much less light in winter – a problem for their photosynthetic symbiotic algae – and chillier cold seasons. So how might corals compensate for cooler conditions as they venture north or south? Yvonne Sawall (Bermuda Institute of Ocean Sciences) and Anna Nicosia (Lehigh University, USA), with an army of student helpers, decided to find out how two subtropical corals, great star coral (*Montastraea cavernosa*) and mustard hill coral (*Porites astreoides*), adjust to more wintery temperatures.

After collecting the corals from a reef off Bermuda, Sawall and Nicosia settled them in the lab before cooling them at 0.5°C day^{-1} for 8 and 16 days – from 28°C down to 24°C and 20°C, respectively – at which they remained for almost 3 weeks. Over that period, the team collected a small portion of each coral every 4 days, measuring its oxygen production in the light – to determine how much the coral's algae were photosynthesising – before plunging the coral into darkness to determine how much energy the animals were consuming. In addition, the team recorded how much algae the corals were harbouring as the temperature declined and the amount of light-harvesting pigments carried by the algae for glucose production.

Sure enough, as the corals cooled, the amount of photosynthesis they could perform reduced, although the mustard hill coral's photosynthesis declined less than the great star coral's. In addition, after 20 days at the lowest temperature, the metabolic rate of the chilly great star corals had plummeted to ~8% of its initial rate; they were unable to compensate for the impact of the cooler temperature on their metabolism. However, the mustard hill corals suffered much less from the chilly conditions. Their metabolism only dropped to ~43% after 37 days. The mustard hill coral was somehow compensating for the natural slowing that occurs as the temperature drops. But how did the corals' photosynthetic algal lodgers respond to the chilly conditions?

As the great star corals cooled, they dramatically increased the quantities of photosynthetic algae harboured in their tissues, before returning rapidly to normal as the temperature stabilised and the algae adjusted to the new normal. However, the mustard hill coral algae seemed better prepared for the cold, increasing the quantity of light-harvesting pigments they carry to improve their efficiency. In addition, the mustard hill corals grew heavier once the temperature had stabilised, more than doubling in mass after 3 weeks at 20°C. The mustard hill corals accumulated energy stores to tide themselves over during the chilly period; 'they became fatter', Sawall chuckles. The great star corals also gained weight, but not as much.

Overall, the mustard hill coral was better able to compensate for its slower metabolic rate at lower temperatures by increasing the concentration of photosynthetic pigment in the algae within its tissue, but what are the implications for corals wishing to relocate as their reef homes warm? 'Only a few corals are able to cope with low temperatures, because corals have a limited ability to compensate for temperature-driven reduction of metabolic functions', says Sawall, meaning that only the toughest and most adaptable will make it in chillier waters.

10.1242/jeb.244657

Sawall, Y., Nicosia, A. M., McLaughlin, K. and Ito, M. (2022). Physiological responses and adjustments of corals to strong seasonal temperature variations (20–28°C). *J. Exp. Biol.* **225**, jeb244196. doi:10.1242/jeb.244196

Kathryn Knight
kathryn.knight@biologists.com

Inside JEB highlights the key developments in Journal of Experimental Biology. Written by science journalists, each short report gives the inside view of the science in JEB.