OUTSIDE JEB

Batting around a new idea: attracting insect buffets for endangered bats

During the autumn months, many bat species face challenges to find sufficient food and generate the large fat stores they require to survive winter. However, North American bats face an additional challenge: a fungal disease called white-nose syndrome. The disease causes bats to arouse too frequently during hibernation, eventually starving to death before spring. Twelve bat species are currently affected, and some are listed as Endangered in either the USA or Canada. Winifred Frick, from Bat Conservation International and the University of California, Santa Cruz, USA, with a team of collaborators from various US and Canadian institutions, set out to test a new conservation approach that could protect bats by increasing the number of flying insects in an area, allowing the animals to gorge before and after hibernation.

To test their approach, the team chose caves in the Upper Peninsula of Michigan, USA, which were known to have ∼100 remaining hibernating little brown bats (*Myotis lucifugus*) after declines from white-nose syndrome. They then monitored five caves in the autumn of 2019 (1 September–4 October), when the bats were fattening for hibernation, and four caves in the spring of 2021 (19 April–25 May), when bats that survived white-nose syndrome were emerging from hibernation. To attract flying insects, Frick and colleagues placed a single UV light 250 m from each cave entrance, 3 m above the ground. In the autumn, the team alternated nights when the UV lights were on, to assess changes in the number of insects they attracted. However, in the spring, to determine whether the bats could learn to respond to changes in the numbers of insects available to dine on, some of the caves were provided with a UV light on each night, while others had no UV lights on.

The team also measured insect abundance every night during the autumn but only once a week during the spring, using a funnel and bucket to trap insects that were then brought back to the lab to be weighted and identified. To monitor bat foraging activity at the caves, the researchers used bat detectors placed at the sites to record the bats' ultrasonic calls while flying from sunset to sunrise each night during the autumn and spring. Back in the lab, the recordings were reviewed to identify and count the number of 'feeding buzzes' – the echolocation calls that bats make when successfully catching insects – to determine the bats' foraging success rates.

The researchers found that when the UV lights were on during the autumn fattening period, the bats successfully captured and ate three times more insects than on nights when the UV lights were off. Additionally, the team collected a far greater mass of insects (16.7 times more) on the UV illuminated nights. Additionally, in the spring, the hunting bats were 8.5 times more successful in capturing prey, and the mass of insects collected by the team was 26.1 times greater at the locations where the UV lights were on than at the locations where the UV lights were off. These results show that UV lights in the autumn and spring increase the insect abundance for bats to eat, and that bats learn to forage more when there is increased food availability. Overall, Frick and colleagues have successively shown a novel approach for artificially attracting greater numbers of insects for bats to feast on during the critical spring and autumn periods. The results from the study could aid in the recovery of bat populations from white-nose syndrome and inspire wider conservation approaches for critically endangered hibernating bats in North America.

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Jellyfish are sated thanks to GLWamide

At some point, we have all sat down to an excellent meal and after devouring as much as we could, no longer had the hankering to eat again for some time. So, what tells our bodies to stop eating? Hormones and chemicals in our brains called neurotransmitters guide the process of feeling full, but how far back in evolution did those processes become established? Vladimiros Thoma and colleagues from Tohoku University, Japan, with collaborators from other universities in Japan, set out to answer this very question by investigating the origins of these chemicals that control appetite in the jellyfish *Cladonema pacificum*.

To identify the genes that regulate feeding in jellyfish, the team investigated which genes are activated or switched off during feeding by comparing famished with recently fed jellyfish. The researchers found that recently fed jellyfish increased the expression of several genes involved in nerve cell activity, leading the scientists to focus on proteins involved in communication between nerve cells. After testing 43 different proteins – a truly Herculean effort – the researchers narrowed the molecules that regulate satiety down to just a few, including one called GLWamide.

When the *Cladonema* jellyfish feed, they ensnare prey such as brine shrimp with their tentacles, pull them back into their bell and ingest the shrimp. To see what part of this feeding ritual GLWamide impacted, the researchers measured how effectively the jellyfish captured their prey and how swiftly their tentacles retracted if the jellyfish were given GLWamide while still hungry. Thoma and colleagues found that hungry jellyfish were not as good at capturing prey when given GLWamide, but they were still better than jellyfish that had just eaten. The hungry animals dosed with GLWamide delayed tentacle contraction when they were fed just like the ones that had already had their fill. This suggests that GLWamide is an appetite suppressor that stops the tentacles from contracting. Next, the team wanted to see where the GLWamide was produced in the jellyfish's body and whether the levels of GLWamide changed based on when the jellyfish were fed. The researchers found that levels of GLWamide in the base of the tentacle increased 3–6 h after feeding, which may be how it suppressed the appetite of the jellyfish.

Finally, the team wanted to explore the possibility that GLWamide represents an ancestral signalling system for appetite suppression in all animals. To do this, the researchers looked at a related chemical, called myoinhibitory peptide, in fruit flies. When the hungry jellyfish were given fruit fly myoinhibitory peptide, it reduced the jellyfish's appetite. Additionally, when the researchers gave fruit flies GLWamide, it reduced their appetites as well, showing that GLWamide represents an ancestral signal for appetite suppression. Thoma and colleagues also point out the importance of investigating the function of these chemicals in even more ancient animals than jellyfish, such as single-celled organisms, to discover the true origin of these appetite-suppressing systems. So, the next time you are feeling full after a huge meal, know that your body is working just like it has been programmed to for millions of years.

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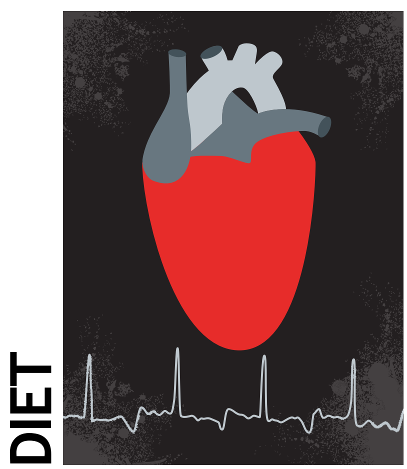
Hot hearts can beat faster when meat is on the menu



As our planet continues to warm, biologists are sweating over how animals will cope with the changing climate. For cold-blooded animals (ectotherms), high environmental temperatures pose a particular problem because their body temperature closely matches that of their surroundings. Imagine being unable to turn down your house's thermostat when outside temperatures get blisteringly hot – yikes! To make matters worse, the heat accelerates many vital physiological processes in ectotherms, including heart rate. Because hearts can only beat so fast while maintaining a proper rhythm, there are limits to the temperature that ectothermic animals can tolerate. But, if these animals can find ways to increase their maximum heart rate, allowing their hearts to keep pumping at temperatures that would otherwise prove fatal, they may gain an advantage in a warming world. In a fascinating new study led by Emily Hardison from the University of California, Santa Barbara, USA, a team of researchers tested whether diet can help ectothermic opaleye (*Girella nigricans*) regulate their hearts better at high temperatures.

Opaleye are small fish commonly found in the rocky shallows along the west coast of North America, and their generalist diet allows them to choose between eating plants and/or animals to meet their nutritional requirements: a herbivorous diet is rich in antioxidants and minerals, while a carnivorous diet is packed with proteins and fats. To understand how these different diets might impact opaleye heart function, the researchers first maintained fish at 12°C and fed them a carnivorous (brine shrimp), herbivorous (algae) or omnivorous (algae and brine shrimp) diet for 2 weeks. Next, they exposed the fish to temperatures ranging from approximately 12°C to 34°C and monitored how fast their hearts were beating at each 1°C increment. To make sure the fish were giving it their all, the researchers gave them a little boost with two different drugs to encourage their hearts to beat as fast as possible.

The team found that maximum heart rate was similar between all fish, despite being fed different diets. The fish's heart rates increased with rising temperature, reaching a peak of 150 beats min^{-1} at approximately 28°C. So, the researchers decided to take their study one step further and see whether the fish could modify how their hearts work after prolonged exposure to a high temperature. This time the researchers warmed the fish up to 20°C for 2 weeks while feeding them the same carnivorous, herbivorous or omnivorous diets. After the hot tub-like experience, the team measured each fish's maximum heart rate across the same range of temperatures. Interestingly, the meat-eating fish (carnivorous and omnivorous diets) now had a higher maximum heart rate at 28°C than they did before. Herbivorous fish, in contrast, had the exact same maximum heart rate as before, indicating that they were not able to adjust to the warming climate. It turns out that a little bit of meat on the menu allowed the fish's hearts to beat faster in the heat – an adjustment that might make them more heat tolerant overall.

Hardison and her colleagues then pondered why the opaleye on a meat-based diet could handle the heat better. Maybe it's what's on the menu that counts? After all, meaty meals are usually high in fatty acids, which serve as tiny building blocks for many cellular structures in the body. The researchers analyzed the fatty acid composition of the fish's hearts and, as expected, the meat-eaters had a fatty acid composition better suited to high temperatures. Now, this doesn't mean that people should start devouring sirloin steak in the name of thermal tolerance, but it does suggest that a balanced diet might just give animals an edge against the elements in our rapidly warming world.

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