

INSIDE JEB

Damsel fish are coral fans



A damselfish in the Red Sea. Photo credit: Nur Garcia-Herrera.

Bustling around their reef homes, Red Sea damselfish (*Dascyllus marginatus*) do quite well out of their co-habiting arrangement with hood coral (*Stylophora pistillata*). ‘The coral provide the fish with shelter from predators and a place for social interactions and egg laying’, says Nur Garcia-Herrera, from the Alfred-Wegener-Institut, Germany. Yet the agreement isn’t entirely one sided. ‘In return, the damselfish remove sediments from the coral surface, protect it from predators such as butterflyfish or crown-of-thorns starfish, and excrete nutrients such as nitrogen and phosphorus that the coral takes up’, Garcia-Herrera explains. But she and her colleagues, Amatzia Genin, from the Hebrew University of Jerusalem, Israel, and Sebastian Ferse and Andreas Kunzmann, from the Leibniz Center for Tropical Marine Ecology, Germany, also wondered whether the gentle water currents generated by the fish’s ceaselessly fanning fins may also nurture the coral and enhance coral photosynthesis.

Joining Genin at the Interuniversity Institute for Marine Sciences of Eilat on

the Red Sea coast, Garcia-Herrera collected corals and their fish lodgers from the sea floor and returned with them to the lab. There, she and Genin embarked on a complex series of experiments recording oxygen levels in the water as it flowed over the isolated fish, isolated corals, fish nestled inside the coral, fish that were excluded from the coral, and fish that had taken refuge inside dead coral. By repeating some of the measurements in light and dark conditions, Garcia-Herrera, Genin and Ferse were able to tease out how much oxygen was produced by coral photosynthesis during the day in contrast to the oxygen consumed by both organisms when there was no light.

Comparing the oxygen produced by coral photosynthesis when a fish was allowed to nuzzle inside with the oxygen produced by coral when the fish was near but excluded from the branches, the team was impressed to see the oxygen production rocket by 22% when a fish was secluded amongst the coral branches. In contrast, the team discovered that the oxygen consumption of the damselfish and corals did not vary –

regardless of whether they were isolated or together – although the metabolic rates of the fish rose when their only refuge was a piece of dead coral, suggesting that the fish may have been stressed.

Garcia-Herrera and Genin then went swimming with the damselfish in the Red Sea to get a better appreciation of the fish’s impact on the coral. ‘Diving in the Red Sea is a wonderful experience’, says Garcia-Herrera, who observed the fish continually beating their fins as they took shelter inside the coral at night, before venturing out during the day to feed on plankton. Garcia-Herrera also noticed that the fish never ventured far from their coral homes – darting back inside the haven whenever danger loomed – to the extent that the coral was occupied by at least one fish for almost a third of the day.

Combining their observations and physiological recordings, the duo suspects that the fish’s continually beating fins may generate sufficient water flow to boost coral photosynthesis when in residence. Garcia-Herrera says, ‘This is the first evidence of positive effects by a coral-associated fish on coral photosynthesis’; although she suspects that the fish’s presence may only boost the coral’s daily photosynthetic rate by up to 6% in practice. And she warns that the plucky little fish could come under increasing pressure if their coral refuges dwindle as a result of climate change, while the corals could become even more dependent on their roaming fish-fans for the oxygen that is fundamental for recovery from increasingly stressful conditions.

10.1242/jeb.161760

Garcia-Herrera, N., Ferse, S. C. A., Kunzmann, A. and Genin, A. (2017). Mutualistic damselfish induce higher photosynthetic rates in their host coral. *J. Exp. Biol.* **220**, 1803-1811.

Kathryn Knight

Even larvae act sick when they are poorly

Most of us can tell when we’re coming down with something. At the first sign of illness, we lose our appetites, become

lethargic and begin to feel cold. This suite of behaviours, often referred to as sickness behaviour, is thought to limit the spread of infection within, and between, individuals and is easily recognised in under-the-weather humans. Michael Pankratz and colleagues from the University of Bonn, Germany, wondered whether poorly insects may also go off their tea when they pick up an infection. Intrigued by the possibility, Pankratz and Benjamin Wäschle set about trying to make fruit fly larvae sick by feeding them an infected snack.

However, Pankratz recalls that encouraging the larvae to consume infectious *Pseudomonas entomophila* was problematic. ‘We tried choice assays, different agar conditions, yeast conditions, different larval stages, even adults’, says Pankratz, who only succeeded in getting the larvae to consume a diseased dinner when there was no alternative. Providing larvae with one of three dining opportunities – yeast (their preferred diet), yeast mixed with dead non-toxic bacteria and yeast mixed with the live bacteria – Sandya Surendran filmed the larvae and saw that they were content to remain in place when consuming the first two (uninfected) meals over a 12 h period. In contrast, the larvae that were served with infected yeast chose to move on, but they were expressing more than a simple

aversion. Larvae that simply wish to avoid an unpleasant flavour take immediate action; however, the larvae that were provided with infected yeast only began moving away in search of uncontaminated food after 2–3 h, with 80% of the animals evading the infected food 12 h later. The larvae were also able to identify, and avoid, the yeast that was infected with live bacteria, while they were happy to chomp on the dead bacteria mix that presented no risk. However, when Surendran served infected yeast to ravenous larvae, half of the insects were prepared to risk picking up an infection in favour of a good dinner.

Having discovered that fruit fly larvae can recognise infected food, Pankratz wondered whether hugin neurons, which relay sensory information to the animals’ brains, might be involved in their aversive reaction. ‘We knew that activating neurons that express the hugin neuropeptide can downregulate feeding, as well as inducing wandering behaviour’, says Pankratz. Could the circuit lie at the heart of the larvae’s discerning behaviour?

After disabling the larvae’s hugin neurons and presenting the insects with an infected meal, Surendran found that the impaired larvae left the patch of infected yeast much more slowly. And

when she reduced the amount of hugin produced by the larvae, they were as active as untreated larvae, but less sensitive to the infection lurking in their lunch.

As hugin neurons relay signals from bitter taste interneurons to the larval brain centres, Pankratz wondered whether the larvae are using a clever taste trick to avoid a toxic treat. Sebastian Hückesfeld measured the calcium activity in the neurons after the larvae had been offered either live or dead bacteria, in addition to measuring the levels of the hugin neuropeptide in the neurons, and found that both were elevated after an infectious meal. ‘Our idea is that activating the hugin neurons makes the animals “think” that they are tasting bitter food’, says Pankratz,

So it seems that *Drosophila* larvae perform their own variety of sickness behaviour, and Pankratz says, ‘Even lower organisms are capable of startlingly highly sophisticated evasion programs to protect themselves from sickness’.

10.1242/jeb.161752

Surendran, S., Hückesfeld, S., Wäschle, B. and Pankratz, M. J. (2017). Pathogen-induced food evasion behavior in *Drosophila* larvae. *J. Exp. Biol.* **220**, 1774-1780.

Kathryn Knight
kathryn.knight@biologists.com