© 2023. Published by The Company of Biologists Ltd | Journal of Experimental Biology (2023) 226, jeb245610. doi:10.1242/jeb.245610

INSIDE JEB

Having eyes all over helps chitons see better

A West Indian fuzzy chiton. Photo credit: Alexandra Kingston.

The eye is an extremely complex organ and is genuinely one of nature's wonders. The ability to see your environment helps to find food, escape predators and potentially find mates. Eyes are found in many different animals from chimpanzees to squid, but animals generally have two eyes and a 'brain' to process the information coming from the eyes. However, some animals, such as scallops and chitons, have eyes distributed all over their body and no recognizable 'brain' with which to process the incoming information. So how do these animals process what their eyes are seeing, and where does this take place? Daniel Chappell and Daniel Speiser of the University of South Carolina, USA, turned to the West Indian fuzzy chiton, *Acanthopleura granulata*, to answer these questions.

First, Chappell and Speiser needed to see how good the eyes of the chitons were. The researchers placed chitons inside a clear plastic tub filled with seawater with a piece of slate on the bottom, then filmed the chiton's responses to a grey dot in the middle of a black-and-white checkerboard pattern. If the chiton was able to sense the grey dot, which it thought was a predator, it would suction itself to the slate and stop moving. By increasing the size of the squares in the checkerboard pattern, Chappell was able to determine how good the mollusc's eyesight was by noting the size of the checkerboard pattern that the animals responded to. When the squares in the checkerboard pattern were very small (~0.5 cm squares), the chitons continued to move around, suggesting that they couldn't see the large grey dot in the middle of the pattern. As the squares got bigger (~1 to 2 cm squares), the chitons hunkered down and suctioned onto the piece of slate, showing that they could see the grey dot looming overhead. Now understanding how good their vision was, the researchers turned their attention to determining where the information coming from the eyes was processed.

Chappell used a dye to follow the nerves coming from individual eyes through the shell plates and into the body. After the nerves come into the body, they form an H-shaped structure, branching in both directions and overlapping with the nerves from nearby eyes. The nerves from one eye may overlap the nerves from multiple neighbouring eyes on each side, which helps the chiton determine which direction the information is coming from. These overlapping nerves form a ring around the inside of the chiton close to the body wall.

Interestingly, when the researchers stained this nerve ring in *A. granulata* with a fluorescent compound, they discovered that the nerve ring in this species of chiton has both an inner and an outer layer. This is different from other chitons that don't have fully developed eyes, called eye spots, or eyeless chitons that only have one layer in the nerve ring that circumnavigates their body. So why have two layers? The researchers suggest that the layers may be associated with different behaviours, or that they control different tissues, such as muscles. However, Chappell and Speiser are also quick to point out that more research needs to be done to solve this new mystery. Remarkably, having hundreds of eyes and no brain doesn't seem to faze these little molluscs, but instead helps them to survive their complex environment, just like having two eyes and a brain helps so many other animals do the same.

10.1242/jeb.245610

Chappell, D. R. and Speiser, D. I. (2023). Polarization sensitivity and decentralized visual processing in an animal with a distributed visual system. *J. Exp. Biol.* **226**, jeb244710. doi:10.1242/jeb.244710

Jarren Kay
jarren.kay@biologists.com