Transparent larvae hide opaque eyes behind reflections

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Becoming invisible is probably the ultimate form of camouflage: you don't just blend in, the background shows through you. And this strategy is not as uncommon as you might think. Kathryn Feller, from the University of Maryland Baltimore County, USA, explains that the larval life stages of many marine species are transparent. However, there is one part of the anatomy that most creatures cannot make transparent. Feller explains that the animals with compound eyes have to shield each individual eye unit with an opaque pigment to prevent light leaking between adjacent eye structures. This could blow the larvae's cover and poses the question, how do larvae disguise their conspicuous eyes?

Many aquatic species use reflectors on scales to reduce their contrast with the background, so when Thomas Cronin told Feller that the eyes of tiny mantis shrimp larvae shone when caught in light, she wondered whether the transparent larvae were hiding their opaque compound eyes behind a reflection. The duo publish their discovery that the brilliant eye reflections match the light spectrum of the surrounding water, making the opaque eyes blend in with their surroundings and disappear, in *The Journal of Experimental Biology*.

However, before she could begin investigating the intriguing reflections, Feller headed south to the Lizard Island Research Station on Australia's Great Barrier Reef, where she could wade into the tropical waters at night to lure tiny mantis shrimp larvae into her net. She then illuminated the larvae's eyes with white light back in the lab, and recalls that the display was dazzling: 'The whole sphere of the retina at the centre of the eye reflects this sparkly blue-green light; it's quite brilliant,' she says.

Measuring the spectrum of the reflected light – known as eyeshine – Feller realised that the minute mirrors in the eyes of *Pseudosquillana richeri* and a *Harpiosquilla* larva only reflected blue-green light: 'They produced very discrete peaks in that region of the spectrum', she says. However, when she investigated the eyes of Pullosquilla thomassini, she was amazed to see that the upper region of the eye produced green reflections, while eyeshine from the lower portion of the eye was blue. 'We suspect that it is something similar to counter shading; perhaps the dorsal part of the eye is held against background that is greenish and the ventral part of the eye is more bluish', Feller suggests.

But how well would these reflections conceal the larvae's conspicuous eyes? Donning SCUBA gear, Feller took some of the larvae back to the ocean so that she could photograph their eyes against the natural background. 'It was very labour intensive to get the in situ images', recalls Feller, adding that it took a day to collect shots of each larva from different directions at various depths and times of day.

Back in the lab, Feller subtracted the intensity of the background from the eyeshine and calculated the eye's contrast to see how well the eyes blended in, and admits that she was amazed to see that there was virtually no contrast between the eye reflections and the surrounding lighting environment. 'Larval eyeshine does a really nice job, I didn't expect it to do as good a job as it does, that's for sure', Feller chuckles. And when she compared the spectrum of the eyeshine with the spectrum of the surrounding environment, they were a tight match. 'The peak wavelength that is reflected off the eye is the same as the peak wavelengths that are available in the environment', says Feller, adding that larvae found in Atlantic waters produce eyeshine with a completely different spectral range that is probably tuned to their light environment too.

More information: Feller, K. D. and Cronin, T. W. (2014). Hiding opaque eyes in transparent organisms: a potential role for larval eyeshine in stomatopod crustaceans. J. Exp. Biol. 217, 3263-3273. jeb.biologists.org/content/217/18/3263.abstract

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