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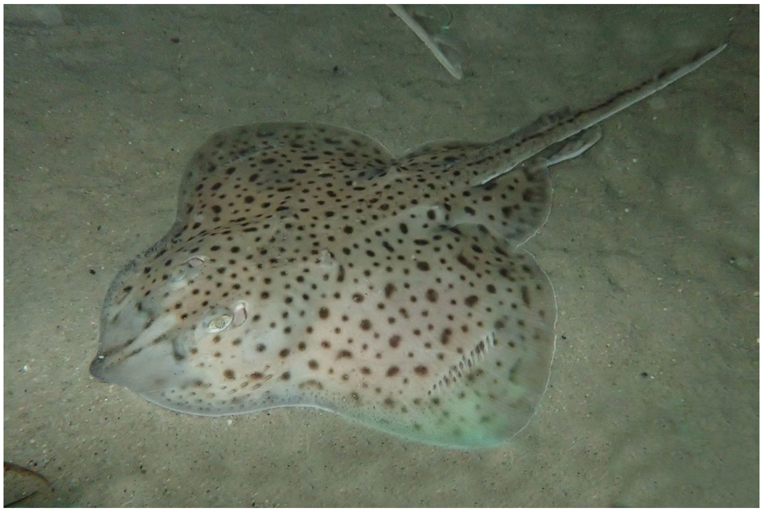
INSIDE JEB

Skate eyes adapt subtly to see but not be seen



A little skate (*Leucoraja erinacea*) resting on sand. Photo credit: Lydia Mäthger.

For both hunters and the hunted, being cryptic is imperative. By mimicking the patterns, shapes and architecture of their surroundings, animals have evolved extraordinarily clever ways of camouflaging themselves against the multi-textural world they live in. But, according to Lydia Mäthger from the Marine Biological Laboratory, USA, animal eyes can still present a problem. ‘By definition’, she says, ‘the pupil has to be a black hole that lets light into the retina. In most animals it has a very regular shape. And anything that has a very regular shape is relatively easy to detect against an irregular background’. Cuttlefish, rays and skates may have found a way around this. They all have unusually shaped pupils: U-shaped, W-shaped, and some are even more complex. One reason for these shapes might be camouflage, but Mäthger says that this idea had never been tested. While most researchers have focused just on the pupil shape in these clever sea dwellers, Mäthger and her collaborators wanted to see whether pupil dilation was also important in the animals’ ability to go unnoticed.

Mäthger and her colleagues used a checkerboard background, a common tool for testing how well colour-changing animals are able to camouflage themselves, to determine whether little skates (*Leucoraja erinacea*) would adjust the size of their pupils to blend in with their surroundings. They tested the skates on checkerboards with different check sizes, placing the skates in tanks lined with squares that were one-quarter, one-half or the full size of the animal’s eye. Then, for each of the check sizes, they exposed the skates to light at three different levels. This allowed the researchers to determine whether skates were changing their pupil size to adjust to the amount of incoming light, to attempt to match the background, or both. ‘Interestingly’, Mäthger says, ‘the skates really didn’t do anything that would suggest a camouflage function’. Their pupil sizes adjusted to the amount of incoming light, but stayed the same across all check sizes.

But then Mäthger had an epiphany. To become invisible, she says, skates bury themselves in sand or gravel with only their eyes showing. When they’re sitting on top of a checkerboard background, their bodies are closest to their eyes, not the checks. But if the skates were allowed to bury themselves in something, ‘It makes a lot more sense for them to try to camouflage against something that is literally next to their eyes’, she says. So, the team repeated the experiments, providing the skates again with three different backgrounds and three light levels for each background, but this time the backgrounds were sand or two different sizes of gravel – up to about half the width of the eye – allowing the skates to bury themselves up to their eyes in these lab-simulated seabeds.

This time, not only did pupil size change with the amount of incoming light, but there was also a subtle, but significant, adjustment in pupil size depending on the size of the sand or gravel in which the skates buried themselves. Mäthger says she was surprised, but excited. ‘Light is still the main driving force, but to find that additional potential function is very cool’. And, she says, it finally provides some evidence for the decades-old theory that motivated this study. The question now, Mäthger says, is, ‘Does that very slight adjustment give the animal a real camouflage advantage?’ Whether pupil size truly is the key to concealment remains to be seen.

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