The Ingenious Camouflage of Fish Skin

Deep in the ocean, fish hide from predators by using their shiny scales as a mirror.

A school of silvery herring.

PHOTO: SHUTTERSTOCK

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When you sit down to eat fish, the silvery skin glittering on the platter hardly looks like camouflage—its shininess makes it stand out from everything else. But that's just because it's hiding in the wrong place. In the ocean, those silver scales help fish to disappear into their surroundings, concealing them from predators.

The water that fish swim in isn't silvery; it ranges from inky blackness below to lighter blue above. So how did they evolve this particular form of camouflage?

Fish in the open ocean have a problem. The exact hue of the water is constantly changing, depending on the time of day, the depth and how much chlorophyll-tinged life is nearby. That's why fish aren't blue: Any particular blue hue would be the wrong one most of the time.

What a fish wants is to look exactly like the water behind it. Since that's the same color as the water in front of it, the solution is to become a mirror. Glass mirrors are made with a thin coating of metal; with fish, the reflective effect comes from stacks of super-thin plate-like crystals of the chemical compound guanine. The guanine crystals are far thinner than the wavelength of light, but a neat bit of optical physics means that if they're stacked one quarter of a wavelength apart, the overall effect is almost perfect reflection.

Normally when light is reflected it becomes polarized, meaning that the light waves all vibrate in a single plane. You can see this if you look out over a lake wearing polarized sunglasses: The glasses will filter out the light reflected from the water, because its polarization is distinctive. If fish reflected light in this way, a predator could easily detect it by spotting the polarization mismatch. But fish skin is made with a mixture of two forms of guanine crystal, which makes the polarization of the light going out match what came in.

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There is one final nifty trick hidden in fish skin. Imagine a predator looking down on a fish from above and to one side. If the mirror-skin was simply wrapped around the body of the fish, it would reflect back the brighter sunlight coming from above, making the fish easily visible against the darkness below. To avoid this, the stacked guanine layers are oriented so that the mirrors are vertical everywhere on the fish, rather than lying flat against its body. As a result, a predator looking down from above only sees the reflection of the darkness below. Sadly for the fish, today's fishermen don't rely on sight to find them, so camouflage doesn't help.

A silver fish wants to look like everything around it, but down in the deepest parts of the ocean, some species use a different strategy. At that depth, the only light is the dull glow of bioluminescence, but it's enough to reveal a nearby fish to a predator. Earlier this year, a study discovered that 16 species of deep sea fish have skin so black that it absorbs more than 99.5% of all the light that falls on it.

Instead of guanine, these fish have a tightly-packed layer of melanin, the same pigment that colors our skin, which acts as a light trap. If light isn't absorbed by the first pigment particle, it bounces down further into the layer to be absorbed by the next particle it hits. It's staggeringly efficient, as good as the most ultra-black man-made material, and may be even more elegant than spending a lifetime cloaked in a mirror.

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