Archerfish recognize that insects they have never seen before are animals

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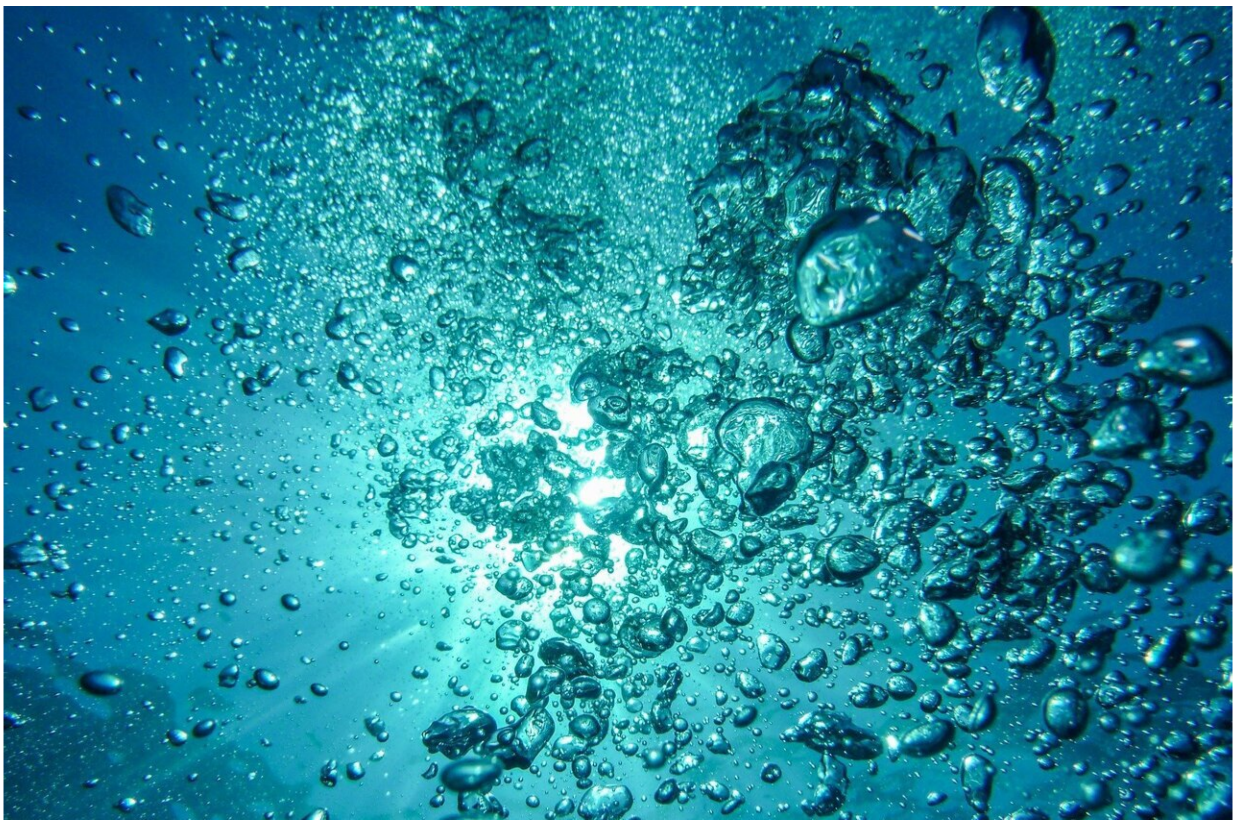

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Lurking beneath overhanging foliage, archerfish have one thing on their mind: taking a well-aimed pot-shot at the next insect that settles within range. Squirting a ballistic jet of water, these tenacious assassins precisely target their victims, ready to dine.

"Object recognition is critical for animal survival," says Ronen Segev from Ben-Gurion University of the Negev, Israel, explaining that distinguishing dinner from non-edible objects is an essential life skill.

But how do archerfish differentiate a tasty treat from an unpalatable plant?

"It's a complex task," says Segev, who was curious to find out which visual features archerfish depend on when identifying a potential meal.

He and his colleagues published their discovery that archerfish are capable of recognizing that an unfamiliar insect is an animal while detailing the features that archerfish use to distinguish plants from animals in the *Journal of Experimental Biology*.

Fortunately, the fish were quite content to squirt at images on a computer screen, so Segev and Svetlana Volotsky (Ben-Gurion University of the Negev) first encouraged the archerfish to take fire at a square on a screen, in return for a food pellet reward. Then, Volotsky trained the snipers to aim at images of one specific spider viewed from a range of angles while trying to distract them with an image of a piece of vegetation.

Once the fish were reliably spitting at the spider images, Volotsky tested whether they were capable of recognizing the spider from any random direction by offering the fish a completely new view of the spider beside an image of a piece of vegetation or another spider. If the fish had really learned to recognize their spider, they would still take a shot at it, even if they were seeing it from an unfamiliar angle.

Impressively, the archerfish were still able to select their target spider, regardless of the direction of view, showcasing their ability to recognize individual objects.

But could the fish learn from experience to categorize an insect that they had never seen before as an animal?

To investigate, Volotsky trained the fish to spit at images of insects, ranging from ants and beetles to flies and spiders, while trying to distract them with images of plants. Once the fish were dependably taking shots at the insects, she tried outwitting them by presenting them with images of unfamiliar insects to find out whether the fish could recognize that any insect is an animal.

The fish still targeted the insect images, even though they had never seen those creatures before. "Archerfish can generalize from examples to make object recognition of natural object classes," says Segev.

But how were the fish able to learn to distinguish plants from animals?

To answer this question, Volotsky and Segev along with Ohad Ben-Shahar and Opher Donchin, also from Ben-Gurion University of the Negev, teamed up to break down images of insects, flowers and leaves into 18 different features.

Then, they built a computer program (known as a support-vector machine) that reproduced the fish's decision-making process to find out which features were necessary for archerfish to distinguish between animals and plants.

The fish only needed six essential features, including the loose perimeter encircling the object, how jagged or smooth the shape is, and the texture of its surface, to distinguish animals from plants, with the first two factors being the most significant.

As humans, we use a similar, albeit slightly more elaborate, strategy to recognize each other's faces, so the team hopes to apply the lessons they have learned from archerfish to understand visual recognition in other animals and design man-made object recognition systems.

More information: Svetlana Volotsky et al, Recognition of natural objects in the archerfish, *Journal of Experimental Biology* (2022). DOI: 10.1242/jeb.243237

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