Glimpse into ancient hunting strategies of dragonflies and damselflies

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Jewelwing damselfly. Credit: Sam Fabian

Dragonflies and damselflies are animals that may appear gentle but are, in fact, ancient hunters. The closely related insects shared an ancestor over 250 million years ago—long before dinosaurs—and provide a glimpse into how an ancient neural system controlled precise and swift aerial assaults.

A paper recently published in *Current Biology*, led by University of Minnesota researchers, shows that despite the distinct hunting strategies of dragonflies and damselflies, the two groups share key neurons in the circuit that drives the hunting flight. These neurons are so similar, researchers believe the insects inherited them from their shared ancestor and that the neurons haven't changed much.

Gaining insight into their ability to quickly process images could inform technological advancements. These findings could inform where to mount cameras on drones and autonomous vehicles, and how to process the incoming information quickly and efficiently.

"Dragonflies and damselflies are interesting from an evolutionary point of view because they give us a window into ancient neural systems," said Paloma Gonzalez-Bellido, assistant professor in the Department of Ecology, Evolution and Behavior in the College of Biological Sciences and senior author on the paper. "And because there are so many species, we can study their behavior and compare their neural performance. You can't get that from fossils."

A noticeable difference between dragonflies and damselflies is the shape and position of their eyes. Most dragonflies today have eyes that are close together, often touching along the top of their head. Whereas damselflies sport eyes that are far apart. The researchers wanted to know whether this made a difference in their hunting habits, and if it affected how their neural system detects moving prey.

Researchers found:

- dragonflies and damselflies hunt prey differently, with dragonflies using a higher resolution area near the top of their eyes to hunt prey from below and damselflies leveraging increased resolution in the front of their eyes to hunt prey in

front of them;
- in dragonflies with eyes that merge at the top, the eyes work as if they were two screens of an extended display (i.e. the image of the prey, which would be equivalent to the mouse pointer, can fall on either the left or the right, but never in both screens at the same time);
- damselflies eyes work as duplicated screens, where the prey image is seen by both eyes at once (i.e. they have binocular vision);
- both designs have pros and cons, and their presence correlates with the type of prey and the environment;
- despite different strategies, the neurons that transfer information about a moving target from the brain to the wing motor centers are nearly identical in the two groups—indicating they were inherited from the common ancestor.

The different hunting strategies pay off in different environments. Dragonflies tend to hunt in an open area, leveraging the contrast of the sky to help them spot their target. Although they can't calculate depth using two images, they rely on other cues. Damselflies tend to hunt among vegetation, where the selective pressure for fast reaction may be absent, or the need for depth perception stronger.

Researchers are now looking to understand how the extended versus duplicated images are calculated in the brain, and how the information is implemented into muscle movements.

"There is still a lot we do not understand," said Jack Supple, a recent Ph.D. graduate from Gonzalez-Bellidos laboratory. "We do not know how these neurons coordinate all the different muscles in the body during flight. If we tried to build a realistic robotic damselfly or dragonfly tomorrow we would have a difficult time."

In addition to examining the differences amongst the two insect families, researchers continue to explore differences in species within each family. "While most dragonflies have eyes close together, there are a handful of species with eyes far apart," said Gonzalez-Bellido. "Some of them are abundant in Minnesota and we are eager to leverage the new flight arena to study their behavior in a controlled setting."

Researchers aim to collect at Cedar Creek Ecosystem Science Reserve and Itasca Biological Station and Laboratories this summer, both areas with diverse populations of dragonflies and damselflies.

More information: Binocular Encoding in the Damselfly Pre-motor Target Tracking System, *Current Biology* (2020). doi.org/10.1016/j.cub.2019.12.031

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