© 2022. Published by The Company of Biologists Ltd | Journal of Experimental Biology (2022) 225, jeb244597. doi:10.1242/jeb.244597

INSIDE JEB

Slurping damselfish never quite reach their evolutionary optimum

Coral reef including green damselfish (*Chromis viridis*) in the Red Sea. Photo credit: Shachaf Ben-Ezra.

The complex combination of traits that comprise each animal roaming the planet today has been moulded by millions of years of selective pressures. How differing factors conspire to shape an animal's behaviour is almost unimaginably complex, with individual evolutionary influences sometimes combining to enhance their impact, while others counteract. Intrigued by the complex factors that influenced how fish slurp up morsels of food – from the size of their mouths to the speed at which they approach a tasty bite – Roi Holzman from Tel Aviv University, Israel, and colleagues decided to find out how these factors interact to determine whether the feasting animals are performing at the top of their game.

First, the team filmed schools of green chromis (*Chromis viridis*) darting around the coral reefs off the coast of the Inter-University Institute in Eilat, Israel, with a pair of high-speed underwater cameras, capturing the moments when individual hungry fish gulped down plankton. Then, Tal Keren (Tel Aviv University) digitized the images, identifying 110 strikes when the fish thrust out their jaws in an attempt to capture a passing morsel, to determine: how wide the fish flung their jaws, how long that took, how far forward their jaws protruded, the speed at which the fish were swimming and how long it took for the fish's jaws to reach their maximum protrusion.

Having defined what the fish were doing in practice, the team then calculated the manoeuvres of 3291 strike strategies where a simulated fish performed the entire range of possible movements, no matter how unlikely they are to occur in practice. Once the researchers had defined the full range of potential feeding manoeuvres, Keren and Holzman determined how likely the fish, real and simulated, were to land lunch, by calculating the likelihood that a particular strategy would successfully suck in a morsel of food. 'It took a team effort to understand how we could best account for all the possible evolutionary scenarios that could shape the population', says Holzman.

However, when the team compared the fish's genuine performance with the optimal performance that they would have expected the fish to achieve as a result of the evolutionary pressures that could mould feeding, the fish never quite reached their full potential. 'We found out that there were many simulated fish that did much better than any of the observed fish. In the case of *Chromis viridis*, evolution did not manage to converge on the best possible combinations of traits required to suction feed, although it came quite close', says Holzman.

He suspects that other factors, such as the ability to hide in coral – which affects body size and muscle mass – could have a significant impact on the fish's abilities to feed. And the agility of the zooplankton upon which the damselfish feast could also affect the fish's feeding strategy. For example, if the optimal tactic for capturing super-sensitive prey requires too much energy, then it makes sense for the damselfish to select a strategy that might appear less ideal when focusing on less nimble prey.

'Recent progress in computational capabilities allows us to simulate the capacity of animals to feed, move and interact with their environment. This enables us to explore how far the real population is from their peak ability to feed and which traits might be the ones stopping them from getting to this peak', says Holzman, who hopes to use this computational approach to understand how fish feeding styles change during their lifetime, from larvae to adults.

10.1242/jeb.244597

Holzman, R., Keren, T., Kiflawi, M., Martin, C. H., China, V., Mann, O. and Olsson, K. H. (2022). A new theoretical performance landscape for suction feeding reveals adaptive kinematics in a natural population of reef damselfish. *J. Exp. Biol.* **225**, jeb243273. doi:10.1242/jeb.243273

Kathryn Knight
kathryn.knight@biologists.com

Inside JEB highlights the key developments in Journal of Experimental Biology. Written by science journalists, each short report gives the inside view of the science in JEB.