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INSIDE JEB

Pectoral fin swimmers turn to save energy in coral reef waves

A kole tang (*Ctenochaetus strigosus*) on a coral reef in Hawaii. Photo credit: Keith Korsmeyer.

It takes all sorts to make a coral reef community. From elegant shimmering Hawaiian flagtails (*Kuhlia xenura*) to vivid kole tangs (*Ctenochaetus strigosus*) and stripy sergeant major fish (*Abudefduf vaigiensis*), these creatures all make their homes in the perpetual swell of the coral reef waters off Hawaii. 'The waves over shallow reefs create constantly changing water flows that may help explain the great variety of fish body shapes and types of swimming we see among reef fishes', says Keith Korsmeyer from Hawaii Pacific University, USA. Some fish swim sinuously, gently beating their tails from side to side, while others manoeuvre and hover deftly by wiggling their wing-like pectoral fins. But all must be able to withstand strong surges and remain in place, even when the turbulence of the strongest storms blows through. Yet it wasn't clear just how much of an effort it takes for fish with different builds and swimming styles to hold their own in turbulent coral reef waters. Korsmeyer teamed up with Mathias Schakmann (Hawaii Pacific University) and the pair recreated the wavey conditions on a reef to find how much effort it takes fish to stay in place and how much swimming style affects their exertions.

'I went fishing at the local pier and was lucky to catch fish with interesting differences in body shape and how they swim', says Schakmann, who came back with Hawaiian flagtails, kole tangs, sergeant major fish and saddle wrasse (*Thalassoma duperrey*). He then set up a fish 'treadmill' in the lab with water flowing through a tube, where he could measure the fish's oxygen consumption to calculate the energy they used as they swam at different steady speeds, in addition to how hard they had to swim when the water washed to and fro as he simulated coral reef waves. 'All the fish quickly adjusted to each wave surge and kept swimming into the flow', says Korsmeyer.

It was quickly clear that the fish switched direction each time a simulated wave washed through, speeding up and slowing down to remain in place as the waves surged past. Although all of the fish swam harder to stay put in the wavey conditions, when Schakmann compared the fish's swimming styles, it was evident that the pectoral fin wiggling swimmers were far more efficient than the tail-beating Hawaiian flagtails. The flagtail's energy use increasing 2.5-fold as the waves increased from one every 10 s to one every 3.3 s, while the fin-flapping saddle wrasse only increased their exertions by 1.5-fold and the disc-shaped fin-wiggling sergeant major fish barely made any additional effort (0.5-fold increase). 'The fish that swam with flapping pectoral fins could deal with the increasing wave motion more easily, which would save energy while living in these wave-swept habitats', says Korsmeyer.

However, when Schakmann compared the exertions of the three pectoral fin swimmers, the deepest-bodied kole tangs and sergeant major fish swam more efficiently than the slimmer saddle wrasse as they switched back and forth. 'Our results suggest that more rounded disc-shaped bodies seem to be the most efficient for dealing with staying put in a wave surge water flow', says Schakmann.

So disc-like fish that depend on their pectoral fins for manoeuvrability are best suited for life on wave-swept coral reefs, turning on a dime as each wave washes through, and it takes all sorts to make a community, although some are better suited to steady swimming in the calmer deep waters off coral reefs.

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