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INSIDE JEB

Strategic strikes by mantis shrimp smash shells selectively

A mantis shrimp setting up a shell by tapping with its antennules before striking. Photo credit: courtesy of the Patek Lab.

For a tiny crustacean, Caribbean rock mantis shrimp (*Neogonodactylus bredini*) pack a ferocious punch. Bludgeoning the shells of snails and other crustaceans to gain access to the sweet meat within, mantis shrimp flick their cudgel-like claws at accelerations approaching those of a bullet exiting a gun. Yet, Rachel Crane from Stanford University, USA, explains that the ballistic shrimp is the odd one out in the world of snail and crustacean demolishers: 'Animals like crabs and fish slowly crush shells'. However, despite the wealth of high-speed information about mantis shrimp pulverising attacks, little was known about the stomatopod's overall strategies. Would the smashing crustaceans strike shells haphazardly or would they precisely pinpoint their assaults? And could they change their plan of attack if thwarted? Intrigued, Crane and her PI, Sheila Patek from Duke University, USA, began investigating the feisty creatures' striking strategy.

'Collecting these mantis shrimp is usually easy', recalls Crane, describing how the animals live in shallow clear water and are conspicuous when they poke their eyes and antennules out of their burrows. Fortunately, the inquisitive scientists' fingers were at little risk from the spirited crustaceans – which weren't averse to taking a swipe – as the animals were so small, although Crane recalls that they could draw blood if they unfurled their dactyl spears.

Back at Duke, Crane and Samantha Kisare tempted the stomatopods with snails ranging from squat-shelled *Nerita versicolor* to long helical-shelled *Cerithium atratum* to catch the mantis shrimp in the act. 'We have endless hours of video footage of mantis shrimp doing pretty much everything besides eating', chuckles Crane, but the team's patience was eventually rewarded as they caught the animals carefully rotating the shells into position with their maxillipeds, before placing their antennules on the shell and delivering the first of as many as 460 blows. And when Crane and Kisare teamed up with Suzanne Cox to analyse the strike pattern, it was clear that mantis shrimp primarily focused their attack on the opening of the shorter squat shells, chipping away to gain access to the snail within. However, Crane admits that she was blown away when she and Kisare watched a crustacean dine on longer skinny *Cerithium* snails. Explaining that the mantis shrimp in Patek's lab usually consume squat-shelled snails, she was astonished when the animals switched the point of their attack to the apex of the long *Cerithinum* shells after failing to penetrate the open end.

Wondering whether the crustaceans were deliberately targeting the most fragile regions of the shell, Crane and Cox assaulted the shells with a mantis shrimp robot – affectionately known as Ninjabot, which Cox had built previously with David Schmidt, Yahya Modarres-Sadeghi and Patek – to test which portions of each shell were most vulnerable. However, the team quickly realised that the crustacean's shell-positioning ritual was far more sophisticated than they had thought. 'Setting up tiny shells to be struck [by Ninjabot] at exactly the desired angle against a complex substrate was exceptionally frustrating and time consuming', Crane recalls. Eventually, she and Cox confirmed that the central portion of the shell, which the mantis shrimp avoid striking, is the most robust while the opening and apex regions are more fragile. They also realised that the resourceful animals only resorted to hammering on the pointy end of the longest and slimmest shells when they were no longer able to chip away at the opening, because the thick ridges that run across the whorls prevented the damage from penetrating further.

So, mantis shrimp target specific regions of a shell and they can adapt their strategies to suit, but there are still many more tantalising mantis shrimp mysteries to resolve.

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