# Muscle powers spearing mantis shrimp attacks

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Mantis shrimps pack a powerful punch, whether they smash or spear their victims. According to Maya deVries and Sheila Patek from University of California, Berkeley, smasher mantis shrimps power their claws' ballistic blows using a catapult mechanism, but how do spearers deploy their weapons? Analyzing the movements of large Lysiosquillina maculata, the duo found that they unexpectedly use muscle power to launch their claw spears although smaller Alachosquilla vicina use a catapult mechanism like smashers.

A hungry mantis shrimp may be the last thing that a passing fish sees before it is snatched from the water by the predator. Maya deVries from the University of California, Berkeley, says 'Spearer mantis shrimps stay in their sandy burrows and they wait for a fast-moving prey item to come by, but then they come out of nowhere and grab the prey with their long skinny appendages.' However, little was know about how these vicious predators unleash their lightning-fast attacks. According to deVries, the spearing shrimp are closely related to smasher mantis shrimps, which pulverise the shells of crustaceans and molluscs with a single explosive blow from their mighty claws. Having decided to find out how the crustaceans unleash their deadly assaults, deVries says, 'We thought that the spearers would be just as fast – if not faster – than the smashers because they have a smaller time window in which to capture their prey.' deVries and her colleagues publish their discovery that *Lysiosquillina maculata* spearer mantis shrimps power their mighty spears with muscle alone while smaller *Alachosquilla* vicina spearer mantis shrimps use a more conventional catapult mechanism in *The* Journal of Experimental

Biology.

Working with her PhD advisor, Sheila Patek, deVries took a short trip along the corridor to Roy Caldwell's lab to film some of his *L. maculata* mantis shrimps. Coaxing the nocturnal lobster-sized crustaceans to assault frozen prawns, deVries recalls that the animals were reluctant to attack; 'They probably didn't like the bright lights', she says. However, when the duo analysed the speed of the strikes, they were surprised that the spearer's harpoon speed was much slower than that of their smashing cousin's. Explaining that smashers can unleash strikes at speeds ranging from 10 to 23m/s, the duo were taken aback that *L. maculata* could only muster 2 m/s.

Smasher mantis shrimp store catapult energy in skeletal springs that they unleash during a deadly assault; therefore deVries analysed the trajectories of several *L. maculata* claws in action, and realised that the hefty crustaceans were not using the same mechanism. 'The spear has all the same components [as the smashers]', explains deVries, but she adds that the shape of some of the structures are subtly different and the spring did not deform to store energy prior to an attack – possibly because it is too stiff – preventing *L. maculata* from firing a ballistic attack. 'If the *L. maculata* movement is similar to other ambush predators that have muscle-driven strikes, it is possible that these guys are creating strikes with muscle movement', says deVries.

Next, deVries and Patek tested the reactions of another, smaller mantis shrimp, *Alachosquilla vicina*, to find out whether all spearing mantis shrimps have opted for muscle-powered strikes. Elizabeth Murphy filmed the animals snapping up brine shrimp however, it was obvious that the diminutive crustaceans were using a spring-loaded catapult to spear their nimble prey. The team could clearly see energy-storing deformations in the spring structure before the mantis shrimp unfurled their deadly assaults at 6m/s.

But the team were still puzzled by *L. maculata*'s sluggish performance. Maybe the lab-based animals had become too unfit to produce explosive attacks? Traveling to Australia to film *L. maculata* hunting in the wild, the team were relieved to see that the animals' reactions were well within the range of speeds that they had measured in the lab. Adult *L. maculata* use muscle-powered attacks all the time.

Having confirmed that it is possible for the large shrimp to produce lightening-fast strikes without using a spring mechanism, deVries says 'We're trying to get more *L. maculata* in the lab to look at the complete size range in one species to see how the strike scales and to find out if there is a size threshold above which you can't have a spring-loaded strike anymore.'

**More information:** deVries, M. S., Murphy, E. A. K. and Patek, S. N. (2012). Strike mechanics of an ambush predator: the spearing mantis shrimp. J. Exp. Biol. 215, 4374-4384. jeb.biologists.org/content/215/24/4374.abstract

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