© 2019. Published by The Company of Biologists Ltd | Journal of Experimental Biology (2019) 222, jeb203356. doi:10.1242/jeb.203356

INSIDE JEB

Mantis shrimp fine-tune ballistic blows

Two mantis shrimp fight over access to a burrow. Photo credit: Roy Caldwell.

Mantis shrimp are feisty little beasts. Fiercely defending their burrows against interlopers, the aggressive crustaceans determinedly bludgeon each other's tails with their hammer-like raptorial appendages until the loser retreats. And when it comes to smashing dinner, the creatures pulverise the shells of snails and crabs to dine on the sweet meat within. But how much effort does it take a spirited shrimp to retain its supremacy, and, more to the point, can they fine-tune how hard they thwack trespassers and tea alike?

'I am interested in how animals adjust their use of energy to achieve different tasks', says Patrick Green, from Duke University, USA, adding that the trade-off between exertion and outcome often determines how particular individuals behave. Knowing that Sheila Patek, also from Duke, and Matt McHenry, from the University of California, Irvine, USA, had built a computer simulation that allows them to calculate the energy released by a mantis shrimp's explosive hammer-like blows, Green decided to put the hungry and combative creatures through their paces to find out whether they tweak their blows depending on the context.

'There's very little danger in working with these mantis shrimp. While powerful, they're still very small and being struck doesn't really hurt', says Green, recalling collecting the weeny creatures from the seagrass beds off the Smithsonian Tropical Research Institute's Galeta Marine Laboratory in Panama. After returning to Duke, Green filmed the crustaceans' contests over burrows and when dining. 'Mantis shrimp are highly territorial', says Green, recalling how the animals easily came to blows when their burrows were nestled against each other. 'What was more difficult was getting them to eat', he recalls, adding, 'Sometimes, a shrimp would jam its snail into a corner of its burrow and start striking away, but all of these strikes would be useless to me, because the angle relative to the camera was off'. Green recorded the duels and snail assaults at 40,000 frames s^{-1}, and then painstakingly digitized the hammer swipes and calculated the speed and energy of each movement.

Impressively, when he compared the speed and strike energies, it was clear that the animals fine-tuned their blows, depending on whether they were engaged in combat or simply trying to open a snack. Larger mantis shrimp were able to deliver more energy in their blows when competing for a burrow than smaller assailants, and Green suggests that this increase may 'signal larger body size to an opponent'. However, when it came to smashing a snail, the smallest mantis shrimp dealt faster blows than the larger crustaceans, suggesting that the larger animals may only be striking with as much energy as they need to open their snail suppers. Green also calculated how much the mantis shrimp were compressing the spring that fires off their ballistic blows, and it was clear that the animals that struck the most energetic blows compressed the spring most. 'This tells us… how animals with spring-powered movements can achieve variations in those movements', says Green. He also determined whether the crustaceans tweak how much energy they pack into the blows that they deliver to opponents, and it appears that they do, suggesting that they may be able to gauge how powerful an adversary is.

So, mantis shrimp can adjust the speed and energy of their strikes depending on their size and at what they aim their blows. And, having discovered that the crustaceans can adjust the scale of an attack, Green is now eager to learn how they judge opponents and prey to fine-tune their assaults.

10.1242/jeb.203356

Green, P. A., McHenry, M. J. and Patek, S. N. (2019). Context-dependent scaling of kinematics and energetics during contests and feeding in mantis shrimp. *J. Exp. Biol.* **222**, jeb198085.

Kathryn Knight
kathryn.knight@biologists.com