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Inside JEB

CRAFTY CRAYFISH CHEAT


Picture by Anthony O'Toole

Nestled just off the east coast of Australia, picturesque North Stradbroke Island is a haven for local wildlife. Yet some of the inhabitants of the island's creeks and swamps are far from peaceful. Slender crayfish are aggressive territorial creatures, explains ecologist Robbie Wilson of the University of Queensland, Australia. When two crayfish catch sight of one another, they size each other up in a ritualistic display, which can quickly escalate from careful tapping of their opponent's chelae (enlarged front claws) to a full-blown fight. Studying these fascinating animals, Wilson discovered that crayfish decide whether to flee or fight based on the size of their adversary's chelae, and that victorious females always have larger and stronger claws. But, to his dismay, he found that some males with weaker claws cheat; they defeat stronger foes despite having a weaker – albeit larger – claw. 'Theory does not predict such dishonesty,' Wilson says. Deceptive signals of weapon strength should not exist, as opponents would quickly stop taking notice of an unreliable cue. So how do males get away with it, Wilson wondered (p. 853).

Teaming up with Candice Bywater, Wilson first took a closer look at the relationship between claw size and strength in female crayfish, to compare them with the males. 'We knew that male signalling is unreliable, so we expected to see more variability in weapon strength in males than in females,' Wilson explains. To measure crayfish claw strength, Frank Seebacher of the University of Sydney, Australia, helped Wilson design a custom-made apparatus consisting of two thin parallel beams with external force transducers. Luckily, it wasn't too tricky to entice the animals to clamp down on the contraption. Crayfish are 'very enthusiastic about biting,' says Wilson. 'We just had to direct their claws to the device and they'd bite.' The team found that, for a given claw size, males had huge variation in claw strength compared with females. This makes it hard for males to size each other up using claw size alone, which allows males to cheat when it comes to advertising their strength.

To understand just how serious the cheating was, muscle physiologist Rob James from Coventry University, UK, measured how much force crayfish muscles produce. He found that the muscles of female crayfish are actually more powerful than those of males. 'So males are not only cheating by creating large chelae with little muscle inside, but the muscle they do put in there is actually weaker,' Wilson concludes.

But these findings still didn't explain how males get away with cheating. Wilson wondered if there might be a disadvantage to growing large claws – if growing intimidating weapons is costly, this would ensure that males' unwieldy claws are actually a reliable signal of their prowess. To test whether large claws might be a handicap when it comes to escaping danger, Wilson and Bywater measured how quickly crayfish sped off when startled. Sure enough, while females' swimming performance was unaffected, 'the large claws of the cheating males reduced their swimming speed,' Wilson says. This suggests a potentially serious fitness cost to growing large claws; males encumbered by big claws may end up as a predator's lunch.

According to Wilson, the importance of dishonesty in weapon signalling is underappreciated, and may play a larger role than previously suspected. The next step, he says, is to 'find out how frequently cheating occurs in nature.'

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Wilson, R. S., James, R. S., Bywater, C. and Seebacher, F. (2009). Costs and benefits of increased weapon size differ between sexes of the slender crayfish, *Cherax dispar*. *J. Exp. Biol.* **212**, 853-858.

Yfke Hager

HOW PORPOISES TRACK PREY WITH ECHOLOCATION

Humans have long been fascinated by animals that detect the world through sensory systems that we lack, such as dolphins and porpoises, which navigate by echolocation. However, many of these animals, which dwell in coastal waters, are at increasing risk from human activity. Ursula Verfuß from the University of Tübingen explains that many die entangled in fishermen's nets; 'either they don't perceive the nets or they don't perceive them as a threat,' she says. Knowing that harbour porpoises residing in the German Baltic are particularly at risk, Verfuß and her colleagues Lee Miller, Peter Pilz and Hans-Ulrich Schnitzler were curious to know how the animals perceive the world around them. Having already discovered that the porpoises navigate by reducing the interval between echolocating clicks as they approach a landmark, the team decided to

find out how the animals adjust their sonar as they close in on a tasty snack (p. 823).

Verfuß travelled to the Fjord&Bælt centre in Kertminde, Denmark, to work with two young porpoises, Freja and Eigil. According to Verfuß, the porpoises were very cooperative and fun to work with, but working in the open was a challenge. 'We couldn't film for days after a storm because the water was disturbed and another time the enclosure was full of jelly fish,' Verfuß recalls. However, when conditions were good, one of the porpoises' trainers threw a brook trout into the porpoises' enclosure while Verfuß filmed the animals and recorded their echolocation clicks as they homed in on the victim.

According to Verfuß, the porpoises speeded up after hearing the splash and eventually rolled onto their backs in the final moments before sucking the fish down. And when Verfuß repeated the experiments with Freja's eyes covered, she slowed a little but still caught the fish. The porpoises could hunt successfully by echolocation alone, but how were they using echolocation to locate the hapless fish?

Analysing the porpoises' click sequences, the team realised that the pursuit could be broken down into three phases: search, initial approach and final approach. During the search phase, the porpoises seemed to lock their navigation system onto a local landmark and gradually reduced the time intervals between clicks as they closed in. But as soon as the animals spotted the trout, the click pattern changed. The porpoises maintained a constant average click interval as they drew closer to the victim until they were close enough to pounce. Then they rapidly accelerated their click rate and reduced the click interval to a few milliseconds, just like echolocating bats, which produce a buzz of clicks in the moments before capturing an insect.

Verfuß admits that she hadn't expected the porpoises to switch to an almost constant click interval during the initial approach phase. She had thought that the animals would continue shortening the click interval, sending clicks out as soon as the echo returned, speeding up the echolocation process as they approached the trout. However, Pilz suggested that maybe the porpoises switch to a constant click interval to confuse their targets. Verfuß explains that some fish have good hearing, and could be alerted to the porpoises' approach by the accelerating clicks. According to Verfuß, it is possible that by switching to a constant average click rate, the porpoises lull their prey into a false sense of security, making it easier to sneak up and gulp them down.

10.1242/jeb.030353

Verfuß, U. K., Miller, L. A., Pilz, P. K. D. and Schnitzler, H.-U. (2009). Echolocation by two foraging harbour porpoises (*Phocoena phocoena*). *J. Exp. Biol.* **212**, 823-834.

LIZARDS ADJUST MOVEMENTS AS THEY BITE

Every creature has its own dining style. Some animals locate fruit lunches before sitting down to munch, while others sneak up and grab an unsuspecting snack. And then there are different ways to snag a meal. Some lizards fire out sticky ballistic tongues, while others snap up treats with their jaws. But getting a meal isn't just about what you do with your mouth. While some lizards seem to feed perfectly well by simply sticking their tongues out, most animals have to move too. Which made Stéphane Montuelle and Vincent Bels from the Muséum National d'Histoire Naturelle in France wonder how closely correlated the two systems are. Having previously found that *Anolis* lizards always use the same jump pattern when capturing prey with their tongues, Montuelle and Bels decided to test out the table manners of other lizards to find out whether other species can adjust their body movements in response to different feeding actions (p. 768).

Knowing that *Gerrhosaurus major* lizards seem equally happy using their tongue and jaws to catch prey, the duo contacted Anthony Herrel in Antwerp to see if they could test out his *Gerrhosaurus* lizards' eating habits. Travelling down to Paris with his lizards on the train, Herrel offered the lizards meals ranging from stationary morsels of banana to super-fast grasshoppers while Paul-Antoine Libourel and the rest of the team filmed the animals with a high-speed 3D camera rig to find out how the reptiles adapted their feeding styles to different diets. Herrel remembers that the lizards were fantastically cooperative and they had collected all of the film data within a week, but analysing the data with the help of engineer Lionel Reveret was much more laborious for Montuelle.

So how did the lizards grab lunch? According to Herrel the lizards had two clear strategies depending on the prey type. They opted to land lumps of banana and slow moving meal worms with their tongues, while snapping up larger and faster mice and grasshoppers with their jaws. Herrel admits that he was surprised that the lizard's behaviour was so clear cut. He explains that feeding strategies in other species don't seem as hard wired as they are in *Gerrhosaurus*. For example, each individual *Anolis* lizard selects its own strategies, but always uses the same strategy for that particular morsel.

The team was also surprised that in contrast with the *Anolis* lizards, which never vary their jump pattern when catching food with their tongues, the *Gerrhosaurus major*s always adjust their movements to some extent. The amount that the animals reared up seemed to depend on their victim's mobility, with the lizards straightening their elbows most to capture the fastest grasshoppers. And when the team analysed the extent to which the lizards threw their jaws wide, they found the lizards could open their mouths faster the higher they reared up, giving them the element of surprise over their victims and increasing their chances of success.

Having found that the lizard's feeding actions and body movements were tightly coupled, Bels and his colleagues are curious to know how the reptiles synchronize their mouths with their bodies to snatch a snack.

10.1242/jeb.030379

Montuelle, S. J., Herrel, A., Libourel, P.-A., Reveret, L. and Bels, V. L. (2009). Locomotor–feeding coupling during prey capture in a lizard (*Gerrhosaurus major*): effects of prehension mode. *J. Exp. Biol.* **212**, 768-777.

CIRCADIAN AND PHOTOPERIOD CLOCKS SHARE NEURONS

The daily and seasonal rhythms of life are controlled by biological clocks. The circadian clock tells us when to sleep and wake up, and the photoperiodic clock tells many creatures how to behave in response to seasonal changes associated with changing day length. But no one knew whether components of the daily circadian system functioned in the insect's longer-term photoperiodic clock (p. 867).

Sakiko Shiga and Hideharu Numata from Osaka City University, Japan, decided to test the roles of circadian neurones in the photoperiodic clock by removing neurons that regulate the blow flies' circadian rhythms, and monitoring the blow flies' ability to become dormant in response to shorter days associated with the onset of winter.

The team found that flies lacking the circadian clock's small lateral ventral neurons were unable to distinguish between long and short days, with 48% of the insects going into diapause when the days were long (and they shouldn't have), while only 55% of the flies went into diapause when the days were short and all of them should have hunkered down.

So neurones involved in regulating daily rhythms also seem to be involved in regulating seasonal behaviours and the photoperiodic clock shares some of the circadian clock's neural elements.

10.1242/jeb.030361

Shiga, S. and Numata, H. (2009). Roles of PER immunoreactive neurons in circadian rhythms and photoperiodism in the blow fly, *Protophormia terraenovae*. *J. Exp. Biol.* **212**, 867-877.

Kathryn Knight
kathryn@biologists.com
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