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INSIDE JEB

# Minute mecysmaucheniid spider triggers fastest trap-jaws

The cephalothorax of an *Aotearoa magna* (left) and *Zearchaea* sp. (right) spider, showing the chelicerae in the resting position.

When Hannah Wood first encountered tiny mecysmaucheniid spiders scurrying through the leaf litter in Chile, she had no idea that some of the minute arachnids would have more in common with a family of ants – trap-jaw ants – that attack their victims with spring-loaded jaws. Instead of sitting enthroned in a web, the feisty spiders grasp their quarry in a vice-like grip with a pair of fierce-looking chelicerae – jaws tipped with fangs – which snap closed to ensnare their prey. However, some members of the family performed the manoeuvre so fast that it could not be powered by muscle alone. Knowing that trap-jaw ants depend on springy structures held open by a latch prior to slamming their jaws shut, Wood travelled to New Zealand in search of other members of the mecysmaucheniid family, to discover how the spiders bring their jaws crashing together.

After sifting the leaf litter through a fine mesh to collect the 2–4 mm long spiders, Wood goaded the animals into clamping their jaws shut by prodding them with an eyelash attached to a pin as she filmed the chelicerae slam closed at speeds of up to 100,000 frames $s^{-1}$. Focusing on two of the closest members of the family, *Zearchaea* spp. and *Aotearoa magna*, Wood realised that *Zearchaea* clamped their jaws shut at blistering speeds of up to 18.2 m $s^{-1}$. 'This is the fastest arachnid movement ever documented', she says. In contrast, *Aotearoa* closed their jaws more sedately, only reaching average speeds of around 0.09 m $s^{-1}$. Then, Wood calculated the power necessary to produce *Zearchaea*'s eye-watering accelerations and realised that the spiders would require a muscle that could produce 670,000 W $kg^{-1}$ of power – which is completely impossible – to close their jaws in 0.07 ms, although *Aotearoa* jaw muscles should be more than capable of powering their slower closure.

Knowing that *Zearchaea* must depend on a spring-loaded catapult to provide the enormous power required to clamp their jaws shut, Wood CT scanned the minute spider's heads with Dula Parkinson at the Lawrence Berkeley National Lab Advance Light Source synchrotron to reveal how the jaws of both species connected to the carapace through muscles and ligaments. The slower *Aotearoa* jaws were equipped with nine pairs of muscles – one pair to pull the jaws open while the remaining eight muscle pairs clamp them shut. *Zearchaea*, in contrast, seem to have done away with three of the pairs of closure muscles.

Focusing on the muscles that lever the jaws open in both species, Wood noticed that they rotate the jaws upwards before opening them wide in preparation for an attack; but there the similarities ended. Although she could see that four of the pairs of *Aotearoa* muscles were required to squeeze the chelicerae together, *Zearchaea* jaws seem to be slammed shut by a powerful catapult mechanism. By building a 3D printed model of the spider's head, Wood realised that a pair of springy ligaments linking *Zearchaea*'s chelicerae to the carapace could store energy like a catapult when they are stretched as the jaws open, before being locked in place by a piece of the exoskeleton close to the jaw bases. Wood suspects that this latch is only released when muscles attached to the hinge linking the two chelicerae yank it back, allowing the stretched ligaments to recoil, slamming the jaws together.

While *Zearchaea*'s spring-loaded jaws definitely earn them a place in the arachnid record book, Wood is also keen to understand why the close relatives evolved such different strategies in the relatively brief time since they last shared a common ancestor.

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