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INSIDE JEB

Lateral line helps premature treefrogs evade jaws of death

A parrot snake (*Leptophis ahaetulla*) attacking a clutch of red-eyed treefrog eggs. Photo credit: Karen Warkentin.

Faced with the choice between hatching prematurely or ending up on the menu of a voracious snake, precocious red-eyed treefrog (*Agalychnis callidryas*) embryos usually plunge for the former, wriggling free of their eggs before tumbling into the pond beneath their rainforest tree home when under attack. Sensing the tell-tale tearing motion and vibrations produced by a predator devouring their siblings, the embryos quickly digest a hole in their egg membrane to make a break for it. Julie Jung from Boston University, USA, explains that the embryos detect the impending threat through vibration-sensitive otoconial organs in their developing ears, which begin to function about 4 days after fertilisation. However, Jung and PI Karen Warkentin, also from Boston University, realised that the youngsters can effect an escape even before their otoconial organs come online, suggesting that another vibration-sensitive structure may also provide an early warning. Knowing that tadpoles are equipped with strings of motion-sensitive organs distributed across their skin, known as the lateral line system, the duo decided to investigate whether this additional sense helps the escapologist embryos.

Travelling to the treefrogs' tropical home in Panama, Jung and Warkentin teamed up with Shirley Serrano-Rojas at the Smithsonian Tropical Research Institute to collect freshly laid frog spawn. Back in the lab, once the embryos were able to hatch, the team jiggled the eggs with a probe – as if they were under snake attack – every few hours to see how many broke out. In addition, they checked for signs that the embryos' otoconial organs were beginning to function, at which point the team temporarily deactivated the lateral line sensors of some of the developing animals by gradually increasing the dose of an antibiotic – gentamicin – over half a day, before evaluating how many hatched when attacked with the probe.

As the embryos grew, it was clear that the youngsters that had lost the use of their lateral lines were at a disadvantage. Even when their otoconial organs had begun to function – 4.2 days after fertilization – only 2% of the embryos that had lost their lateral lines broke out of their eggs when attacked, compared with ~40% of the embryos from untreated clutches. In addition, the youngsters that had lost the use of their lateral lines were slower to hatch. 'The lateral line system is providing important information to embryos under direct attack, but it's only essential for the very young ones, whose ears don't work yet', says Warkentin.

However, when the team simulated the vibrations produced by a snake munching on the other side of the clutch, to check whether the embryos' lateral line sensors helped them to detect warning vibrations transmitted though the clump of spawn, the gentamicin-treated embryos were not at a disadvantage, hatching as well as the untreated embryos. In other words, the embryos' lateral line may not be sensitive to vibrations alone carried through the eggs.

'It seems that when a snake attacks an egg mass, some embryos will sense it with just their ears and others, closer to where the snake is biting, will sense it with both their ears and the lateral line sensors on their skin', says Warkentin. And when Jung painstakingly monitored how the lateral line sensory organs developed, the team was impressed to find that the youngsters had a remarkably large number, ranging from 247 to 434; far more than have been found in other frogs at the same stages of development. So, tiny red-eyed treefrog embryos are even more sensitive than we knew, depending on two sensory systems to hatch prematurely when needing to evade the jaws of death.

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