INSIDE JEB

Bats locate boastful frogs by echolocation

Robofrog model calling in the Panama rainforest. Photo credit: Ryan Taylor.

Attracting the ladies is all about putting on the best performance, so male túngara frogs make sure that they stage a spectacular extravaganza. 'They have these huge vocal sacs that are almost twice the size of their normal body', describes Wouter Halfwerk from the Smithsonian Tropical Research Institute, Republic of Panama, adding that the males inflate the sacs as they serenade the females. But Halfwerk was intrigued; if the male frogs were so effective at advertising to females, who else was picking up on the ostentatious display and which sensory systems were these eavesdroppers using to check out the action? Halfwerk explains that fringe-lipped bats are particularly partial to a túngara frog snack, so he wondered which part of the amorous display a hungry bat might tune in to and which senses could the stealthy hunters use to home in on their boastful prey (p. 3038)?

Intrigued, Halfwerk set off into the rainforest to catch some bats. 'That's the fun part', he chuckles, describing how he used recordings of frog choruses to lure bats into a net. However, instead of using live frogs to test the bats' reactions, Halfwerk had access to incredibly life-like túngara frog models – made by artist Barrett Klein in collaboration with Halfwerk's colleagues Ryan Taylor, Rachel Page and Michael Ryan – that could put on a mating display realistic enough to seduce female frogs.

Having settled the bats into their new home, Halfwerk and colleague Patricia Jones, helped by May Dixon and Kristina Ottens, tested the animals' responses to the robot frogs' performances. Offering the bats a choice between a static robofrog and a singing robofrog that were 0.5 m apart, the duo was impressed to see that the bats only attacked the vocalising frog models. Robofrog's mating performance was definitely attracting the predators, but which component of the frog display were the bats locking on to?

The team tested whether the bats were attracted to the movement of the vocal sac or the shear size of the inflated organ. The bats enthusiastically attacked robofrog models that had been inflating their vocal sacs and they even responded to frogs that had been moving but froze as soon as the bat left its perch. The team also tested the range over which the bats could pick out the frogs and were surprised that the bats could detect their prey over an impressive distance of 4 m.

But which sense were the bats using to detect their frog victims? According to Halfwerk, the female frogs use vision and hearing to assess their males, but could the bats be using echolocation alone? First, the team placed the bats in darkness to force them to rely on echolocation and waited to see how well the bats targeted the robofrogs. The bats had no difficulties identifying calling robofrogs in the dark. However, when the team interfered with the bats' echolocation – by shielding the frogs' moving vocal sac with a transparent cup – the animals were completely flummoxed, selecting the static and mobile frog models at random.

Instead of relying on vision to identify male túngara frog victims, predatory fringe-lipped bats use their echolocation channel, and Halfwerk admits that he is impressed that it only takes two echolocation squeaks for the bats to locate their victims. However, he adds that predation by the bats is pretty bad for the sexual signal and he suggests that it could be one of the factors that helps to keep the size of the male's vocal sac in check, otherwise what would stop them expanding to three or even four times their own body size?

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Kathryn Knight

Varroa mites switch hitch preference as hive collapses

Choice experiments to test mite preference. Photo credit: Federico Cappa.

They might be only tiny, but the *Varroa* mite has the potential to bring large parts of western agriculture to its knees. Infesting and destroying honeybee hives, the pernicious arachnid is already causing untold damage by disabling the trusty insects that pollinate much of our staple diet. However, having brought a hive to the verge of collapse, the mites are confronted with a dilemma: stay put and perish, or – like all good rats – abandon the sinking ship ready to infest another pristine hive. 'Halting mite transmission among beehives is of primary importance', say Rita Cervo and colleagues from the Università degli Studi Firenze, Italy. According to Cervo, mites prefer to hitch rides on nurse bees when the colony is healthy, in order to infect new brood at home. However, the team wondered whether the mites could switch preferences when conditions become overcrowded, choosing instead to thumb a lift from a non-nest mate forager that could transport them to uninfected hives when their current home is about to expire (p. 2998).

Testing the mites' preferences for hitching rides on hive-bound nurses or roving foragers, the team found that mites from hives with low rates of infection preferred to hop aboard nurses. However, as the rates of mite infestation

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in hives climbed, the mites became less choosy; they seemed equally content to ride on foragers and nurses alike. Intrigued, the team analysed the blend of waxy substances coating the bees' surfaces and found that the mites could probably distinguish between the nurses and foragers in hives with low rates of mite infection, because the nurses' waxy blend was very different from the blend of the foragers. However, the wax mixtures on nurses and foragers from the hives with the highest levels of *Varroa* mite infection were more similar, making it harder for the mites to distinguish between nurses that would keep them in the dying hive and foragers that could carry them to safety. The presence of the mites had altered the foragers' waxy coatings.

The team says, 'These results show that, at low mite abundances, mites stay within the colony where they are born'. However, they explain that by losing the ability to distinguish between nurses and foragers when infection rates are high, mites increase their chances of getting a lift from a forager that happens to be visiting from another hive, improving their chance of survival when their home faces extinction.

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Kathryn Knight

Leaky toads have complex lymph system

Toads have a little problem with water retention; their circulatory system is extremely leaky. Lymph is continuously lost from the blood as it filters out through capillaries, and the animals have to recycle the precious fluid to maintain their blood volume. Michael Hedrick, from California State University, USA, says, 'Lung ventilation and specialised skeletal muscles move lymph from the ventral [lower] part of the animal to the dorsally located lymph hearts [in the back] that pump lymph back into the venous circulation'. However, it was not clear to Hedrick and Tobias Wang, from Aarhus University, Denmark, how the animals pumped fluid from cavities low down in the body up to the lymph hearts. 'Knowing how the lymph sacs and sinuses are connected doesn't tell us how much lymph might move through these pathways toward the lymph hearts', explains Hedrick. Teaming up with Kasper Hansen, Hedrick injected a solution that shows up in CT scans into the lymph sacs of cane toads and scanned the animals at Aarhus University Hospital to see how the fluid was pumped through the body prior to being returned to the animals' bloodstream (p. 2990).

'The toads were extremely cooperative', recalls Hedrick, explaining that although each scan took only 10 s, the toads had to remain still for several hours at a time as the dye moved slowly through their bodies. However, after scanning six toads and analysing the data with Hansen, Jesper Thygesen, Michael Pedersen and Henrik Lauridsen, Hedrick was pleased to identify several lymph return routes that had been predicted, including one where lymph flowed vertically from the interfemoral sac through the pubic sac up to the lymph hearts. In addition, they identified several novel routes, including one where dye injected into a lymph sac above the lungs moved down between the lungs before travelling back toward the hindlegs and the lymph hearts. 'This was completely unexpected', says Hedrick, concluding, 'The lymphatic system in frogs and toads is a complex arrangement of lymph sacs and sinuses, and movement of lymph occurs through complicated and surprising pathways'.

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