INSIDE JEB

Sensing CO_2 makes black-legged ticks quest for hosts

Two black-legged ticks questing for a host. Photo credit: Carola Städele.

Finding something to eat is of the utmost importance for all animals, but they have different strategies for finding food. Some small blood-feeding animals actively hunt their hosts, while others, like the black-legged tick (*Ixodes scapularis*) climb a piece of grass and frantically wave their front legs about until a meal passes by. But waving your front legs around all day could prove fruitless. Ticks need a way to sense when their host is coming, so they know when to start their leg waving. But what cue do they use? Do they use CO_2 to home in on their target like some other blood feeders? Perhaps, like ticks that actively hunt for hosts, black-legged ticks start heading towards the source of CO_2 before waving their legs, hoping to catch a ride on their unsuspecting host. This uncertainty led Carola Städele of the University of Göttingen, Germany, to ask how do black-legged ticks respond to CO_2 and how are they sensing it?

Städele placed 5 ticks at a time into a clear, air-tight container and videoed their behaviours. When first placed in the container, many of the ticks just wandered around. After letting the tiny arachnids settle down, Städele started increasing the levels of CO_2 in the chamber, first to 1%, then 2%, then 4% – the amount present in a normal human exhalation – and finally to 8%. After videoing 50 ticks, Städele noticed something surprising: 80% of the ticks responded to the lowest concentrations of CO_2 by either walking faster, if they were already moving, or by starting to wave their front legs in the air. Once the concentration of CO_2 in the chamber reached 4%, almost all the ticks were responding to the increased levels of CO_2. This suggests that the ticks were able to sense even low levels of CO_2 and that these levels are enough to cause the ticks to start seeking their potential hosts. However, the way that these ticks sense the CO_2 is still a mystery.

Studies on other species of ticks suggested that CO_2 is sensed by a small organ on the tip of the tick's front legs, called the Haller's organ. With this in mind, Städele repeated her tests on the ticks, but this time she covered the Haller's organ with blue wax to stop it from sensing CO_2. To her surprise, Städele found that 60% of the ticks still responded to the CO_2. However, it took the ticks longer to respond and their reactions didn't last as long as when their Haller's organs were wax free. Städele suggests that there are two different ways that these ticks are sensing CO_2, 'a fast one via the Haller's organ and a slower one via a hitherto unidentified structure'. She also thinks that the purpose of the Haller's organ in this species of ticks may be to sense CO_2, thereby priming the ticks for finding their future host, as it increases the waving of their front legs. This waving behaviour could also allow them to gather more information about direction and distance of their potential host. There could be other cues that the Haller's organ also senses when a new host gets closer, such as body heat or other chemical odours.

While it's still too early to tell what other mechanisms help ticks sense CO_2, it is certain that black-legged ticks can sense CO_2 without their Haller's organ, but that it also acts as a fast-acting sensor that starts their questing behaviour when CO_2 is nearby. Although it might not be their only CO_2 detector, the Haller's organ is certainly important in the black-legged tick's quest for food.

10.1242/jeb.247611

Städele, C. (2024). The black-legged tick *Ixodes scapularis* detects CO_2 without the Haller's organ. *J. Exp. Biol.* **227**, jeb246874. doi:10.1242/jeb.246874

Jarren Kay
jarren.kay@biologists.com

Inside JEB highlights the key developments in Journal of Experimental Biology. Written by science journalists, each short report gives the inside view of the science in JEB.