Super Senses — Scorpion

Exhibit main message

Scorpions sense vibrations in the sand to find prey nearby.

Quick fact

Scorpions glow when they are placed under an ultraviolet lamp.

They can survive irradiation, drought and famine. It is an urban myth that scorpions 'commit suicide' by stinging themselves and injecting their own venom. Studies show that scorpions are immune to their own venom when it is administered in a laboratory setting.

Graphic panel text

Sand scorpions use the sense of touch on their eight feet to hunt at night.

If prey make the slightest movement, they send out vibrations through the sand.

Tiny levers on the scorpion's feet detect vibrations as small as one millionth of a millimetre!

Special nerves judge the timing and direction of the vibrations, so the scorpion can pinpoint exactly where the prey is hiding.

The scorpion quickly turns towards the prey and grabs it before inflicting a paralysing sting with its tail.

Want to know more about scorpion hunting behaviour?

During the day, desert scorpions burrow under the sand and emerge at night onto the surface to hunt prey. A scorpion's eyesight is rather poor, so it relies on its sense of smell and vibrations in the sand to pick up the location of its next meal.

Whenever an insect walks across sand, it can't help generating vibrations that travel out through the sand. Sand is fairly absorbent, so vibrational waves tend to travel up to 40 centimetres from a source. This means that there is little 'background noise' and the scorpion can pinpoint the source of vibrations fairly easily.

Scorpions can detect compression and surface waves that travel through sand.

Tiny levers called sensillum are found on each leg just above the joint of the foot. When surface waves pass by, the foot acts like a lever, and squeezes the sensillum. Nerves behind sensillum react when the sensillum moves, so the scorpion knows which leg was stimulated.

Other sensory hairs touching the sand are more sensitive to compression waves. These hairs can detect a shift in sand as small as one millionth of a millimetre.

Scorpions react to the timing, rather than the strength of vibrations. If one weak, but detectable vibration passes under a scorpion, quickly followed by a second much stronger vibration, the scorpion only reacts to the first, weaker vibration.

Once the scorpion detects vibrations through the sand, it quickly turns in the direction of the prey to grab it with its front pincers. Then the scorpion flicks its tail forward over its own head to subdue the prey with a sting on the tip of its tail.

Extra for experts

Scorpions react to timing of vibrations in the sand, rather than vibrational strength. They are able to detect vibrations that have a certain amplitude (wave height) and frequency (300–400 Hertz).

Scientists placed a sand scorpion on two independently movable platforms (four of the scorpion's right sided legs on one platform, its remaining four, left sided legs on the neighbouring platform).

The scientists vibrated the platforms at different times and at different intensities to observe how the scorpion behaved.

The scorpion reacted to the time delay of platform vibrations rather than the intensity of vibration by always turning toward the platform that moved first.

Even when the second platform's vibrations were much stronger, the scorpion moved towards the platform that vibrated first. The scorpion could also detect vibration order even when the first platform vibrated just 0.2 milliseconds before the second platform.

Scientists have developed a mathematical theory to show how the scorpion's nervous system may react to vibrations. This theory is called a time window model and it shows how the scorpion's eight legs 'vote' on which direction the scorpion should turn.

The scorpion's eight legs may be seen as a circular pattern labelled R1 to R4 front to back on the scorpion's right side and L1 to L4 on the scorpion's left side. Each leg has its own sensilla to detect vibrations and nerves from the sensilla carrying signals to the brain and other parts of the scorpion.

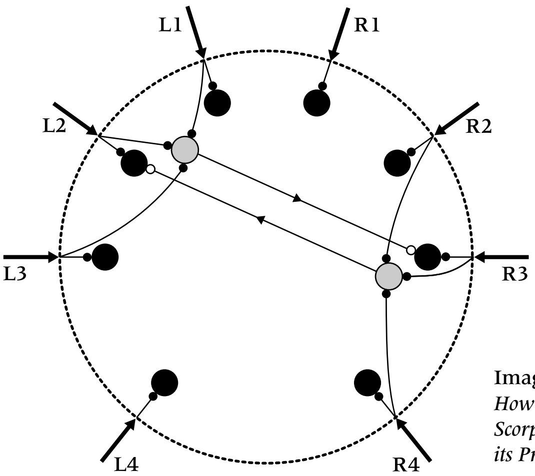

Image from *How the Sand Scorpion Finds its Prey.*

If a cockroach is burrowing 90 degrees to the right hand side of a scorpion, waves travel through the sand and pass beneath the scorpion's eight feet.

As the cockroach burrows and waves travel out through the sand, the scorpion's R3 leg (which is closest to the cockroach) detects the wave first, followed by legs R4, R2 and R1. All of these signals pass through the scorpion's brain.

However, as the R3 nerve is firing, an inhibitory neuron iR3, fires at the same time. This inhibits any nervous signals from travelling across to the opposite side of the scorpion and stimulating its L2 leg. The scorpion's other right-sided legs (R4, R2 and R1) send similar inhibitory signals to the left-sided legs.

There may be a 1 millisecond delay between legs R3 and L2 being excited by a passing surface wave. This may be enough time for the R3 leg to become vigorously excited while the L2 leg is inhibited.

After this initial inhibition of signals to the left sided legs, vibrations and signals may be allowed to pass through to the scorpion's left leg.

The scorpion may quickly calculate this time difference (or time window) and work out the direction and angle it should turn to face prey nearby.

Further information

How the Sand Scorpion Finds its Prey. http://www.aps.org/meet/MAR00/baps/vpr/layy3-03-04.html Philip H. Brownell and J. Leo van Hemmen.

Museum Victoria, Scorpion fact sheet http://www.museum.vic.gov.au/infosheets/0266.pdf

The time of sands. *Nature*. Haw, Mark. 19 June 2000. http://www.nature.com/nsu/000622/000622-4.html

Theory of arachnid prey localization. *Physical Review Letters*. 2000. Sturz, W., Kempter, R., van Hemmen, J.L. Vol 84: 5668–5671.

The soft footfall that signals dinner. *New Scientist.* 03 April 1999. Vol 162 (2180): 6. http://archive.newscientist.com/secure/article/article.jsp?rp=1&id=mg16221800.900