



Non-visual orientation of desert sand scorpions.

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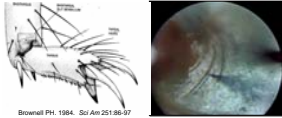


1 Introduction / Background.

Scorpions are nocturnal arthropods that have minimal surface activity and prefer to leave their burrows during periods surrounding the new moon (Warburg & Polis 1990). Although scorpions have very sensitive eyes, vision is not the primary sense used in prey detection (Fleissner & Fleissner 2001; Warburg & Polis 1990). Instead, scorpions track mechanical disturbances of the ground and air to detect and localize prey (Brownell 2001). On each leg, scorpions have basitarsal compound slit sensilla (BCSS), which are groups of eight slits that are responsive to vibrational waves in sand (Brownell & Farley 1979a). On each of their claws, scorpions have small hairs called trichobothria, which are extremely sensitive to air currents and low frequency sound waves (Brownell 2001).

Basitarsal Compound Slit Sensilla.

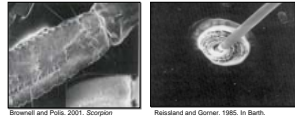
- Detect vibrations in sand up to 50 cm away
- Found on all eight legs
- Determine direction of disturbance by the time delay of the arrivals of the waves between leg



Brownell PH, 1984. Sci Am 251:86-97

Trichobothria.

- Small hairs on pedipalps
- About 70 on each pedipalp
- Detect airflow disturbances and allow scorpions to orient to prey in the near field (<10 cm)

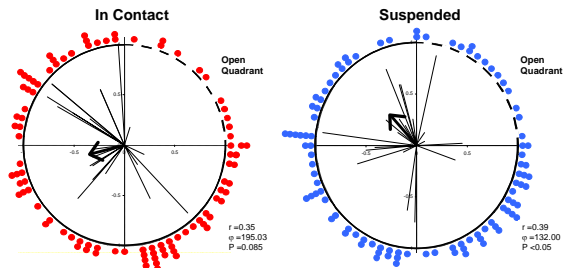


Brownell and Polis, 2001. Scorpion Biology and Research.

Fleissner and Corner, 1985. In Barth, ed. Neurobiology of Arachnids.

2 Previous research shows tendency for scorpions to move toward enclosures (in dark).

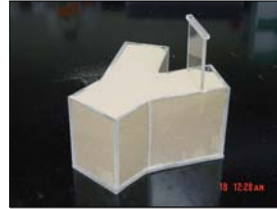
Since scorpions can detect vibrational waves and airflow pattern disturbances caused by moving prey, they may also be able to detect vibrations and airflow disturbances created by their own movements. An honors thesis by Vail Stephens in 1999 indicated that scorpions preferred the closed area of an arena to the open area when dropped into the arena in total darkness (Stephens, 1999). These results indicate that scorpions might be using non-visual sensory systems to orient in the dark.



Scorpion orientation behavior relative to an open quadrant of a circular arena. A total of 142 trials were run for both "arena in contact with sand" and "arena suspended above sand" trials. The animals' initial wall contacts are plotted relative to the clockwise boundary of the open quadrant. Each dot represents initial wall contact for one trial. The thin lines indicate the mean vector for each animal while the thick lines indicate the mean vector for each group. Abbreviations: r = mean length of vector, ϕ = mean angle of vector, and P = probability based on Rayleigh tests for randomness. [data from Stevens, OU Honors Thesis]

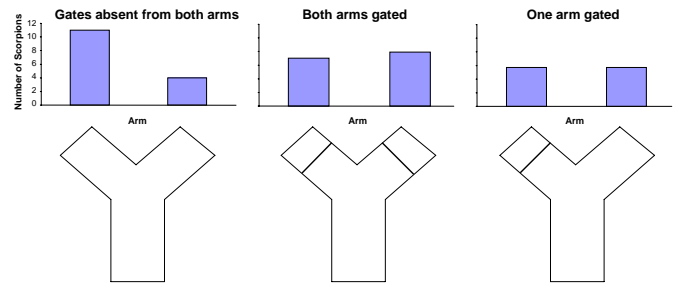
3 New Behavioral Approach / Methods.

For my honors research, I am extending this investigation on the potential for non-visual object detection in scorpions. I have developed a test arena that allows for better control of the test situation and allows for clearer determination of animal choices.



In the results reported here, we used ten *Paruroctonus utahensis* in five experiments with each scorpion performing two trials in each experiment. The scorpions were placed on a hollow Y-shaped plastic arena filled to the top with sand to create a flat sand platform. The animals were placed on the single (base) arm of the arena and allowed to choose between the other two arms. Each arm had removable plastic gates. Experiments were performed with the gates absent from both arms, with gates in both arms, and with a gate in only one arm. All experiments were conducted in complete darkness and filmed with an infrared camera to eliminate the scorpions' visual capabilities. In addition, the arena was rotated 90 degrees between each trial to control for orientation relative to magnetic North. The sand surface was replenished with clean sand and leveled between trials to control for chemical cues left by previous scorpions. Reviewers unaware of the test situation scored the animal choices.

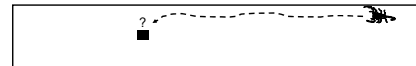
4 Scorpions did not show a bias relative to objects in sand.



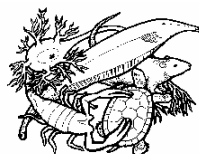
Results of experiments on scorpion orientation. In the first experiment with gates absent from both arms, 11 animals chose arm one and 4 chose arm two. In experiment two, with both arms gated, 7 chose arm one and 8 chose arm two. In the third experiment with only one arm gated, 7 chose the open arm and 7 chose the closed arm. Only trials in which a choice was made were scored in these results. Trials in which scorpions either ran off the side of the arena or did not make a choice within five minutes were not included. Statistical analysis of these data showed no arm preference in any of the three test situations.

5 Conclusions / Further Research.

- Scorpions displayed no preference for either a gated arm or an open arm.
- Under the conditions of these experiments, scorpions do not appear to be using non-visual senses to orient to objects.
- In future trials we will see if scorpions are attracted to objects in the sand, causing them to deviate from their normal wall-walking tendency.



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Works Cited.

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