A Sting in the Night: Pallid Bat Detection of Dangerous Prey

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Biology

Abstract

It has been observed in previous studies that Hemprich long-eared bats (Otonycteris hemprichii) are frequently stung during predation attacks on scorpions. Although a highly toxic and dangerous prey, the scorpion toxicity does not kill the bat. The sting, however, does seem to inflict a great amount of pain. Here, we examine the role of bat vision in predator-prey interactions between a similar bat species, pallid bats (Antrozous pallidus) and northern scorpions (Paruroctonus boreus). We address the question: do bats use visual information provided by moonlight to plan attacks on dangerous prey? We predicted that under moonlit conditions, pallid bats would plan attacks on scorpion prey, therefore, being stung less often. Our experiments took place in a flight room in both simulated moonlight and complete darkness. The interactions were recorded live by three high-definition cameras mounted in three separate corners of the interaction arena. Keywords: Sensory Ecology, Pallid Bats, Bruneau Sand Dunes, Northern Scorpions, Passive Listening

Sensory Ecology

Sensory ecology is a relatively new field of ecology that focuses on how animals acquire, process, and use sensory information, and the sensory systems involved. Tasks such as finding food, avoiding predators, attracting mates, and navigating through complex environments are all governed by sensory systems. Subsequently, animals have evolved an astounding range of sensory organs that are crucial to survival and reproduction. These sensory organs determine much of their evolution and behavior. Sensory ecologists investigate the type of sensory information that is gathered by animals, how it is used in a range of behaviors, and the evolution of these traits. They ask both mechanistic questions (such as how an organ of interest works) and functional questions (such as what role does the organ play in terms of survival). There is a study being conducted at Boise State University that works as an example of the work sensory ecologists are doing.

This study is examining the role of bat vision in predator-prey interactions between bats and scorpions because this information can help ecologists better understand the evolutionary mechanisms that bats rely on for survival. More importantly, this research is the result of new information about bat vision and its evolutionary function that has only recently become available because of sensory ecology. Sensory modalities such as vision, hearing, and echolocation all play vital roles in these fierce interactions. The work done examining the role of vision in these predator-prey interactions is extremely limited and sensory ecologists are able to approach these questions from a new angle. This article will use the BSU study as an example of the current work in the field of sensory ecology.

Pallid Bats

Pallid bats (*Antrozous pallidus*) are nocturnal desert gleaning bats (primarily catching prey items on the ground). They are the sole species of the genus *Antrozous* and can be found from south-central British Columbia to central Mexico and Cuba. They prefer to live in arid regions with rocky outcroppings, rather than open, sparsely vegetated grasslands. They have cream colored fur on their backside and white fur on their belly. Perhaps the most notable physical characteristic of pallid bats is their large ears. Unlike aerial-hawking bats (that rely on echolocation to localize prey), pallid bats use a foraging tactic known as passive listening. Their exceptionally large ears have been evolutionarily tuned to detect specific sound frequencies produced by the walking noise of prey items. Once the prey is detected, the bat will land and attack the prey on the ground. They are widely known to be one of the few

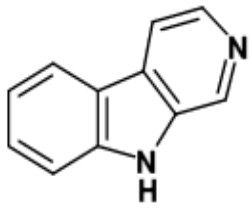
bat species that seeks out and eats scorpions. In addition to gleaning, pallid bats have also been known to be plant pollinators (Frick et al., 2009).

Figure 1. Pallid Bat

Scorpions

We can trace the evolutionary history of scorpions to the Silurian era (about 430 million years ago) (Gess, 2013). They can adapt to a wide range of environments and have proven to be extremely evolutionarily successful. Out of the estimated 1750 scorpion species, only 25 species possess venom that is lethal to humans. Since they act as both predators and prey, scorpions play a pivotal role in the energy flow of desert ecological systems (McCormick et al., 1990). Largely solitary, they are nocturnal chelicerates that glow a bright cyan-green under ultraviolet light (UV). This glow is due to a substance located in the scorpion exoskeleton called beta-carboline (Stachel et al., 1999). When UV light comes into contact with the scorpion exoskeleton, beta-carboline converts the incoming UV rays into the cyan-green glow.

Figure 3. A scorpion under UV light.



Beta Carboline

Figure 4. The molecular structure of beta carboline.

Some scientists argue that scorpions may use the glow for shelter detection (Gaffin et al., 2012), while others argue that the glow may be used for prey attraction (Polis, 1979). None of these hypotheses, however, have withstood scientific scrutiny. Currently, the evolutionary function of this fluorescence still remains a mystery (Gaffin et al., 2012). In some desert habitats, scorpions make up a substantial portion (over 70%) of gleaning bat diet (Goerlitz *et al*., 2010). Some desert scorpions have been known to possess high levels of toxicity. This study used northern scorpions (*Paruroctonus boreus*) which are relatively small scorpions that possess minimal levels of toxicity. During these predator-prey interactions, bats are frequently stung (often times directly in the face) (Goerlitz et al., 2010). Although stings appear to be painful, the bats seem to be immune to the scorpion toxicity (Holderied et al., 2011).

The Bruneau Sand Dunes

Bruneau Dunes State Park is a state park of Idaho featuring several large sand dunes and two small lakes. The park is located south of Mountain Home, Idaho. The state park includes desert, dune, prairie, lake, and marsh habitat. Desert wildlife is diverse and includes coyotes, waterfowl, raptors, pallid bats, and northern scorpions.

Figure 5. Bruneau Dunes State Park, ID.

Complications

Sensory ecologists face many complications both in the lab and in the field. Programming, training animals, as well as weather, time of year, equipment, and even moonlight are all obstacles that sensory ecologists must overcome. Catching animals to study can prove to be a tedious and intricate process. To reduce risk of injury to the person or the animal, it is vital to be properly trained on how to catch and handle wild animals. Bats for this project were caught at Bruneau Sand Dunes, Idaho. Species caught included pallid bats (*Antrozous pallidus*), big brown bats (*Eptesicus fuscus*), little brown bats (*Myotis lucifugus*), and townsend's big-eared bats (*Corynorhinus townsendii*). Although we caught bats regularly, it was difficult to catch pallid bats specifically. Factors such as moonlight, temperature, and weather all influence pallid bat activity.

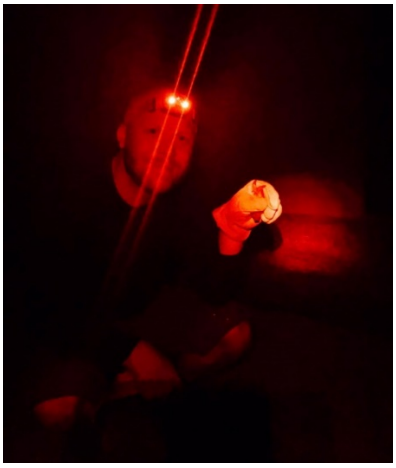


Figure 6. A townsend big-eared bat.

Figure 7. A townsend big-eared bat.

Discussion

Sensory ecology is new and upcoming field of ecology that addresses a variety of issues regarding animal sensory systems. Currently, one the largest area of sensory ecological research is the impact of anthropogenic light

pollution on wildlife. As urban sprawl accelerates, the amount of anthropogenic light pollution has increased significantly (Hölker et al., 2010). The consequence of this light pollution on wildlife, however, is largely unstudied.

Since almost all bats are nocturnal, they are an ideal animal for studying the effects of anthropogenic light pollution. Some researchers have examined the effects of this light pollution on bat behavior. They used high pressure sodium lights to show that bat activity was reduced dramatically and the onset of commuting behavior was delayed in the presence of lighting, with no evidence of habituation (Stone et al., 2009).

Bat vision and anthropogenic light pollution are closely linked (Gaston et al., 2013). Conversely, it is still unclear how much of a role vision has on bat survival. The work we do examining the role of bat vision in predator-prey interactions may lead to discoveries that offer solutions to the negative effects of anthropogenic light pollution on wildlife.

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