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Year in School: Senior
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Funding Source: Life Sciences Undergraduate Research Opportunity Program

Bat avoidance behavior in *Neoconocephalus retusus* (Orthoptera: Tettigoniidae)

Nocturnally flying insects avoid predation by insectivorous bats by monitoring for echolocation calls and, when detected, using evasive behaviors. We examined the responses of Neoconocephalus retusus to models of bat calls during tethered flight. The bat calls were 8 ms in duration and frequency modulated (FM) from 80 to 35 kHz with the main energy concentrated at 40 kHz. Such calls resemble the search phase calls of the Big Brown Bat (Eptesicus fuscus), an insectivorous bat commonly found in Missouri. We simulated a bat in the search phase as if it were approaching the katydid to characterize the response types of N. retusus. At low amplitudes of the bat call, equivalent to a distance of approximately 24m from the insect, N. retusus steered away from the sound source by extending one hind leg. At higher intensities (~20m from the insect) the insect interrupted the beating of the hind wings while remaining in flight posture. At even higher bat call intensities, corresponding to approximately 15m from the insect, flight stopped and the animal assumed a dive position: both sets of wings folded up, the antennae folded back, and all legs were placed flush against the abdomen. All three behaviors occur before a bat would be able to hear the katydid's echo.
We used a series of 7 FM pulses of constant amplitude to determine the thresholds for the three behaviors. The thresholds for steering, interruption of flight and cessation of flight are 46.5 dB SPL, 51 dB SPL, and 59.5 dB SPL respectively. We also examined the thresholds using a single FM pulse in which the thresholds were approximately 5-6 dB higher. Bat avoidance in N. retusus differs strikingly from that of the closely related N. ensiger, which shows only a behavior equivalent to our interruption of wingbeat response, but no steering or dive behaviors. However, the avoidance behaviors of N. retusus were similar to those of a more distantly related katydid as well as those of crickets and some moths. Thus, bat evasive behavior might differ significantly among closely related species, but often shows convergence among distantly related groups. This suggests that such behaviors readily adapt to changing predation pressures rather than being conserved within phylogenic groups.