Light dependent behavioural responses in certain insects to bat predation

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Abstract

Predation implicates the evolution of several morphological and behavioural characteristics in animals by exerting strong selection pressure on the predator as well as on the prey. This thesis focuses on the influence of light on bat-insect interactions, particularly from the prey's point of view, i.e. how insects avoid being captured by bats. Ultrasound sensitive ears in some insects provide a tool with which they can hear an approaching echolocating bat, and the insects may perform avoidance behaviour in response to the bat calls.

However, my results show that the prevailing light level may influence the insects' responses to bat predation in several ways. Mercury vapour streetlamps attract winter moths *Operophtera* spp. (Lepidoptera, Geometridae), and inhibit their normal evasive responses to imitated bat calls (i.e. ultrasound). Hence, winter moths are more susceptible to bat predation around these streetlamps.

The activity period of small china-mark moths *Cataclysta lemnata* (Lepidoptera, Pyralidae) extends mainly from the afternoon into the night. Thus they are exposed to predation from both diurnal birds and nocturnal bats. Anti-predator responses in these moths are light dependent, in that during daytime they respond to simulated predation from birds as well as bats by increased flight speed and sometimes also increased erraticism in flight. At night, however, they respond to simulated bat calls preferentially by landing. The different responses probably are based upon the most likely predator to encounter; hence, the moths switch type of predator response to appropriately meet the different foraging tactics performed by the two predators.

Insects that are non-sensitive to ultrasound have to rely on sensory input other than hearing to notice the appearance of, and thereby being able to avoid, foraging bats in advance. The presumed anti-predator strategies may or may not be deliberately chosen. In any way, the insects' behaviour makes them less exposed to bat predation.

Water striders *Aquarius najas* (Hemiptera, Gerridae) and whirligig beetles *Gyrinus substriatus* (Coleoptera, Gyrinidae) are unpalatable to some vertebrates, but they have no clearly repellent effects on Daubenton's bats *Myotis daubentonii* (Chiroptera, Vespertilionidae). Water striders and whirligig beetles do not have ultrasonic hearing. Instead, the falling light level may initiate their withdrawal behaviour from open water towards sheltered areas like near vegetation and rocks, where echoes from the insects may be difficult to separate among echoes from the background for echolocating aerial-hawking bats, and thus the insects become acoustically concealed. In addition, at night whirligig beetles increase the frequency of their whirling behaviour, which probably makes them difficult to locate and follow, particularly for echolocating bats.

Male ghost swift moths *Hepialis humuli* (Lepidoptera, Hepialidae) are large (wingspan ca. 6 cm), conspicuously silvery white moths that lack ultrasonic hearing. They swarm in hayfields for half an hour around dusk during early summer in Sweden, and are intensively exploited by northern bats *Eptesicus nilssonii* (Chiroptera, Vespertilionidae). In contrast to water striders and whirligig beetles, ghost swift moths probably are less effectively sheltered among the clutter-providing vegetation. Acoustic concealment is useless, particularly for conspicuous prey, since northern bats, in addition to echolocation, at least initially use vision to facilitate detection of stationary targets (mounted moths). The bats attacked dead moths that we mounted with their dorsal white side up more frequently than those with their ventral dark side up. However, they never attacked stationary targets immediately above the vegetation, but only moths mounted at 1 m above the grass panicles. In addition, the bats attacked rapidly moving targets (white or black paper marbles simulating flying moths) preferentially at 1 m above the grass panicles, but they also performed attacks immediately above the vegetation. On the other hand, wing flutter from stationary prey does not facilitate its detection by northern bats, since they attacked mounted dead and spread moths as frequent as live fluttering ones.

Key words: acoustic clutter, bat-insect interactions, behaviour, Chiroptera, Coleoptera, echolocation, Hemiptera, Lepidoptera, light, predation, ultrasonic hearing

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