Eklöf, J. Vision in echolocating bats

Zoology Department, Göteborg University

Key words: acoustic clutter, foraging tactics, Microchiroptera, perception, sensory ecology, ultrasound, visual acuity

ABSTRACT

The use of ultrasonic echolocation (sonar) in air is seriously constrained by the attenuation of high frequency sounds and unwanted echoes from the background (called clutter). Therefore, in many situations, echolocating bats have to rely on other sensory cues. The aim of this thesis is to investigate the use of vision by echolocating bats.

Bat eyes are generally small, especially among aerial hawking insectivores, with the exception of members of the family Emballonuridae. In gleaning, and in frugivorous species, however, the eyes tend to be larger and more prominent. The eyes of all bats are well adapted to low illumination, having mainly rod-based retinas, large corneal surfaces and lenses, and generally large receptor fields. Bats can easily detect small differences in brightness on clear nights, and the visual acuity remains relatively good in dim illuminations. The visual resolving power (as obtained from counts of retinal ganglion cells or by optomotor response tests) varies considerably among the different species of bats, from less than 0.06° of arc in *Macrotus californicus* (Phyllostomidae) to almost 5° in aerial hawking *Myotis* species (Vespertilionidae). Generally, the visual acuity is similar to that of rats and mice, suggesting that cm-sized object can be discriminated at ranges less than a few metres. Studies on pattern discrimination have yielded highly variable results. Fruit and nectar eating species respond to patterns to a larger extent than aerial insectivores.

One of the most fundamental roles of the eyes is to register the amount of ambient light, in order to establish photoperiodic cycles. Some tropical bats avoid too bright conditions, i.e. moonlit nights probably due to increased predation risk, a behaviour not found in high latitude species.

As sonar only works well at short ranges, vision is primarily used for detection of landmarks and to avoid objects when moving over long distances, for example during seasonal migration and when commuting between feeding sites. In these situations, there seems