

Acoustic Diversity and Activity Patterns of Insectivorous Bats in a Riverine Forest at Gunung Mulu National Park, Malaysian Borneo

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Bats are keystone species that perform vital ecosystem and economic services and are, therefore, an important fauna to be monitored. Acoustic monitoring with ultrasonic detectors has emerged, in recent years, as an essential tool to quantify the activity of echolocating insectivorous bats and identify key habitats used by them for commuting and foraging. However, only a few acoustic studies have been conducted in the tropical forests of Southeast Asia. In order to monitor bats using acoustic methods, a library of echolocation calls needs to be available for the region or even better from the specific locality. Between May and November 2016, a full spectrum ultrasonic detector was used to record bat activity during 105 nights, at 35 points along three rivers of different width and also adjacent trails and forest interior 50 metres from trails and rivers. Recorded calls were analysed by spectrogram viewer software and compared manually to a collection of reference calls recorded from 502 individuals representing 30 species of insectivorous bats, previously captured within the same area. Discriminate function analysis was performed on reference calls to determine which species could be accurately identified from their calls. A total of 273.02 gigabytes of files containing an estimated 104,834 bat passes were recorded. Overall, 93% of passes were recorded at rivers, while 5% were recorded on trails and 2% in forest interior. Based on results from discriminant function analysis, five species of cave roosting Rhinolophidae, seven Hipposideridae, *Chaerephon plicatus* and *Miniopterus australis* could be identified and represented 62% of total recorded passes. A further 36% of passes were identified to a *Myotis* species call group and at least four call types from unknown species were detected. Accurate identification of low intensity, high frequency calls from members of the forest roosting Vespertilionidae subfamilies Kerivoulineae and Murinineae proved to be problematic, however this group of species only represented 1% of recorded calls. Most species recorded were detected more often at rivers than in other habitats. Acoustic sampling, although challenging to conduct in a megadiverse tropical environment, is proving to be an effective method in providing information about the ecology of insectivorous bats. This study also highlights the importance of rivers as critical habitats for foraging insectivorous bats in a tropical karst environment.

Co-author: Mr KHAN, Faisal Ali Anwarali (Universiti Malaysia Sarawak)

Presenter: Ms MC AURTHUR, Ellen (Gunung Mulu National Park)

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