

**Habitat Relationships, Activity Patterns and
Feeding Ecology of Insectivorous Bats of the
Top End of Australia.**

Thesis submitted by

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Abstract

The wet-dry tropics of the Northern Territory (the Top End) has a diverse microbat fauna. It supports 28 of Australia's 65 species, including one endemic species (*Taphozous kapalgensis*), both of Australia's monotypic genera (*Rhinonictoris* and *Macroderma*) and two species considered to be rare or endangered (*Saccolaimus saccolaimus* and *Hipposideros diadema*). However, most aspects of the ecology of this fauna are poorly known. The aim of this study was to investigate the composition of microbat assemblages; describe the habitat relationships of the microbat fauna at both the community and species levels; assess microbat activity patterns at several temporal scales; and to conduct a dietary analysis of the microbats of the Top End.

Robust methods for sampling bats are still being developed and tested. Based on recordings derived from the Anabat II detector, I compared the results of surveys where I changed the orientation of the detector, the type of recording media, and static versus active hand-held recording. Detector orientation did not significantly affect any survey results, more call passes were identified from digital recordings and more species were detected using hand-held recordings. I also derived species-accumulation curves for the Top End microbats and provide guidelines for minimum sampling effort in future studies.

Patterns in the composition of assemblages of microbat species sampled during the late dry season (the 'build-up') in the Top End were assessed against a range of environmental factors as well as four *a priori* defined habitat types (riparian, escarpments, coastal and woodlands). In general, species assemblages were not clearly defined and the number of significant environmental associations was relatively few. The most distinct species assemblages were strongly associated with topographic and climatic variables. There were also limited associations with vegetation structure, fire and local roost potential but no associations with insects or water availability. Total species diversity at sample sites was associated with distance to rivers and rainfall.

Generalised linear modelling (GLM) was used to develop habitat models for 25 of the 28 microbat species of the Top End. Based on these models, a geographic information

system (GIS) was used to derive probability of occurrence maps for each species. Almost all of the models identified a unique combination of environmental variables, and the resulting probability of occurrence maps revealed a variety of patterns of predicted distribution. Annual rainfall and habitat complexity were identified as significant variables in the majority of the models. All of the spatial models were combined to derive a probability map of species richness of microchiropteran bats in the Top End. This map shows greatest species richness in the north-west and north-central parts of the study area.

Temporal patterns of microbat activity and species richness were assessed at four scales: hourly, nightly, monthly and yearly, in relation to biotic (insect availability) and abiotic features in the environment. At the hourly scale, bat activity was highest in the first hour after dusk and declined throughout the night. Hourly bat activity was most closely associated with temperature. At the nightly scale there were significant associations between bat activity, moon light and temperature as well as a complex association with both moon phase and time of night. At the monthly scale bat activity increased dramatically in October which was possibly triggered by a combination of changing climatic factors that occur at this time of year in the Top End. At the yearly scale there was no overall difference in bat activity between years ($n = 4$) and no associations with climatic variables.

The dietary composition for 23 of the 28 Top End microbat species was described by identifying the prey remains collected from stomachs and faecal pellets to the lowest possible taxonomic level (usually order or lower). Dietary analysis revealed that most species consumed a variety of orders indicating that Top End microbats have generalist dietary requirements and/or opportunistic foraging habits. However, the dietary compositions for *H. diadema*, *H. stenotis*, *Mormopterus loriae*, *Nyctophilus geoffroyi*, *N. bifax* and *T. kapalgensis* contained only one or two insect orders suggesting these species may have more specialised diets. Microbats in the 'Uncluttered' foraging guild consumed proportionally more insects belonging to the orders Orthoptera and Coleoptera whereas the 'Background clutter' and 'Highly cluttered' foraging guilds consumed proportionally more Lepidoptera.

This study has greatly increased our understanding of some aspects of the ecology of microbats in the Australian wet-dry tropics. I make a number of recommendations for the conservation management and future research of Top End microbat fauna, most notably to investigate the association between microbat diversity and riparian areas, conduct further microbat surveys throughout the region to redress the still meagre number of records, and initiate targeted monitoring programs for microbats.

Preamble

This thesis is structured into eleven sections that includes seven chapters, a bibliography and three appendices. Chapter 1 is the introduction and is presented in a 'standard' thesis format (Times New Roman 12 font, 1.5 line spacing). The following five chapters are the main body of work for this study. Four of these (Chapters 2-5) have been published and are presented in their original published formats. The remaining chapter (Chapter 6) is unpublished and presented in standard thesis format as well as Chapter 7 (the conclusion). The appendices have also been published and are also presented in their original published formats.

The Bibliography presents references for the unpublished chapters only (Chapters 1, 5 and 7). The remaining published chapters and appendices have not been edited so references for these sections are included within each. The placement and formatting of these references is dependant on which journal they were published in.

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