Behavioural Ecology and Thermal Physiology of Australian Owlet-Nightjars (*Aegotheles cristatus*)

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A thesis submitted for the degree of Doctor of Philosophy of the University of New England

November 2007

Acknowledgements

I am sure many of you reading this will agree, when you take on a project such as this in a foreign country, it becomes not just a degree, but an adventure; often one that is not always easy, but always worth the effort. As with all such experiences many, many people played an important role and I will attempt to thank some of them here.

I would like to thank my three supervisors, Fritz Geiser, Mark Brigham and Chris Pavey for much advice, wine, dinners and laughter. All were responsible for restoring my tenuous grip on sanity at one time or another throughout the lengthy fieldwork. I do like to work independently, but it is good to know there are people in your corner when you need them. Fritz and Mark, thank you for taking on an unknown student with a background in marine and fish biology to do a PhD on bird physiology. I hope the risk paid off. Chris without your logistical support and friendship the central Australia field work would not have been possible, and would have been far less enjoyable.

A special thanks to my spouse, Fred Harvey, who was willing to take yet another big leap and move to Australia. A carpenter by trade, he took a year off work to assist me with my first season of field work in the Centre, and will always remain the best field assistant I could hope to have. He knew how to work hard, long hours, keep me laughing, and not to ask too many irrelevant questions. Fred, now maybe you can see why it was important to climb a 300 m cliff to look in a rock crevice. Fred helped with everything from erecting elaborate antennae structures atop windy cliffs to counting endless numbers of moths, and we are still together.

Thanks to the rangers at Ormiston Gorge and the staff at the Alice Springs Desert Park for their support, friendship and such a warm welcome to Alice Springs. I would especially like to thank Jason Bell, Karina Cartwright, Anthony Molyneux, Nat Hoffman, Jon Delaine, Gary Fry, Bruce Pascoe and Andy Davies. Your friendship meant a lot and made all the difference. I would also like to thank the various volunteers that gave up their time and spent one or more nights mist-netting with me in the cold. Some of you I met that day and don't even recall your names and others became good friends. All of you encouraged me with your enthusiasm and interest.

Thanks to David Page and the Bird Banders of North-east New South Wales for sacrificing several weekends to teach me all the intricacies of birds, mist-netting and banding. You improved my efficiency ten-fold and made field work so much simpler.

Many people in Zoology at UNE require extensive thanks. Gerhard Körtner built most of the equipment used in this study, designed software to analyze the extensive amounts of data, taught me how to fit a bird into a jar, and exhibited patience when I was lacking. Stuart Cairns gave me essential statistical advice. Nigel Andrew provided insect sampling equipment and much needed advice on insect sorting and identification. Rebecca Drury assisted with the early difficulties of the respirometry equipment. Nereda Christian helped with sorting insect samples and was a good friend and sounding board when needed. And thanks to my lab-mates Chris Turbill, Lisa Warnecke, Jamie Turner and Clare Stawski for many suggestions, discussions and help along the way.

Finally, thanks to my parents, family and friends in Canada for their love and support and for understanding that we must seize opportunities when they come our way.

Although sometimes a struggle, the work involved in the creation of this thesis has left me with many great memories and experiences. And as the Aussie's say, "Thanks for that!"

Permits for this research were issued by the University of New England Animal Ethics Committee, the New South Wales National Parks & Wildlife Service, the Northern Territory Parks & Wildlife Commission, and the Australia Bird & Bat Banding Scheme. This study was facilitated by funding from the University of New England, the National Science and Engineering Council of Canada, and the Australian Research Council. Small grants were provided by Birds Australia, the Royal Zoological Society of New South Wales, and the Australian Bird Study Association. Thank you for your assistance. It was greatly appreciated.

Abstract

The Australian owlet-nightjar (*Aegothelidae cristatus*) is a sedentary, nocturnal, avian insectivore that uses a variety of adaptations to balance its energy budget. This has enabled this species to successfully inhabit diverse habitats throughout Australia. Owlet-nightjars are Caprimulgiformes, a group that typically have low metabolic rates and are capable of entering torpor to conserve energy. However, unlike many species of Caprimulgiformes, owlet-nightjars do not migrate and therefore must cope metabolically and behaviourally with seasonal variations in ambient temperature (T_a) and food resources. They are also unique amongst the Caprimulgiformes in that they are obligate cavity users year-round.

I studied the behavioural and physiological qualities that enable this species to subsist in two dissimilar habitats, the semi-arid desert of central Australia and the comparatively cold, mesic, eucalypt woodlands atop the Northern Tablelands of NSW. I used radiotelemetry to locate diurnal roost sites, to track birds to determine home range, and to quantify body temperature (T_b) fluctuations in relation to roost and ambient thermal conditions. I compared characteristics of cavity roosts with randomly selected unoccupied cavities and used an information theoretic approach to assess variables which may be important for roost selection. Faecal samples collected from birds and cavity roosts at both locations were used to compare the diet and inferred foraging tactics between the two habitats in relation to arthropod availability. Finally, I measured the metabolic rate and thermal conductance of individual birds in the laboratory during both summer and winter using open-flow respirometry in the laboratory.

A high degree of flexibility in ecological requirements at least partially explains the success of owlet-nightjars. In the semi-arid zone of central Australia, owlet nightjars use both rock crevices and tree hollows as roosts. Rock crevices are better insulated and thus, more thermally stable than tree roosts, apparently requiring owlet-nightjars to enter torpor less often. Nonetheless, tree roosts are used regularly; the lower T_a in hollows facilitates torpor use on days when T_a is especially low or foraging unsuccessful and entry into torpor is necessary. The temperature in tree hollows increases quickly with T_a on sunny days allowing heterothermic birds to passively rewarm with minimal energy expenditure. Based on these conditions, owlet-nightjars select deep rock crevices that are thermally stable and tree hollows that are exposed to radiant solar heat.

Owlet-nightjars used torpor regularly at both desert and eucalypt woodland sites during winter when exposed to low T_a, but torpor was more frequent, deeper, and of longer duration in habitats and in years with reduced prey availability. Birds using torpor frequently during winter maintained a high body mass, indicating that a state of pronounced energetic deficit did not occur. Owlet-nightjars cope well with seasonal changes in T_a, maintaining a constant basal metabolic rate (BMR) between summer and winter, likely due to their relatively large size, foraging strategy, and the use of cavity roosts during their rest phase. Reduced conductance and RMR at low T_as in winter-acclimatized birds suggests that an increase in insulative plumage enhances their ability to tolerant cold winter conditions.

Ground foraging for terrestrial prey was more prevalent amongst owlet-nightjars than predicted, especially in the eucalypt woodland habitat where the winter diet appears to be composed entirely of terrestrial insects. Terrestrial foraging likely requires less energy than aerial prey capture, and may be the preferred method of foraging if adequate cover is available which offers protection from predators. Owlet-nightjars used a variety of foraging tactics including sallying, perch-and-pounce, and hopping along the ground while picking up small arthropods. This flexibility in foraging enables owlet-nightjars to maintain stable home ranges year-round by switching prey instead of foraging farther afield. Thus, the high degree of territoriality exhibited by owlet-nightjars may reflect the need to protect known food resources and/or energetically valuable cavity roosts.

Owlet-nightjars are a species capable of adapting to a wide variety of ecological situations while exhibiting substantial energetic efficiency. Flexible energy saving behaviour, including selecting roosts with ideal thermal microclimates and obtaining prey through ground foraging, and physiological features, such as having a low BMR and entering torpor regularly during winter, allow this species to adapt to and successfully exploit these energetically demanding habitats.

Declaration

I certify that the substance of this thesis has not already been submitted for any degree and is not currently being submitted for any degree or qualification.

I certify that any help received in preparing this thesis, and all sources used, have been acknowledged in this thesis.

[redacted]

Lisa I Doucette

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List of Abbreviations

AIC	Akaike's Information Criteria
AIC_c	Akaike's Information Criteria for small sample sizes
ANCOVA	analysis of covariance
ANOVA	analysis of variance
BM	body mass (g)
BMR	basal metabolic rate (ml O_2 g^{-1} hr^{-1})
C	thermal conductance (ml O_2 g^{-1} hr^{-1} $^oC^{-1}$)
D	desert study site
DMAX T_{IN}	daytime (sunrise to sunset) maximum temperature inside roost
DMIN T_{IN}	daytime (sunrise to sunset) minimum temperature inside roost
EFA	essential fatty acid
EW	eucalypt woodland study site
EWL	evaporative water loss
FMR	field metabolic rate
ID	irrigated desert study site
K	number of parameters in Akaike's Information Criteria models
MAX T_a	maximum ambient temperature (°C)
MAX T_{IN}	maximum daily (24 hour) temperature inside roost
MAX T_{OUT}	maximum daily (24 hour) temperature immediately outside roost
MIN T_a	minimum ambient temperature (°C)
MIN T_b	minimum body temperature (°C)
MIN T_{IN}	minimum daily (24 hour) temperature inside roost
MIN T_{OUT}	minimum daily (24 hour) temperature immediately outside roost
MIN T_{skin}	minimum skin temperature (°C)
MR	metabolic rate (ml O_2 g^{-1} hr^{-1})
NMAX T_{IN}	nighttime (sunset to sunrise) maximum temperature inside roost
NMIN T_{IN}	nighttime (sunset to sunrise) minimum temperature inside roost
P	roost variable relevant for protection from predators
RANGE T_{IN}	range of temperatures (maximum – minimum) in roosts (°C)
RMR	resting metabolic rate (ml O_2 g^{-1} hr^{-1})
T	roost variable relevant to thermal qualities
T_a	ambient temperature (°C)
T_b	core body temperature (°C)

TIMEMAX	time to reach maximum temperature inside roost from sunrise (minutes)
T_{IN}	ambient temperature inside roost (°C)
T_{lc}	lower critical temperature (°C)
TMR	torpid metabolic rate (ml O_2 g^{-1} hr^{-1})
TNZ	thermal neutral zone
T_{OUT}	ambient temperature immediately outside roost (°C)
TP	roost variable relevant for predator and thermal protection
T_{skin}	skin temperature (°C)
T_{uc}	upper critical temperature (°C)
VO2	rate of oxygen consumption
w_i	Akaike weight of model parameters