

Food quality, fasting periods and
temperature stress:
effects of energy challenges on
the feeding patterns of avian nectarivores

by
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The whitebellied sunbird (*Cinnyris talatala*)



The amethyst sunbird (*Chalcomitra amethystina*)



The brown honeyeater (*Lichmera indistincta*)

Table of Contents

List of Tables	x
List of Figures	xi
Acknowledgements	xiii
Declaration	xv
Disclaimer	xvi
Publications and manuscripts in preparation	xvii
SUMMARY	1
GENERAL INTRODUCTION AND OUTLINE OF THE STUDY	3
Nectar as food source	5
Nectarivorous birds	7
Energetic challenges in avian nectarivores	8
Study species	11
Objectives of my research	13
References	16
CHAPTER 1	27
FOOD INTAKE OF WHITEBELLIED SUNBIRDS (<i>CINNYRIS TALATALA</i>):	
CAN MEAL SIZE BE INFERRED FROM FEEDING DURATION?	
Abstract	28
Introduction	28
Materials and methods	30
Study animals and their maintenance	30
Experimental design	30
Data processing	31
Statistical procedures	32
1) Meal size and feeding behaviour	32
2) Differences between the sexes and body mass relationships	32



3) Daily rhythm, feeding patterns and consumption on the different diets	33
Results.....	34
1) Meal size and feeding behaviour	34
1.1) Feeding duration	34
1.2) Feeding frequency	34
2) Differences between the sexes and body mass relationships.....	35
3) Daily rhythm, feeding patterns and consumption on the different diets.....	35
Discussion.....	36
Meal size and feeding duration	36
Viscosity effects and compensatory feeding.....	37
Daily rhythm in feeding patterns	37
Differences between the sexes and individual variation	37
Acknowledgements.....	38
References.....	39
Figure legends.....	42
Figures	43
CHAPTER 2	47
CHANGES IN NECTAR CONCENTRATION: HOW QUICKLY DO WHITEBELLIED SUNBIRDS (<i>CINNYRIS TALATALA</i>) ADJUST FEEDING PATTERNS AND FOOD INTAKE?	
Abstract.....	48
Introduction.....	49
Materials and methods	51
Study animals and their maintenance.....	51
Experimental procedure	51
Data collection	52
Definitions and processing of feeding data.....	53
Definitions and processing of bird mass data	53
Statistical procedures	54
Results.....	55



Differences between treatments	55
Food intake.....	55
Feeding frequency.....	55
Mean feeding duration	55
How fast do birds adjust feeding patterns and food intake?	56
2.5% treatment	56
8.5% treatment	56
30% treatment	57
Control treatment	57
Sucrose intake, body mass and flight activity on the different treatments	57
Discussion.....	58
Differences between treatments	58
How fast do birds adjust feeding patterns and food intake?	59
Sucrose intake, body mass and flight activity on the different treatments	60
Acknowledgements.....	63
References.....	63
Tables.....	70
Figure legends.....	72
Figures	73
CHAPTER 3.....	75
THE RESPONSE OF TWO AVIAN NECTARIVORES TO INTERRUPTIONS IN	
FOOD AVAILABILITY	
Abstract.....	76
Introduction.....	76
Materials and methods	78
Study animals and their maintenance.....	78
Experimental procedure and processing of data	79
Statistical analysis	81
Results.....	82
Food intake.....	82



Adjustment of feeding behaviour in sunbirds	83
Body mass	83
Discussion.....	84
Adjustment of food intake after the fast.....	84
Does the fast lead to an energy deficit?	85
Physiological constraints to food intake	86
How do whitebellied sunbirds adjust their food intake?.....	87
Acknowledgements.....	89
References.....	89
Figure legends.....	97
Figures	98
CHAPTER 4.....	101
LOW TEMPERATURE CHALLENGES IN SUNBIRDS:	
EFFECTS ON FOOD INTAKE, FEEDING PATTERNS AND BODY MASS OF	
<i>CINNYRIS TALATALA AND CHALCOMITRA AMETHYSTINA</i>	
Abstract.....	102
Introduction.....	102
Materials and methods	106
Study animals and their maintenance.....	106
Experimental procedure	107
Data collection	107
Data processing	109
Statistical analysis	110
Results.....	112
Food and sugar intake	112
Feeding patterns	112
Body mass	114
Sugar assimilation in whitebellied sunbirds.....	114
Gut morphology, sucrase activity and predicted maximal intake.....	115
Discussion.....	115



Compensatory feeding	115
Physiological constraints to food intake	117
Maximal food intake in sunbirds	119
Energy-saving mechanisms.....	120
Feeding patterns	122
Conclusion	122
Acknowledgements.....	123
References.....	123
Table	134
Figure legends.....	135
Figures	136
CHAPTER 5.....	140
TEMPERATURE CHALLENGES IN BROWN HONEYEATERS (<i>LICHMERA</i>	
<i>INDISTINCTA</i>): ACUTE COLD EXPOSURE AND POSSIBLE EFFECTS OF	
ACCLIMATION	
Abstract.....	140
Introduction.....	141
Materials and methods	143
Study animals and their maintenance.....	143
Experimental procedure	144
Part I: Acute cold exposure.....	144
Part II: Repeated cold exposure	145
Diet density, sugar assimilation and gut physiology measurements.....	145
Data processing	146
Statistical analysis	148
Results.....	149
Food and sugar intake	149
Part I: Acute cold exposure.....	149
Part II: Repeated cold exposure	150
Body mass	151



Part I: Acute cold exposure.....	151
Part II: Repeated cold exposure	151
Sugar assimilation	151
Gut morphology, sucrase activity and predicted maximal intake.....	152
Discussion.....	152
Compensatory feeding and physiological constraints.....	153
Did honeyeaters exhibit energy-saving mechanisms?	155
Did honeyeaters acclimate to the cold?.....	157
Acknowledgements.....	159
References.....	159
Table	166
Figure legends.....	167
Figures	168
CHAPTER 6.....	171
NECTAR EXTRACTION BY SUNBIRDS: DOES LICKING BEHAVIOUR CHANGE WITH NECTAR CONCENTRATION AND AFTER A FASTING PERIOD?	
Abstract.....	171
Introduction.....	172
Materials and methods	175
Study animals and their maintenance.....	175
Experimental procedure	176
Part I: Licking behaviour and sugar concentration	176
Part II: Licking behaviour and a fasting period	177
Data processing	177
Statistical analysis	178
Results.....	178
Part I: Licking behaviour and sugar concentration	178
Part II: Licking behaviour and a fasting period	179
Discussion.....	180



The effect of sugar concentration on licking behaviour	180
The effect of experimental devices on licking behaviour	183
Licking behaviour and a fasting period.....	185
Differences in licking behaviour between species	185
Conclusion	187
Acknowledgements.....	188
References.....	188
Table	195
Figure legends.....	196
Figures	197
CONCLUSION	201
The importance of studying animal responses to energy challenges	201
Suitability of avian nectarivores for my study.....	202
The response of sunbirds and honeyeaters to energy challenges.....	203
Individual variation	206
The integration of physiology and behaviour	208
Directions for future research	208
References.....	212
APPENDIX	220
The model of sucrose hydrolysis	221
Photographs of the experimental equipment.....	223

List of Tables

CHAPTER 2

Table 1: Experimental design	70
Table 2: Food intake, feeding frequency and mean feeding duration of whitebellied sunbirds	71

CHAPTER 4

Table 1: Food and sugar intake of sunbirds	134
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CHAPTER 5

Table 1: Linear regression results	166
--	-----

CHAPTER 6

Table 1: Licking parameters of sunbirds	195
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List of Figures

CHAPTER 1

Figure 1: Experimental equipment.....	43
Figure 2: Meal size as a function of feeding duration in whitebellied sunbirds.	44
Figure 3: Intake rates of whitebellied sunbirds.....	45
Figure 4: Sucrose intake of whitebellied sunbirds.....	46

CHAPTER 2

Figure 1: Food intake, feeding frequency and mean feeding duration of whitebellied sunbirds.	73
Figure 2: Cumulative feeding duration of whitebellied sunbirds.	74

CHAPTER 3

Figure 1: Food intake rates of sunbirds and honeyeaters.....	98
Figure 2: Number of feeding events of sunbirds and honeyeaters.....	99
Figure 3: Body mass of sunbirds and honeyeaters.....	100

CHAPTER 4

Figure 1: Food intake of sunbirds.	136
Figure 2: Sucrose intake of sunbirds.....	137
Figure 3: Number of feeding events of sunbirds.	138
Figure 4: Body mass of sunbirds.	139

CHAPTER 5

Figure 1: Food intake of brown honeyeaters.	168
Figure 2: Sugar intake of brown honeyeaters.	169
Figure 3: Body mass of brown honeyeaters.....	170



CHAPTER 6

Figure 1: Experimental feeding aperture.	197
Figure 2: Frequency of tongue licks of sunbirds.	198
Figure 3: Mean lick duration of sunbirds.....	199
Figure 4: Food intake per lick of sunbirds.....	200

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Declaration

The experimental work described in this thesis was carried out in the Department of Zoology and Entomology, University of Pretoria, South Africa, and in the School of Veterinary and Biomedical Sciences, Murdoch University, Western Australia, from 2006 to 2008. I, Angela Köhler, declare that the thesis, which I hereby submit for the degree Doctor of Philosophy (Zoology) at the University of Pretoria, is my own work and has not previously been submitted by me for a degree at this or any other tertiary institution.

Angela Köhler

Date

Disclaimer

This PhD thesis consists of chapters that have been prepared as stand-alone manuscripts. These manuscripts have either been published or are being prepared for future submission. As a consequence, there may be some repetition between chapters.

Publications and manuscripts in preparation

In the course of this research, several manuscripts were published or are currently in preparation. A list of these manuscripts follows in chronological order:

Journal publications

Köhler A., Verburgt L. and Nicolson S.W. 2008. Nectar intake of whitebellied sunbirds (*Cinnyris talatala*): can meal size be inferred from feeding duration? *Physiological and Biochemical Zoology* 81: 682–687.

Köhler A., Verburgt L., Fleming P.A. and Nicolson S.W. 2008. Changes in nectar concentration: how quickly do whitebellied sunbirds (*Cinnyris talatala*) adjust feeding patterns and food intake? *Journal of Comparative Physiology B* 178: 785–793.

Journal articles in preparation

Köhler A., Verburgt L., Fleming P.A., McWhorter T.J. and Nicolson S.W. The responses of two avian nectarivores to interruptions in food availability.

Köhler A., Verburgt L., McWhorter T.J. and Nicolson S.W. Low temperature challenges in sunbirds: effects on food intake, feeding patterns and body mass of *Cinnyris talatala* and *Chalcomitra amethystina*.



McWhorter T.J., Fleming P.A., Köhler A. and Nicolson S.W. Does digestive spare capacity in honeyeaters vary with body size? An experimental test and a model.

Köhler A., Verburgt L. and Nicolson S.W. Nectar extraction by sunbirds: does licking behaviour depend on nectar concentration or viscosity?

SUMMARY

The small size of nectarivorous birds is associated with high mass-specific metabolic rates and energetic lifestyles. Their energy balance is likely to be strongly influenced by environmental factors. Firstly, nectar varies in sugar concentration between different food plants and birds must adjust their consumption to maintain a constant energy intake. Secondly, unfavourable weather conditions, such as storms and heavy rains, may prevent birds from feeding, and they must increase their energy intake to compensate for the loss in foraging time. Low ambient temperature, as a third energetic challenge, results in higher energy demands for thermoregulation, which leads to increased food intake. However, these compensatory feeding responses may be constrained by physiological limitations to nectar ingestion, digestion and osmoregulatory processes.

My research focused on the behavioural and physiological responses of captive sunbirds (Nectariniidae) and honeyeaters (Meliphagidae) to energetic challenges, namely variations in nectar quality and availability and in ambient temperature. For sunbirds, I also investigated on a novel short-term scale how feeding patterns are adjusted in order to compensate for alterations in energy intake or requirements. Feeding events were recorded using a photodetection system, and body mass was monitored continuously by connecting the perches to electronic balances, interfaced to a computer.

Whitebellied sunbirds (*Cinnyris talatala*) were fed various nectar sugar concentrations. Their feeding durations were found to provide an estimate of meal size on all food concentrations. When exposed to a decrease in sugar concentration, birds generally demonstrated an increased feeding frequency and food intake within 10 min. The number and duration of meals increased in the first few minutes after return of a more concentrated diet. When whitebellied sunbirds and brown honeyeaters (*Lichmera indistincta*) were exposed to a 2 h fasting period during the day, they increased their nectar intake and energy accumulation after the fast. Sunbirds achieved this by increasing

meal size but not meal frequency. However, both species weighed less in the evening following the fast than the previous evening, indicating that the compensation for lost foraging time was incomplete. During acute cold exposure, whitebellied sunbirds, amethyst sunbirds (*Chalcomitra amethystina*) and brown honeyeaters increased their nectar intake, but lost body mass irrespective of nectar sugar concentration. Honeyeaters ingested more food at subsequent cold exposure, suggesting physiological adaptation to high feeding rates. A chemical reactor model of digestive capacity, which assumes sucrose hydrolysis to be the limiting step in nectar digestion, accurately predicted maximal food intake in honeyeaters, but mostly underestimated it in sunbirds. Sugar assimilation efficiency was higher than 99% in whitebellied sunbirds and brown honeyeaters. Lastly, licking frequencies and tongue loads of whitebellied and amethyst sunbirds were investigated. In both species, tongue lick duration increased, and licking frequency and consumption per lick decreased, with increasing nectar concentration. Birds did not adjust their licking behaviour after a fasting period.

In conclusion, the response to varied energy challenges is shaped by both compensatory feeding and physiological constraints. Although unrelated, sunbirds and honeyeaters showed convergence in their responses, probably due to their similar nectar-feeding lifestyle.