Energetics and foraging behaviour of the Platypus *Ornithorhynchus anatinus*

by
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Submitted in fulfilment of the requirements for the Degree of Doctor of Philosophy

University of Tasmania, April 2002

Declaration of originality

This thesis contains no material, which has been accepted for a degree or diploma by the University or any other institution, except by way of background information and duly acknowledged in the thesis. To the best of my knowledge and belief this thesis contains no material previously published or written by another person except where due acknowledgment is made in the text.

Statement of authority of access

For Tom, Louise, Karl, Albert, Eric,
Fritz, Gerda, Hilde,
Isolde, Julia, Konrad, Lydia

Abstract

In this work, behavioural field studies and metabolic studies in the laboratory were conducted to elucidate the extent of adaptation of the platypus *Ornithorhynchus anatinus* to its highly specialised semiaquatic lifestyle. Energy requirements of platypuses foraging, resting and walking were measured in a swim tank and on a conventional treadmill using flow-through respirometry. Foraging behaviour and activity pattern of platypuses in the wild were investigated at a sub-alpine Tasmanian lake where individuals were equipped with combined data-logger-transmitter packages measuring foraging activity or dive depth and ambient temperature.

Energy requirements while foraging in the laboratory were found to depend on water temperature, body mass and dive duration and averaged 8.48 W kg^{-1}. Mean rate for subsurface swimming was 6.71 W kg^{-1}. Minimum cost of transport for subsurface swimming platypuses was 1.85 J $N^{-1}m^{-1}$ at a speed of 0.4 m s^{-1}. The metabolic rate of platypuses resting on the water surface was 3.91 W kg^{-1} while minimal RMR on land was 2.08 W kg^{-1}. The metabolic rate for walking was 8.80 and 10.56 W kg^{-1} at speeds of 0.2 and 0.3 m s^{-1}, respectively. Minimal cost of transport for walking was predicted to be 2.13 J $N^{-1}m^{-1}$ at a speed of 1.7 m s^{-1}. A formula was derived, which allows prediction of power requirements of platypuses in the wild from measurements of body mass, dive duration and water temperature.

Activity patterns of platypuses in the wild were highly variable. Forty percent of the platypuses studied showed patterns, which deviated considerably from the nocturnal pattern generally reported for the species. Some animals showed diurnal rhythms while others temporarily followed the lunar cycle. Foraging trips lasted for an average of 12.4 h of continuous foraging activity per day (maximum: 29.8 hours). There were significant differences in diving behaviour between sexes and seasons. Activity levels were highest between August and November and lowest in January.

While foraging, platypuses followed a model of optimised recovery time, the optimal breathing theory. Mean dive duration was 31.3 seconds with 72 %

of all dives lasting between 18 and 40 seconds. Mean surface duration was 10.1 seconds. Mean dive depth was 1.28 m with a maximum of 8.77 m. Up to 1600 dives per foraging trip with a mean of 75 dives per hour were performed. Only 15 % of all dives were found to exceed the estimated aerobic dive limit of 40 seconds indicating mainly aerobic diving in the species. Total bottom duration per day was proposed as a useful indicator of foraging efficiency and hence habitat quality in the species.

In contrast to observations made earlier in rivers, temporal separation was found to play a vital role for social organisation of platypuses in the lake system that was investigated. It is suggested that high intra-specific competition as well as limited burrow sites and a limited number of at the same time highly productive foraging locations were responsible for this observation. Mean burrow temperature in the wild was 17.5 and 14.2ºC in summer and winter, respectively, and was fairly constant over the platypus's resting period. In the cooler months, burrow temperature was up to 18ºC higher than ambient air temperature.

By combining both field and laboratory data, a time-energy budget for the platypus was created. Mean field metabolic rate was 684 kJ kg^{-1} day^{-1} and was significantly higher in the winter months. Mean food requirement was 132 g fresh matter kg^{-1} day^{-1}. Feeding rates were 68 % higher in winter than in summer.

While platypuses in the swim tank were found to expend energy at only half the rate of semiaquatic eutherians of comparable body size, cost of transport at optimal speed as well as field metabolic rates were in line with findings for eutherians. These patterns suggest that locomotor efficiency of semiaquatic mammals might have reached a limit for energetic optimisation. The semiaquatic lifestyle seems to pose comparable energetic hurdles for mammals regardless of their phylogenetic origin.

Acknowledgments

Most thanks must go to my supervisors Dr. Sarah Munks and Assoc. Prof. Stewart Nicol for their guidance and continued interest in this project, their enthusiastic support and their constructive criticism on early drafts of this thesis. In particular, I want to thank Dr. Sarah Munks who put many hours and thoughts into setting up the field study at Lake Lea and who introduced me to the secrets and techniques of platypus trapping and handling. Special thanks go to Helen Otley for her endurance and cheerful attitude at all times. Helen was the most pleasant companion in countless freezing cold trapping nights and occupies a special place in my 'platypus memory'.

Many thanks go to David Lovell for indispensable technical and experimental assistance and psychological support throughout this study. I am also grateful to Kevin Langea and Philip Adams from Salmon Ponds staff for their support in catching platypuses in the Plenty River. Many thanks go to the Inland Fisheries Commission, Tasmania, to the Department of Parks, Wildlife and Heritage and to the University of Tasmania Ethics Committee for their kind support and cooperation with permits and ethics approval to conduct the study. Special thanks to Parks and Wildlife Services staff at Cradle Mountain National Park who provided accommodation and technical 'emergency' support during most field trips.

Thanks go to all members of the Discipline of Anatomy and Physiology, in particular to Niels Andersen. Ross Meggs at Faunatech did a fantastic job in putting together the devices used in the field study. Special thanks go to Henry Burrows for the permission to access his land at Lake Lea. Thanks also to the Deloraine Field Naturalists for their donation of transmitters and equipment. Acknowledgments go to Dr. Jean Jackson and Karen Richards of the School of Zoology, University of Tasmania, who identified the diet fragments in platypus cheek pouch samples collected at Salmon Ponds. Donna and Myles Lowe contributed to this study with the supply of hand-sampled compost worms.

Finally, my sincere gratitude go to the many people who assisted in the field work, including (in order of appearance) Graeme Bray, Robin Galbreath, Scott Woodhouse, Ben Maynard, Tyron Blyth, Kara Gillies, Yuri, Gary, David Skedgwell, Luke Einoder, Peter and Pam Verwey, DJ McDermott, Sam Brown, Greg Hogan, Liz Ferguson, Alicia Jacobs, Kathleen Prescott, Sonya Duus, Graeme Knott, Patricia Hetrick, Kelly LaFortune, Kate Bromfield, Jessica McLean, Natalia Atkins, Oscar Aldridge, Sebastien Eckersley-Maslin, Megan Tierney, Tam Kincade, Alexander Kabat, Susie Campbell, Nadja Bush, Derek Hamer, Christina Paterson, Elke Beuser, Thomas Rüther, Dydee Mann, Jutta Schmid, Michael Sharman and Tanya Rankin. Without their help and hard work despite sometimes appalling weather conditions, the field study of this thesis would not have been possibly completed.

Last but not least, I want to thank my wife Elke Beuser for her love, support and patience throughout this study. In addition, many friends contributed to the completion of this thesis through their cheerfulness and true friendship, in particular Michael Sharman, Uwe Rosebrock, Thomas Rüther, Nathalie Braussaud, Graeme Bray, Steve Stanton, John Green, Simon Orr, James Benham and John Williams. To my parents thank you because they are just that and stayed with me in their hearts at all times.

This work was supported by the Australian Research Council, an Overseas Postgraduate Research scholarship by the University of Tasmania and a doctoral scholarship by the DAAD (Deutscher Akademischer Austauschdienst, Germany, "Hochschulsonderprogramm III von Bund und Ländern"). Thanks also go to the WV Scott Trust who funded some of the equipment purchase, to Australian Geographic and to private sponsors for their kind support via the Platypus Friends program.

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