Energetics and foraging behaviour of the Platypus *Ornithorhynchus anatinus*

by
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Declaration of originality

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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.

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