The ecophysiology of terrestrial nesting in Australian ground frogs (Anura: Myobatrachinae)

Nicola J. Mitchell

Department of Environmental Biology
University of Adelaide

October 2000

This work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text

I consent to this copy of the thesis, when deposited in the University Library, being available for photocopying and loan

Nicola Mitchell

The ecophysiology of terrestrial nesting in Australian ground frogs (Anura: Myobatrachinae)

Abstract

Variability in the microclimate of oviposition sites is a component of biological fitness that has only recently received serious attention. The fittest phenotypes will be produced if nest characters are consistently optimal; therefore selection should favour the ability of parents to select quality nests. In this study of three species of Australian Myobatrachine frogs I examine how the microclimate of terrestrial oviposition sites influences a), phenotypic traits of embryos, and b), the reproductive strategies and success of adults.

1. *Geocrinia vitellina* and *Bryobatrachus nimbus* develop without larval feeding and fuel their metamorphosis from yolk (endotrophism). Their production efficiencies are respectively, 59.2% and 61.5%, the first such measures for endotrophic amphibians, and their egg energy densities (26.4 and 26.0 J mg^{-1}) are greater than those of exotrophic amphibians (with feeding larvae).

2. Eggs of *B. nimbus* require 13 months to complete metamorphosis in sub-alpine moss nests, at an effective temperature of 8.5° C, and overwintering exhausts most of 249 J of energy contained in the ovum. Eggs in warmer nests (about 14.9° C) can reach metamorphosis in 5 months, and save 123 J, however, this saving is inconsequential if winter temperatures are too cold for froglets to feed.

3. The globular egg masses of *B. nimbus* are vulnerable to hypoxia because of substantial diffusion distances created by extremely large jelly capsules. Models of a spherical, hatching-stage egg mass show that the central embryo in larger clutches (13-21 eggs) experiences profound hypoxia at temperatures above 5° C. However, because broader nests are used as oviposition sites, real masses are typically hemispherical, and embryos are confined to 1-2 layers, which enhances their oxygen supply. Moreover, the photosynthetic nest material enriches jelly oxygen in daylight, when metabolic demands of embryos and larvae are greatest. Laboratory experiments demonstrate that larvae in warm nests (15°-20° C) seek out oxygen-rich jelly at the surface and walls of nests.

4. Incubation of *B. nimbus* embryos at water potentials between 0 and -25 kPa produces normal hatchlings at 0 and -5 kPa, but markedly stunted and asymmetric hatchlings at -10 and -25 kPa, with reduced rates of oxygen consumption. However, similar effects are not observed in natural nests, where desiccation contributes only a small portion (<7%) of embryonic mortalities. This suggests that embryos are able to uptake sufficient water from the surrounding substrate of bryophyte and lichens, and the capacious jelly capsule may be a valuable moisture reservoir.

5. Previous studies have shown broader tolerance to low water potentials in *Pseudophryne bibronii* embryos (0 to -200 kPa), but wetter incubation produced larger hatchlings. Patterns of male *P. bibronii* nest site selection and call advertisement are examined in a field experiment. Males prefer to nest on substrates of high water potential (≥ -15 kPa) and call from these nests at greater rates, and on three times as many nights as males occupying drier areas, presumably because they are not constrained by a risk of dehydration. Male mating success is coupled with calling effort; consequently, females choose between hydrated males, and in the majority of cases, oviposit in a wet nest that produces viable embryos.