ECOLOGY OF TWO POPULATIONS OF *Bufo marinus* IN NORTH-EASTERN AUSTRALIA

Thesis submitted by

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"Marine toads (*Bufo marinus*) have few admirers and are usually described in a derogatory manner, such as looking like mobile cow patties."

George and Patricia Zug (1979)

Declaration.

I declare that this thesis is my own work and has not been submitted in any other form for another degree or diploma at any University or other institute of tertiary education. Information derived from the published or unpublished work of others has been acknowledged in the text and a list of references is given.

22/12/95

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Abstract.

Aspects of the ecology of the terrestrial stage of *Bufo marinus* from two populations in the wet-dry tropics of north-eastern Australia, one at Calvert Hills in the Gulf of Carpentaria of Northern Territory, and the other in the Townsville region on the north coast of Queensland, were examined and compared.

The stages of the toad life cycle examined ranged from small metamorphs, that had only recently emerged from their natal pools, through to large breeding adults. Considerable variation in the growth and survival rates, activity patterns, individual toad size, body condition and shelter requirements were found between and within these two populations.

Once *B. marinus* entered the terrestrial component of its life cycle, ie. emergence onto land at approximately 8mm in length, individual metamorphs were faced with a series of challenges to their survival and growth through to sub-adult size (30mm). The major obstacles to a metamorph's survival through this stage included stresses from dehydration and from high densities of metamorphs present at the water's edge shortly after the peak breeding period in the wet season. Metamorphs remained close to their natal pond until they were large enough to forage without hydric risks. During this time daily survival rate was restricted by environmental factors such as high temperatures. However, metamorph growth rates were dependant on the density of metamorphs, with higher densities reducing the time required to reach juvenile size, ie. approximately 30mm. Once metamorphs obtain this size it appears that they have an increased chance of survival.

Toads above 30mm were subject to a long-term mark-recapture study at Calvert Hills and Townsville. This technique allowed for several aspects of toad population ecology to be examined including growth rates from sub-adult size and seasonal variations in activity patterns, sex ratio, and body size and condition within a given area alongside a water source.

Growth rates of *B. marinus* were documented from first emergence from water through to adult breeding size. Their rate of growth was shown to be higher than previously reported for the species in endemic areas and other species of *Bufo*. Toads at Calvert Hills grew faster than those at Townsville, and attained adult size within one year. A shorter, hotter wet season, corresponding to the period of highest food availability, accounted for the higher growth rates and increased body condition shown by toad populations at Calvert Hills compared to Townsville populations.

Toad activity patterns were shown to vary according to age, size, and seasonal conditions. When toads first emerge from the water (approximately 8mm) and commence their terrestrial stage their activity was centred at the water's edge. With growth and decreased hydric stresses metamorphs gradually foraged further away from water. The activity of sub-adult and adult toads was influenced by the time since rain periods, such as the wet season. Except for breeding periods, male and female toads generally centred their activity patterns away from water during the wet season especially after recent rain. As time since rain increased, toad activity switched back to the edge of a water source probably as a response to increasing hydric stresses.

The number of toads active at a water source was highest at both locations at the commencement of the dry season thus reflecting the influx of smaller cohorts from wet season breeding activity and the requirement for toads to rehydrate because of the onset of hot, dry conditions. Toad size at a water source was largest during the wet season indicating that larger male and female toads invested more energy into breeding than smaller toads. The number of toads at the water's edge was therefore in favour of males during all seasons and at both locations. A male-biased sex ratio probably reflected behavioural differences between the sexes rather than actual variation in densities. For instance, during the wet season, females spent considerable time foraging away from water and only came to the water's edge, when gravid, to breed. The presence of some male toads at a water source throughout the breeding season provided them with a selective breeding advantage whenever female toads came to the water to breed.

The body condition of toads declined into the dry season corresponding with low food availability and dehydration stresses. Furthermore, female body condition demonstrated marked variation by increasing rapidly during favourable conditions, but declining after the wet season. This type of variation reflected energy input during the wet season followed by a sharp decline in condition after egg deposition.

Climatic differences explained much of the variation in toad population ecology, such as growth and survival rates, activity patterns and body size and condition, between the two locations. Although both study regions were located within the wet-dry tropics of northern Australia, the dry season at Townsville was less harsh than that experienced at Calvert Hills and was often punctuated with rain periods. In contrast, the length of the wet season at Calvert Hills was shorter and usually consisted of less rain while the dry season was long and characterised by high temperatures. The climatic variation between the two locations led to variations in the length and timing of the breeding season, rate of growth, and survival through the dry season.

The long, hot dry season at Calvert Hills put severe hydric pressures on toads. A critical requirement for toads was therefore the selection of a favourable shelter site, especially during periods of inactivity when nightly temperatures were low. Favourable shelter sites have high relative soil moisture, high temperatures, and the presence of other toads. Favoured shelters are an essential resource especially during the dry season, and once found by toads, are returned to repeatedly while conditions within the shelter remain favourable and those outside are unfavourable.

Seasonal variation associated with the wet-dry tropics of northern Australia, influences many aspects of *B. marinus* population ecology. Toad populations respond differently to wet and dry seasons by showing breeding or foraging activity during the wet season, and the need to avoid dehydration during the dry season. The seasonal activity patterns of *B. marinus* populations at a water source also affects the structure and size of populations and the growth rates exhibited by toads within those populations.

Finally, two phases of the terrestrial ecology of toad populations in the wet-dry tropics have been identified as being useful for targeting a potential control agent. The first period is the time just after metamorphosis when survival of small toads is restricted by dehydration and high densities. The second period is late in the dry season when toads are active, due to increasing temperatures, but under extreme hydric stress due to the lack of food and increasing temperatures. If developed, the effectiveness of a biological control agent would be highest if implemented during these two phases.

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