

The environmental physiology of the scorpion
Urodacus manicatus (Thorell) (Scorpionidae)

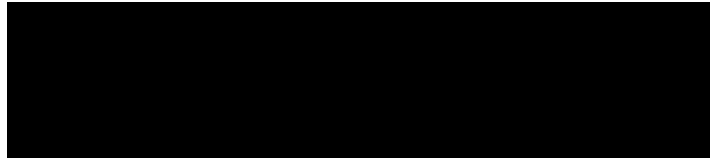
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Declaration

I certify that the substance of this thesis has not already been or is currently being submitted for any other degree.

I certify that, to the best of my knowledge, any help received in preparing this thesis and all sources used have been acknowledged in this thesis.



Chris Holden
February 1996

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Preface

All tables and figures for each chapter are presented at the end of each chapter. Three species name changes have occurred since the publication of some important papers on these species. *Urodacus manicatus* (Thorell) was named *Urodacus abruptus* Pocock at the time of publication of (Smith 1966, Southcott 1954, Willmer 1967). The montane population of *Diplocentrus spitzeri* referred to by (Crawford and Riddle 1974, Crawford and Riddle 1975, Crawford and Wooten 1973) has since been renamed as *Diplocentrus peloncillensis*. *Centruroides sculpturatus* (Bender 1959, Crawford and Krehoff 1975, Hadley 1971, Hadley and Hill 1969, Toolson 1985, Toolson and Hadley 1979, Toolson et al. 1979) has been renamed *Centruroides exilicauda*.

Abstract

The aims of this thesis was to examine the microclimates and the physiological and behavioural responses to seasonal changes in the microhabitats of populations of *Urodacus manicatus* that occur in different parts of the species' range. The aims were achieved by measuring resting metabolic rate (RMR), temperature selection, activity, evaporative water loss and haemolymph osmolality in field-collected specimens during different seasons. Further investigations were then conducted on captive *U. manicatus* to discern the specific effects of biotic and abiotic factors on the scorpions' physiology and behaviour.

This study shows for the first time that *U. manicatus* can extend their distribution from cool temperate ranges to semi-arid plains by selecting shelters for home sites that differ in their thermal properties. In doing so, the upper burrow temperatures are similar between populations that differ in broader climatic conditions.

U. manicatus behaviourally adapts to temperature change but not physiologically so. Regulation metabolic rate and evaporative water loss after high and low temperature acclimation was achieved by the selection of higher or lower temperatures instead of metabolic compensation or alteration of cuticular permeability. The cool temperature which elicited a decrease in selected temperature was the threshold temperature for foraging activity.

U. manicatus also uses behavioural, rather than physiological, means to restrict evaporative water loss when dehydrated. Dehydration to 81% of original body mass resulted in a decrease in temperature selection and activity, but did not significantly affect metabolic rate. The extent of the increase in haemolymph osmolality suggests that *U. manicatus* is more xeric-adapted when compared to other species. Excessive hydration resulted in a decrease of haemolymph osmolality without an increase in body mass.

For the first, it has been shown that scorpions decrease their body temperature along with foraging activity after a meal unlike many other ectotherms that exhibit postprandial thermophily. Survival and reproduction in *U. manicatus* are not affected by irregular prey capture because of their low metabolic rate and their large capacity for storing metabolic reserves. Embryonic growth is maximised during spring when prey abundance is high and minimised when prey abundance is low during winter and late summer. This strategy results in low energetic and somatic costs of reproduction to the females. Offspring mass increases during the last two months of gestation possibly due to water uptake from the hepatopancreas of the female.

This study confirms that the number of instars of *U. manicatus* is seven. Evaporative water loss was shown to scale to surface area up to the sixth instar, but then randomly increased above the values predicted by surface area in sixth instars and adults.