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

By
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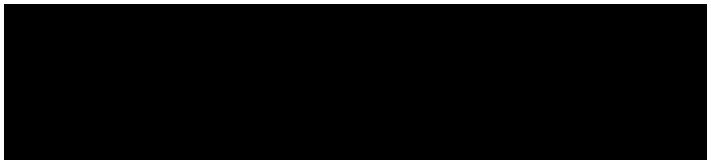
A thesis submitted for the Degree of Doctor of Philosophy
University of New England
February 1996

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 knowle dge, any help received in preparing this thesis and all sources used have been acknowledged in this thesis.



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Acknowledgments

The Forestry Commission of New South Wales granted a permit allowing me to conduct my field research at and collect specimens from Goonoo State Forest.

Thank you to my supervisor Dr Fritz Geiser for making his laboratory available to me and for his assistance during the writing of this thesis. Cheers to my best mate Damon Oliver for his support and for reading parts of the thesis.

Special thanks to Michael Warburg, Gary Polis, Tim Benton, Adam Locket for their infectious enthusiasm about scorpions and particularly to an old mate, Mark Newton, who introduced me to the critters all too long ago.

My field work at Black Mountain was made all the more enjoyable by the wonderful hospitality offered by Terry and Uta Larsen of "Glücksberg" which provided the base for this study. Thanks also to Richard and Lorraine Bird of "Heatherbrae" for allowing me access to their property. The work at Dubbo would never had occurred without the directions of Glen Daymond from the "Apsley" Poll Dorset Stud after he towed out my severely bogged car.

The technical and office staff in Zoology were and still are without par in ALL aspects. I thank Keith Cornish, Wayne Higgins, Sandy Hamdorf, Becky Francis, Louise Percival, Zolton Enoch, David Dye, Sandy Higgins and Barbara Rochester. To Dr Stuart Cairns who was always ready to lend an ear and provide statistical assistance and to Dr Mary Notestine for thinking of me first for demonstrating work. Thank you both. Dr Gerhard Körtner provided invaluable assistance with the oxygen electrode unit and Dr Juliet Roberts kindly gave me permission for use of her vapour pressure osmometer and facilities. My sincere thanks also to Ass. Prof. Rod Simpson for listening to me, to John De Bavay for the use of his water bath and being excellent company in the Herpetology Annexe and to Dr Andrew Boulton for no particular reason I can think of.

My warmest thanks to all my friends who have provided the best times and more support than anyone could wish for. They are: Geoff Barrett, Dave Morton, Susan Wright, Mick Andren, Adrian Stokes, Alison Dare, Ken Zimmerman, Darren Quin, Chris Chilcott, Julian Wall, Harry Hines, Sandra Walpole, Helen Sink, Uschi Munro, Dave Anderton, Rebecca Spence, Ben Sullivan, Denise Gosper, Elizabeth May, Heather Mitchell, Sally Nicol and James Pearson. Dr Mike Ramsey deserves a special mention for not only being a friend, but for also being a fountain of wisdom in all things Ph.D.

Finally, my dearest thanks to all my family for their love and support throughout the years.

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Preface

All tables and figures for each chapter are presented at the end the 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 975, 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 culticular 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.