

# Molecular Systematics and Biogeographic History of Oniscidean Isopod Troglofauna in Groundwater Calcretes of Central Western Australia



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A Thesis Presented for the Degree of Doctor of Philosophy  
March 2014



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## DECLARATION

I certify that this work contains no material which has been accepted for the award of any other degree or diploma in my name, 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. In addition, I certify that no part of this work will, in the future, be used in a submission in my name, for any other degree or diploma in any university or other tertiary institution without the prior approval of the University of Adelaide and where applicable, any partner institution responsible for the joint-award of this degree.

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This study was funded by an ARC linkage grant (#LP100200494) to Andrew D. Austin, Steven J. B. Cooper, William F. Humphreys, Mark S. Harvey and Mark I. Stevens; an ABRS travel grant (BUR212-28) awarded to Seyedmohammad Javidkar and the participating industry partners, Minara Resources, South Australian Museum and Western Australian Museum.

*This thesis is dedicated to:  
My parents, Ebrahim and Zahra  
And my wife, Nahid*

## ABSTRACT

Groundwater calcretes of central Western Australia have revealed an extraordinary diversity of short-range endemic invertebrate subterranean fauna. Although considerable attention has been given to the aquatic dwellers of the calcretes (stygofauna), the subterranean terrestrial fauna of the calcretes (troglofauna), particularly the oniscidean isopods, have been poorly studied. This thesis, including four data chapters, presents the results of multiple-gene and morphological analyses to establish a phylogenetic framework for elucidation of species diversity, systematics, and the biogeographic history of oniscidean isopod troglofauna in arid central Western Australia.

The first data chapter focuses on higher level systematic relationships of the isopod fauna. In order to examine the monophyly of the family Platyarthridae, representatives of the main oniscidean families and genera from Australia, South America, Africa and Europe were analysed using molecular and morphological approaches, including data from a Scanning Electron Microscopy study. The phylogenetic analyses of mitochondrial and nuclear genes (*COI*, *18S*, and *28S*) showed that Platyarthridae is polyphyletic, and also revealed a very distinct Australian lineage with a unique water conducting system on antenna 2. Based on both morphological and molecular data, a new southern hemisphere oniscidean family, Paraplatyarthridae, occurring from subtropical/temperate to arid regions of Australia and South America, is proposed and described.

The second data chapter focuses on the molecular systematics, species diversification and distributional patterns of the oniscidean troglofauna in calcrete aquifers of central Western Australia. The results, based on morphological and multiple-gene molecular approaches, reveal a significant diversity of oniscidean DNA lineages. The application of different species delineation methods, suggests the existence of 28 putative species belonging to four oniscidean families, which most likely represent distinct undescribed species. The phylogenetic analyses show (with some exceptions) that the majority of oniscidean DNA lineages were restricted in their distribution to individual calcrete bodies, lending support to the hypothesis that individual calcretes are equivalent to "Subterranean Islands". In addition, the occurrence of subtropical, littoral and benthic oniscidean groups in the calcretes suggests complex historical events, including the marine inundation of the



Eucla basin during the late Eocene, have shaped the taxonomic representation of the current oniscidean troglofauna.

The third data chapter investigates the biogeographic history of the widespread genus *Paraplatyarthus*, which showed noticeable morphological diversity, from troglophilic to troglobitic forms. The phylogenetic and molecular clock dating analyses provided evidence that evolutionary transitions from surface to subterranean habitats took place from the late Miocene, and further indicated that troglophile ancestral species independently colonised the calcrete aquifers. These findings support both the climatic relict and adaptive shift hypotheses to explain the evolution of the oniscidean isopod troglofauna with aridity being a significant driver of diversification underground.

The final data chapter comprises the morphological description of five new species of the genus *Paraplatyarthus* (*Paraplatyarthridae* fam. nov.) and provides a key to their identification.

## ACKNOWLEDGEMENTS

Thanks be to God, the assisting hands never touched but always felt, the light never seen but always lit my way and the fellow whose sound never heard but his words always perceived.

This PhD thesis would never have been possible without the guidance of my strong supervisory panel: Prof. Steven Cooper, Prof. Andrew Austin, Prof. William (Bill) Humphreys and Dr Rachael King. My very special thanks to Steve that I found him always supportive, encouraging and very keen to help me throughout my PhD. Here, I want to thank him again, even though I know this gratitude is not enough, for accepting my request to do this wonderful opportunity of doing a PhD, training me, making me familiar with new techniques and methods in this area, always responding to my questions with patience and going through all the thesis drafts with professional and constructive comments, suggestions and corrections. My special thanks to Andy who accepted me as his PhD student and kindly supported me/my PhD project both academically and financially. Thanks to Andy, also, for reading the entire thesis and the associated articles in a time when he was loaded with lots of PhD/honours dissertations and for all his professional comments. Thank you to Bill, for his invaluable help in the field, sharing the incredible collection of subterranean fauna with me and his nice corrections/suggestions on my PhD drafts. In my numerous encounters, I found him so enthusiastic to discuss my results and further improve my thesis. I must also thank Rae, Bill's wife, for her excellent hospitality and support during my stay in Western Australia for field trips. Thank you to Rachael, who helped me on species descriptions and went through my PhD drafts with both professional taxonomic comments and precise corrections. My special thanks also to Kathy Saint who trained me in the molecular lab and was always so keen to help and guide me with patience. I sincerely thank Dr Terry Bertozzi who kindly assisted me with the bioinformatics section and helped me to analyse the NGS data.

I must thank Profs. Stefano Taiti and Helmut Schmalfluss for their invaluable comments and sending critical specimens for molecular and morphological experiments. Thank you to Ms Lynette Waterhouse from Adelaide Microscopy for training and helping me in SEM techniques. Thanks to Dr Simon Judd who kindly sent important specimens for further lab

experiments. I would like to thank Andy Austin's lab group: Dr Michelle Guzik and Dr Mark Stevens for their help and arrangements in DNA barcoding; Dr Gary Taylor, Dr John Jennings and Dr Simon Tierney, for support in Microscopy and the associated imaging studies and feedback on my talk presentations.

Thank you to my friends Mohammad Kurgbi, Alejandro Velasco-Castrillon and Rebecca Kittle who provided me with support and made nice moments through my PhD life.

My deepest thanks, which certainly cannot be adequately expressed, to my lovely wife, Nahid, for her love, help, and support and stood by me in every single moment of my life with her. I owe my sincerest thanks to my mother, Zahra, and my father, Ebrahim, who always encouraged and supported me both in life and my studies; to my dear brother, Mohsen, and my lovely sister, Fatemeh, who helped me in every possible moment and were always supporting and encouraging me with their best wishes.

I would like to thank the funding bodies Australian Research Council and the Australian Biological Resources Study for providing grants for lab experiments/equipments, field and conference trips. Finally, I would like to thank the School of Earth and Environmental Sciences of the University of Adelaide, for part funding my PhD stipend and providing project support funds.