# Ecology, Life History and Conservation Status of *Westralunio carteri* IREDALE 1934, an Endemic Freshwater Mussel of South-western Australia

**Michael Willard Klunzinger**

This thesis is presented for the degree of Doctor of Philosophy (Agricultural, Biological & Environmental Sciences) to the School of Veterinary&Life Sciences, Murdoch University, Perth, Western Australia, 2012.

Murdoch UNIVERSITY

## DECLARATION

I declare that this thesis is my own original account of my research and contains as its main content, work which has not previously been submitted for a degree at any tertiary education institution and as author, I reserve the right of copyright under the *Copyright Act 1968*, Commonwealth of Australia.

MICHAEL W. KLUNZINGER

Frontispiece: Lindsay Marshall

# Acknowledgements

First and foremost, I thank my supervisors Alan Lymbery, David Morgan and Stephen Beatty for guiding me towards the finished result contained in this thesis.

I thank the following agencies who funded the study:

| | |
|---|---|
| • PhD Scholarship ($134,792) *Murdoch University* | Murdoch UNIVERSITY |
| • Toshiba laptop computer; Freshwater Fauna Education Program (field guide, brochures, three films & www.musselwatchwa.com) ($50,545 + in-kind assistance) *South East Regional Centre for Urban Landcare*; *Lotterywest*; Ash Ramsay & Joe Northover (*ENVfusion Films*); Ann Jones (*ABC Studios*) | lotterywest ENVfusion ABC Local Radio SERCUL South East Regional Centre for Urban Landcare |
| • State NRM Regional & Community Groups Program ($21,700 + in-kind assistance) *Govt. of Western Australia*; *Lowlands Conservation Assn.* & *Serpentine River Group* | THE GOVERNMENT OF WESTERN AUSTRALIA; LANDCARE Serpentine - Jarrahdale SJ |
| • Holsworth Wildlife Research Endowment ($11,000) *Dr. Holsworth* through *ANZ Trustees* | ANZ TRUSTEES Holsworth Wildlife Research Endowment Fund |
| • Freshwater mussel ecological studies & translocation management during Helena and Serpentine Pipehead Reservoir works ($9,920) *Department of Fisheries* & *Swan River Trust* | SWAN RIVER TRUST Caring for the Swan Canning Riverpark; THE GOVERNMENT OF WESTERN AUSTRALIA Department of Fisheries |

I thank my friends and family for their support along the way. There are many people in my network who helped make this PhD possible. I thank Suresh Job, Karen Hunt, Greg Jenkins and Gavin Partridge for helping me start the journey towards a PhD from my time in Geraldton, not so long ago.

I thank Brother Brandon Schroeder, Fran Stevens, Brian Jones and Keith Walker for writing kind letters of recommendation in my application to study for a PhD at Murdoch. I especially thank Isabella Gijsbertse and Graham O' Hara for working to ensure my application for PhD study was successful and for their influence over the

decision to provide me with a Murdoch University PhD Scholarship, without which this study would not have been possible. I thank school deans David Hampson and Carolyn Jones for administrative, moral support and for supporting my supervisors through difficult financial times. Thanks also to Neil Loneragan for allowing me to represent Murdoch University at the International River Symposium and to the Graduate Research Office for supporting my application to present my work at the World Congress of Malacology in Phuket, Thailand in 2010. Also to Giles Hardy, Treena Burgess and Dianne White for their collaboration during mutually beneficial field surveys of freshwater mussels and riparian tree health studies funded by the Murdoch University Research Capacity Funding Scheme.

I thank Mark Allen, Alice Atkinson, Steffie Basile, Treena Burgess, Tim Drake, Iain Foster, Matt Grimbly, James Keleher, Joyce Lao, Rowan & Samuel Lymbery, Jon Murphy, Tomoe Ota, Bill Richardson, Midge Richardson, David Robertson, Mark Robert, John & Hetty Snowball, Andrew Storey, Ditte Strebel, Gordon Thomson, James Tweedley, students of Central Institute of Technology and SERCUL volunteers for assistance in the field and laboratory.

I thank Mark Angeloni, Midge Richardson, Bill Richardson and Rupert Richardson for allowing me to do research on their property and form a mutually beneficial partnership as part of the community NRM funding scheme and Brian & Trish Easton for allowing the use of their property for mussel growth studies.

I thank Chris Rafferty, Gun Dolva and CIT staff for giving me the opportunity to lecture a group of talented Environmental Science students and recognising the conservation needs of the ‘unseen but not unimportant’ animals that live in our rivers.

I thank David Cale, Jane Chambers, Jeff Cosgrove, Frances D’Souza, Rick Fletcher, Lynette Galvin, Pat Hart, Was Hosja, Rod Hughes, Joanna Hughes-Dit Ciles, Brendan Kelly, Dan Machin, Peter Mawson, Adrian Pinder, Shirley Slack-Smith, Tim Storer,

Kerry Trayler and Corey Whisson for providing data and specimens, moral support and in-kind letters of support from the Western Australian Government.

As a crowning achievement of my desire to pass on knowledge to the community and for their unending support throughout my PhD, I especially thank the South East Regional Centre for Urban Landcare (SERCUL) – Pat Hart and Julie Robert in particular, Melinda Snowball for her creative talent in graphic design and Amy Krupa for doing a fantastic job at the Freshwater Fauna Road shows and sales of field guides. I give my unending thanks to Ash Ramsay for his friendship and unbelievable ability to express our thoughts, knowledge and beliefs on film and I am grateful to Joseph Northover and Ken Ninyette for sharing Nyungar knowledge and introducing me to the Rainbow Serpent (Waugal or Walgu). I thank Ann Jones and ABC Radio studios for her talented voice and to Gillian O'Shaughnessy and Ron Tate for interviewing me. Thanks also go to Robin Walters for her friendly nature and talent in producing the Mussel Watch Western Australia Website and to the many members of the public who responded with Mussel Watch surveys. I thank my colleagues Mahmoud Rashnavadi and Susan Kueh for making Murdoch Fish Health Unit a friendly place to work. I thank Ben Drake, Yonglin and Amy Ren, the Brandons & Potts', Masumi Richardson and Julie & Andy Robert for a safe home in which to reside at a reasonable rent and housemates Wael Aldubayyan, Emily Brandon and Cassie from Montana for being so cruzie.

I give a special thank you to Hugh Jones and Keith Walker for their ongoing collaboration and friendship in freshwater mussel research. Finally, I thank Sir David Attenborough for inspiring me to do what I do and for his warm wishes from my visit to see him in Sydney in 2012 and I thank the staff at the State Theatre for delivering our freshwater fauna education materials to him. I also thank him for acknowledging he received them. His work inspires us all to do what we do.

# Abstract

*Westralunio carteri*, the only hyriid in south-western Australia, was nominated 'Vulnerable' (IUCN) in 1994. The aims of this study were to update the species' range and determine factors limiting its distribution, quantify tolerance to threats, quantify reproduction, describe glochidia morphology, identify host fishes to support the species' life cycle and estimate growth and age.

Extent of Occurrence (EOO) of *W. carteri* is currently 16,011.9 $km^2$, a 63.3% decline from the historic EOO of 43,579.8 $km^2$, suggesting that the species should be classified as 'Endangered' under IUCN guidelines. Multivariate analysis identified flow and drying as explaining most of the variation in the distribution data, while the difference between historic and current distribution was explained principally by salinity. Salinity tolerance experiments indicated $LC_{50}$ values of 1.3 - 3.0 and $LC_{95}$ of 3.2 - 4.3 g $L^{-1}$. Artificial water removal suggested *W. carteri* is intolerant of drying for more than five days during summer without shade or moist sediments.

*Westralunio carteri* spawns during winter; embryos are brooded in the gills of females to become glochidia and released on mucus strings in September – December, when they attach to fins of fishes. Glochidia morphology (size and larval teeth) is distinctive in *W. carteri*, compared to other Australian hyriids.

Glochidia were found on fins of seven native and three alien fish species from 18 populations. Prevalence was 0.0 - 41.0% and 9.2 - 90.5% and intensity 1.0 - 6.0 and 2.3 - 7.1 in alien and native fishes, respectively. Four native and one alien fish species were confirmed as competent hosts in the laboratory. Time to metamorphosis was 21-27 days.

Growth rates were ~12.0 to <0.1 mm $yr^{-1}$ in the smallest (<30 mm long) and largest (>75 mm long) sizes. Calcein validated growth rings as annuli and ages were 3 – 51 years at shell lengths of 12.6 - 82.5 mm, respectively, from five populations. Growth rates and ages-at-length were highly variable between populations.

# Table of contents

# List of figures

# List of tables