

**Systematics and phylogeny of Cheloninae
(Hymenoptera: Braconidae)
with an emphasis on Australian species**



Rebecca Kittel
Dipl.-Biol.

School of Earth and Environmental Sciences
The University of Adelaide
Adelaide, Australia

A thesis submitted for the degree of Doctor of Philosophy
in the Faculty of Sciences at the University of Adelaide

March 2014

Table of Contents

Abstract	iii
Declaration	v
Acknowledgments	vii
Chapter 1: General Introduction	1
Chapter 2: Phylogenetics and biogeography of chelonine parasitoid wasps (Hymenoptera: Braconidae) based on a fossil calibrated multigene analysis	19
Chapter 3: Synopsis of Australian chelonine wasps (Hymenoptera: Braconidae: Cheloninae) with description of two new genera.....	53
Chapter 4: Remarkable range extension of the previously monotypic braconid genus <i>Wushenia</i> Zettel (Hymenoptera: Braconidae: Cheloninae), with description of a second species from Australia.....	75
Chapter 5: Systematics of the parasitic wasp genus <i>Phanerotomella</i> Szépligeti (Hymenoptera: Braconidae: Cheloninae) for Australia, with descriptions of 18 new species	83
Chapter 6: New species of chelonine wasps (Hymenoptera: Braconidae) from the Australian arid zone	141
Chapter 7: General Discussion.....	203
Appendix	211

Abstract

This study explores the systematics of the genera of Cheloninae (Hymenoptera: Braconidae) and presents a number of taxonomic revisions of Australian species. The phylogenetic relationships of the world genera were analysed by applying molecular phylogenetic analyses (based on three markers: *COI*, *28S* and *efl α* , totalling 1454 bp of sequenced data) combined with morphological data. The results show that most genera are monophyletic, although the current tribes were not. Also the previously recognised subgenera of *Chelonus* were not recovered as monophyletic and thus do not represent valid subgenera. A total-evidence approach of 84 sequenced species and 16 dated fossil taxa to calibrate the molecular clock was performed to estimate the age of the subfamily and component genera. Divergence dating analyses and ancestral range reconstruction suggest that the Cheloninae evolved in the Neotropics 150 Ma ago.

Prior to this study, 45 chelonine species were recognised from Australia, of which the majority were described more than 80 years ago. Yet there are many undescribed species, some of which could not be easily assigned to existing genera. Thus the first step of a taxonomic revision was to assess the current state of the fauna. This study evaluates the species richness of the Australian chelonines, provides a key to genera to facilitate their identification, provides a checklist of species and notes on their taxonomy, and discusses their biology. In so doing two new genera, *Austroascogaster* gen. nov. and *Phanaustrotoma* gen. nov. were recognised from Australia, together comprising six new species. Additionally, the genus of *Wushenia*, which was previously known only from a single species from Taiwan has been found in Australia and is represented by a new species. A revision of the Australian *Phanerotomella* species has been conducted, revealing 18 new species. They are described and the three previously species of *Phanerotomella* redescribed. Additionally, nine species belonging to the genera *Phanerotoma* and *Ascogaster* were discovered from central arid Australia, and two species of *Phanerotoma* from this area are redescribed. Dichotomous keys are included to facilitate identification of the species. Finally, the broader implications of the study and future research directions are discussed.

Declaration

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institutions to Rebecca Kittel and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due references is made in the text.

The author consents to this copy of the thesis, once deposited in the University of Adelaide Library, being made available for photographing and loan, subject to the provisions of the Copyright Act 1968.

The author acknowledges that copyright of published works contained within this thesis (as listed below) resides with the copyright holders of those works.

Kittel, R. N., & Austin, A. D. (2014). Synopsis of Australian chelonine wasps (Hymenoptera: Braconidae: Cheloninae) with description of two new genera. *Austral Entomology*, 53(2), 183-202.

Kittel, R. N., & Austin, A. D. (2013). Remarkable range extension of the previously monotypic braconid genus *Wushenia* Zettel (Hymenoptera: Braconidae: Cheloninae), with description of a second species from Australia. *Zootaxa*, 3694(5), 486-492.

Further, the author also gives permission for the digital version of the this thesis to be made available on the web, via the University's digital research repository, the Library catalogue, the Australian Digital Theses Program (ADTP), and through web search engines, unless permission has been granted by the University to restrict access for a period of time.

Rebecca Kittel March 2014

Disclaimer: This thesis is not intended to meet the provision of the ICZN (1999) regarding the publication of new nomenclatural acts [Art. 8.2]. No name or nomenclatural act proposed in chapters 5 and 6 should be considered available as defined by the ICZN.

Acknowledgments

First and foremost I would like to thank the University of Adelaide for my Adelaide Scholarship International, without which I would not have been in Australia in the first place. I am thankful for my co-supervisors Dr John Jennings, Professor Steve Cooper and my principal supervisor Professor Andy Austin for their guidance, encouragement, immensely improving my manuscript drafts and support I received during my candidature. Most of all I am grateful for Andy's suggestion to work on chelonine wasps. They are not only the cutest wasps ever, but they are so easy to work on, they made me enjoy the topic so much!

All the following pages would not have been without the help of a great number of people. Many are already mentioned in the acknowledgements of each chapter. But there are many more people that helped or assisted in some way or another towards the overall thesis, which I would like to thank.

I would like to thank Andy Austin as well as John Jennings for sharing their knowledge of wasp taxonomy and taxonomic work. I would also like to thank Kees van Achterberg and Yves Braet for the discussions we had on morphological characters and systematics of Cheloninae. And I would like to thank Mark Harvey for his help with issues associated with the International Code of Zoological Nomenclature.

Thanks to Kym Abrams and Michelle Guzik for their introduction into the molecular world and for teaching me various molecular biology techniques. I thank Kathy Saint and Andy Wiewel for their time and discussion on improving the lab work. Thanks also to the Australian Centre for Evolutionary Biology and Biodiversity (ACEBB) for providing the facilities.

Thanks to all the postdocs and fellow PhD students of the Invertebrate Systematics group for making the time there enjoyable and productive over the years and for putting up with me and my many questions: Kate Sparks, Kate Muirhead, Sophie Harrison, "Javid" Sayedmohammed Javidkar, and Alejandro Velasco Castrillon. Thanks to Simon Tierney and Seraina Klopstein for their computing knowledge, both arrived late during my PhD in the lab but just on time for my final analyses. I also would like to thank Brittany Hyder, the most enthusiastic undergraduate I know, for her time and effort in imaging many of my

wasps. A special thanks to Gary Taylor with whom I had a great many memorable field trips.

I would like to thank my friends in Adelaide, for sharing the ups and downs of a PhD: Clare Bartholomaeus, Janette Edson, Carla Daunton, Bianca Dunker, Claudia Junge, Steve Richards, and Jillian Schedneck.

This work would not have been conducted without support from the following funding bodies: Australian Biological Resources Study, Australian Entomological Society, Society of Australian Systematic Biologists, Lirabenda Endowment Fund, and Sir Mark Mitchell Research Grant.

A big thank you for the hospitality and material to the following people (in no particular order):

Richard Glatz (Kangaroo Island), Nihara Gunawardene (Barrow Island), Dave Britton (AMS), Nicole Fisher and John LaSalle (ANIC), Graham Brown and Gavin Dally (MAGNT), Peter Hudson (SAM), Susan Wright (QM), Brian Hanich and Terry Houston (WAM), Simon Hinkley and Peter Lillywhite (NMV), Desley Tree (DAFF), Catherine Young (TMAG), Jamie Davies (DPIPWE), Donald Quicke and Gavin Broad (BNHM), Kees van Achterberg (Naturalis), Bob Kula (UNHM), Mike Sharkey (University of Kentucky), Simon van Noort (Iziko South African Museum), Jim Whitfield (University of Illinois), Julia Stigenberg and Hege Vårdal (NRM), Yves Braet (Université de Liège), Jenő Papp and Gellért Puskás (HNHM), Wouter Dekoninck (IRSN), Roy Danielsson (ZIL), David Wahl (AEI), Andrew Bennett (CNC), and Lars Vilhelmsen (SNM).

And last but not least I would like to thank my partner Lars Krieger for his encouragement and good humour, his interest in wasps, discussions, help in the field (best field assistant I have had so far) and in the lab.