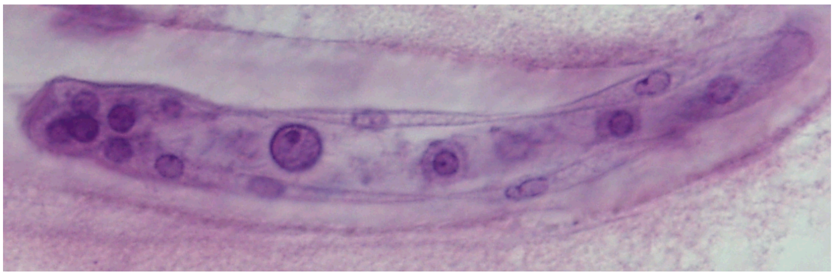
DICYEMID PARASITE FAUNA OF SOUTHERN AUSTRALIAN CEPHALOPOD SPECIES



Sarah Roseann Catalano

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School of Earth and Environmental Sciences

The University of Adelaide

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Supervisors: Prof Bronwyn Gillanders, A/Prof Ian Whittington, Prof Steve Donnellan

Declaration

I, Sarah Roseann Catalano, certify that the research presented in this thesis contains no material that has been accepted for the award of any other degree or diploma in any other university or 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 for any other degree or diploma in any university or other tertiary institute 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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Sarah Roseann Catalano

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Cover image: by Sarah Catalano

Top Left: *Sepioteuthis australis* (southern calamary)
Top Middle: *Octopus kaurna* (southern sand octopus)
Top Right: *Sepia apama* (giant Australian cuttlefish)
Bottom Centre: *Dicyemennea floscephalum* (Catalano 2013) ex *Octopus berrima*

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ABSTRACT

The dicyemid mesozoans (Dicyemida Van Beneden 1882) are a poorly-understood group of marine organisms that are found with high intensities in the renal appendages of benthic cephalopods. The majority of the research focusing on this group is from the northern hemisphere, with very few studies examining the dicyemid fauna of southern hemisphere cephalopod species. Confusion also exists in the literature on the validity of certain families, genera and species within this phylum, and the phylogenetic framework for the dicyemids is scarce. The few studies that have examined dicyemid molecular genetics focus only on single taxon or sole aspects of genome organisation. Furthermore, key parts of the life cycle of dicyemid parasites are unresolved and their position in the Tree of Life is uncertain.

My thesis highlights the taxonomic confusion in the literature that surrounds the Dicyemida, and presents a comprehensive list of all dicyemid species currently described to date (Chapter 2). Ten cephalopods species from Australian waters were collected and examined for dicyemids parasites, resulting in new dicyemid species descriptions (Chapters 3, 4 and 5). Host eggs and filtered seawater samples were collected from the cuttlefish mass breeding aggregation at Upper Spencer Gulf, South Australia, Australia, to assess the unknown host life cycle stage where new infection by the dispersive dicyemid embryo occurs. No dicyemid DNA was detected in any host egg or environmental samples, suggesting new infection occurs after the host embryo hatches rather than at the egg stage (Chapter 6).

Patterns of infections, prevalence, species richness, co-infection and co-occurrence of dicyemids among infected cephalopods species were explored (Chapter 7). Host size in general did not influence patterns of infection, however where dicyemid species co-occurred, restriction to discrete host sizes was observed, suggesting competition between species may be an important factor leading to niche separation. Calotte shape was found to vary between dicyemid species that co-occurred within a single host individual. Additionally, dicyemid fauna composition was found to vary with host geographical collection locality, alluding to the potential use of dicyemid parasites as biological tags (Chapter 7).

The complete cytochrome *c* oxidase subunit I (*COI*) minicircle molecule, including the *COI* gene plus a non-coding region, was sequenced from nine dicyemid species, and comparisons in sequence composition and size were made between and within species

(Chapter 8). The first phylogeny of dicyemids including multiple taxa from the two genera that combined contain over 90% of the nominal described species was estimated from Bayesian inference and maximum likelihood analyses. Monotypic species clades were observed, however the paraphyly to the genera suggests classification based on morphological traits may need revision (Chapter 8).

The hypothesis that parasite genetics of infected cephalopods will allow for a deeper insight into population structuring compared to that gained with complementary methods was tested, with dicyemid mesozoans infecting giant Australian cuttlefish (*Sepia apama*) as the chosen system (Chapter 9). The population structure of *S. apama* previously inferred from host morphology, behaviour and genetics was supported from dicyemid parasite mitochondrial haplotype phylogeography, with an analysis of molecular variance (AMOVA) providing an alternative insight into structuring of this cuttlefish species. This result suggests that in the future, a holistic approach that incorporates parasite and host data (morphology and genetics) should be used to assess cephalopod population boundaries.

An invited review article on the use of parasites as biological tags to assess the population structure of marine organisms is presented as the final data chapter (Chapter 10). Comments are made on the guidelines for selecting a parasite species as a reliable tag candidate, the need to incorporate parasite genetic information and the benefits of a multidisciplinary approach.

The direct outcomes of my study include the description of the first dicyemid species from Australian waters, insights into the unknowns in the dicyemid life cycle, presentation of the first dicyemid phylogeny allowing taxa classification to be assessed outside of the sole morphological approach and analysis of the use of dicyemid parasites as biological tags, supporting the integration of dicyemid parasite genetics alongside other complementary methods to assess cephalopod population structure. In summary, my study has significantly contributed to the field of dicyemid research, increasing both fundamental and applied knowledge on this enigmatic group of organisms.

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