A CONCEPTUAL MODEL FOR ANOSTRACAN BIOGEOGRAPHY

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A DISSERTATION FOR THE DEGREE OF DOCTOR OF PHILOSOPHY OF THE UNIVERSITY OF NEW ENGLAND

October 2014

Candidate's Certification

I certify that the substance of this dissertation has not already been submitted for any degree and is not currently being submitted for any other degree or qualification.

I certify that any help received in preparing this dissertation and all sources used have been acknowledged in this dissertation.

D. Christopher Rogers

[redacted]

1 August 2014

ACKNOWLEDGEMENTS

"Our purpose here . . . is not to (judge) the Crustacea but to be entertained by them; and if that has been realized, who could ask anything more – even of a scientist, or a crustacean?" — Waldo Schmitt, 1931

Many people helped me to accomplish my lifetime goal of earning a doctoral degree. First and foremost, my family gave me the support and love that I needed. James Thorp wanted to help me, and introduced me to Martin Thoms and Michael Reid. Martin Thoms did his utmost to get me matriculated and found the money to cover the majority of the fees; for this I am especially grateful. Ed Martinko believed in me and provided advice and reality checks as I needed them. My dear friend Brian Timms was absolutely essential to this endeavor: he gave me the toughest (and best) reviews, was a great sounding board, drove me all over Australia for field work and meetings, and shared numerous specimens, localities, and geophysical data with me. I am very grateful to each and every one of you. Thank you.

There are many who provided encouragement, advice, honest feedback, specimens and opportunities over the years; I thank you for your friendship (alphabetically): Lynda Beladjal, Dani Boix, Luc Brendonck, Lien-Siang Chou, Graciella Cohen, Luc DeMeester, Stanley Dodson, Lu Eldridge, Clyde Eriksen, Patricio de los Rios Escalante, Aloisio Ferriera, Brenda Hann, Barbara Hayford, Brent Helm, Frank Hovore, Don Huggins, Brian Lang, Jody Martin, Alejandro Maeda-Martínez, Johan Mertens, Leland Miyano, Gopal Murugan, Peter Ng, Hortencia Obregón-Barboza, Jorgen Olesen, Nicholas Rabet, Richard Regnart, Stefan Richter, Jordi Sala, La-orsri Sanoamuang, Alain Thiery, Brian Timms, Fred Schram, Martin Schwentner, Steve Weeks.

I am most especially grateful to my first crustacean mentor Denton Belk (1938-2001), for all his encouragement and selfless help and support, the many collecting trips, the time in the lab and all the literature, books and specimens that he shared with me.

Dedication

To the One who gave us anostracans.

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"After all, the most beautiful and most friendly looking animal of all is a swimming anostracan." – Jens Hoeg, in an email, 2009

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ABSTRACT

The Anostraca are found globally in seasonally astatic basins, temporary pools and/or saline inland aquatic habitats. The primary question posed in this thesis is: why do anostracan taxa occur in some locations and not others? Of the more than 350 described species, greater than one third of anostracans are known to occur in only one location. Anostracan zoogeography research over large spatial scales has focused on climate and water quality data as the primary drivers of spatial distribution. Climate is difficult to quantify and water chemistry in astatic aquatic habitats is highly variable. Anostraca seem to defy any simple explanation of their zoogeography at any scale. In this thesis, the ideas that anostracan biogeography can be explained in terms of island biogeography and the Monopolisation Hypothesis are explored. Results from a series of research studies, undertaken in this thesis, directed to increasing our understanding of anostracan zoogeography highlight the following. First, local adaptation of a broadly distributed anostracan species to temperature across a geographical range, demonstrated that local adaptation to local conditions may drive clinal variation and population isolation. Next, anostracan dispersal pathways were found to affect hatching fractions and amplify priority effects of habitat monopolisation. Furthermore, anostracan speciation must occur allopatrically, either anagenically or cladogenically, because of the nature of the mixing and temporally staggered egg bank. Anostracan bioregions for North America and Australia are quantitatively described in this thesis and defined using Jaccard's Coefficient of Community Similarity, and qualitatively defined using climate data. Fager's Index of Recurring Species Groups is used to quantify species assemblages with the average Fager's Index for a bioregion. The percentage of co-occurring taxa decreases with the length of colonisation time for a given region, suggesting that the Monopolization Hypothesis of De Meester et al. (2002) may function at larger landscape scales. A general relationship between anostracan diversity, endemism, precipitation and precipitation reliability is shown. A statistically significant relationship between specific geochemical components, salinity and dominant salt cations parameters and the distributions of all 63 US species and species assemblages was demonstrated. Distinct geochemical ranges for different species were shown to impose a strong filter on egg banks as well as active stages. Large dichotomies between geochemical tolerance values within each of three species across more than one bioregion demonstrated the presence of cryptic species. Finally a conceptual framework of anostracan biogeographical patterns is presented, demonstrating that anostracan biogeography is structured along the fundamental biogeographic processes of immigration, evolution and extinction. This conceptual framework suggests that patterns of anostracan endemism, distribution and disjunction should be examined through the lens of island biogeography theory. A catalogue of the Anostraca of the world is provided in an appendix to this thesis.