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**The Patterns of Abundance and Demography of Rocky
Intertidal Marine Invertebrates Indicate That
Recruitment Can Set Geographical Range Limits**



**A thesis submitted in fulfillment of the requirements for the
award of the degree of Master of Science (Research) from the
University of Wollongong by**

Eszter Zsafia Hidas

BSc (Hons) (UNSW)

**School of Biological Sciences and Institute for Conservation
Biology, 2007**

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Abstract

The geographical distributions of species are limited by either physical or biogeographic boundaries that inhibit their dispersal, or by changes in abiotic or biotic factors that affect their survival towards their range limits. Benthic marine invertebrates display an array of reproductive modes and dispersal mechanisms, from 'poor' dispersers that produce direct developing crawl-away juveniles to 'good' dispersers that produce planktotrophic larvae, which is likely to influence their population structure and connectivity across the range and at their range limits. Few empirical studies have assessed, however, how the distribution, adult abundance, recruitment and fecundity vary and relate at large spatial scales towards the geographical range limits of benthic marine species, despite the importance of such information for effective conservation practices.

Firstly, I surveyed the large-scale patterns of community composition and species richness of sessile and sedentary rocky intertidal macro-invertebrates at five locations on either side of a biogeographic barrier, and at an isolated habitat patch within the barrier on the southeast coast of Australia, to test the hypothesis that patterns of distribution of these species relate to their reproductive modes across these coastal features. I found that species richness and composition were significantly different north and south of the barrier. Of the total of 40 species sampled, an average of 30 were found in the north, and 27 in the south. Surprisingly, all 8 species that were limited to either side of the barrier were planktonically developing, while the 3 direct developing species were present on both sides. The isolated habitat patch supported 19 of the 32 species that were distributed across the barrier, and all these were planktonically developing. Contrary to my simplistic expectations, therefore, patterns

of species distributions across the barrier were not obviously related to species' reproductive and dispersive modes.

Second, I used surveys of the adult abundances and size-frequency distributions of three planktonically developing rocky intertidal invertebrates that were limited to the north side of the biogeographic barrier to test the predictions of the abundant-centre hypothesis, which states that species are most abundant at the middle of their ranges and least abundant on the edges. I sampled three times, from May 2005 to January 2006, at small (hundreds of m) to large (hundreds of km) spatial scales over a 600 km stretch of coast, from the middle of the range to the range limit of these species. I found that over all three sampling times, the adult abundances of the three species were consistently high within the middle of their ranges, but declined dramatically and significantly at the range limit. Patterns of size-frequency distributions, however, varied towards the range limit among the three species, with one showing no apparent changes, one lacking small individuals, and one lacking large individuals at locations near the range limit. These results indicated that all three species had abundant-centre distributions, but this distribution was not necessarily related to changes in patterns of recruitment.

Lastly, I assessed how demographic processes such as recruitment and fecundity change towards the range limit for the only sessile species that is limited at the barrier, the barnacle *T. rosea*, and explored how these changes related to adult abundance at small to large spatial scales, to reveal the changes in the population dynamics and connectivity of this species from the middle of its range to its range limit. This yielded a complex pattern. Adult and recruit densities, and the proportions of adults producing mature larvae were all consistently large within the middle of the range, but declined

dramatically and significantly at the range limit, indicating a close link between life-history changes and therefore, a relatively closed population structure. However, a significant relationship was only found between adult and recruit densities at large scales at the range limit, whereas fecundity and recruitment did not relate, suggesting that recruitment plays a key role in determining adult abundance at the range limit.

In this thesis, I demonstrated empirically that the adult abundances of three planktonically developing species, and the fecundity and recruitment of one of these species, decline dramatically towards their range limits. Therefore, suboptimal conditions towards the range limits of planktonically developing, rocky intertidal marine invertebrates impact on their demographic processes and thus, adult abundances, despite their potential for long distance dispersal and recolonisation. In this sense, therefore, benthic marine invertebrates with a planktonic larval stage may indeed have ephemeral and vulnerable populations at the edge of their ranges, and may at least partially rely on populations in the middle of the range for survival. Essentially, range edge populations may therefore act as 'sink' populations, however, this proposition should now be tested using genetic assessments of populations across the range and at the range limit.

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