USING SHELL MORPHOLOGY TO CHARACTERISE ABALONE POPULATIONS ACROSS MULTIPLE SPATIAL SCALES

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Declaration

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Abstract

Many sedentary marine invertebrates have a fine-scale (100s m) population structure that complicates their conservation and management. This is a consequence of the limited information on the boundaries between component populations and the biological variability among them. Blacklip abalone (*Haliotis rubra*) form discrete populations many of which are 'stunted' with individuals reaching a maximum length less than those in adjacent areas. A range of morphological measurements from samples of stunted and 'non-stunted' *H. rubra* collected from sites spread across broad (10s km) and fine (100s m) spatial scales in southern South Australia. In addition, information on the growth, size at maturity and fecundity of *H. rubra* was obtained from these same sites. The ratio between shell length and shell height showed clear and significant differences among samples from stunted and non-stunted sites. The fine-scale morphometric collections suggested that stunted populations existed at smaller spatial scales compared to those for non-stunted populations. Spatial variation in these key life history parameters could primarily be attributed to differences between stunted and non-stunted sites. Relationships between each of these parameters and the ratio between shell length and shell height were also examined. The spatial patterns in morphology and biology were highly correlated suggesting that shell length:shell height ratio can be used as a simple 'morphometric marker' to distinguish among populations of abalone and identify their biological characteristics.

The detection of differences *H. rubra* morphology among variable environments cannot determine whether these differences represent a plastic response to the local environment, or whether morphology is genetically fixed. A reciprocal transplant experiment was used to test whether stunted *H. rubra* are the result of a plastic response to the environment or fixed genetic trait. Furthermore, environmental factors that affect food availability were related to differences in morphology. Morphological plasticity was confirmed as the mechanism causing morphological variation in *H. rubra*. Individuals transplanted to sites with non-stunted *H. rubra* grew significantly faster when compared to stunted controls, while individuals transplanted to stunted sites grew significantly slower compared to non-stunted controls. It is suggested that these differences are related to resource availability with areas limited in food supply resulting in stunted populations and areas with abundant food resulting in non-stunted populations.

To reduce the risks of over-fishing and localised depletion of *H. rubra*, management units (MUs) that encompass individual populations need to be determined and then managed according to their life-history characteristics. Potential MUs in the South Australian abalone fishery were identified from the broad-scale, spatial distribution of stunted and non-stunted populations of *H. rubra*, by applying the morphometric marker to commercial shell samples. Key life-history parameters of the *H. rubra* populations within the potential MUs were estimated using relationships between this marker and *H. rubra* biology. Data from fine-scale systematic sampling by commercial fishers were used to validate spatial patterns observed from the more broadly distributed commercial catch samples. The location, distribution and size of potential MUs were largely inconsistent with that of current management. The locations of two MUs were consistent across the broad- and fine-scale datasets with the fine-scale samples being more informative for identifying a potential boundary between these. These results suggest that this morphometric marker can used as a tool for the spatial management of abalone fisheries by simply and inexpensively inferring key biological parameters for individual populations and identify the boundaries among these based on these differences. This approach is among the first to provide a practical means of more closely aligning the scales of assessment and management with biological reality for sedentary marine invertebrates.

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