DISTURBANCES THAT INFLUENCE PATTERNS OF BENTHIC ASSEMBLAGES

One of my study sites, Coffin Bay National Park

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DECLARATION OF AUTHORSHIP

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ABSTRACT

Understanding the influence of disturbance, both natural and human-induced, is a persistent challenge in ecology. Recently, attempts to predict future environments have focused on the consequences of broad scale disturbances. In this thesis I focus on environmental and trophic disturbances as shapers of benthic assemblages. There is growing recognition of the need for greater scientific investment in understanding environmental disturbances to balance the continuing focus of research assessing trophic theories (e.g. herbivory). Historically, it is these theories that have provided a cornerstone to describe and manage subtidal rocky coasts worldwide. In this thesis, therefore, I first assess how our ecological perception of such disturbances (i.e. water pollution and harvesting grazers) may vary as a consequence of the choice of taxonomic classifications used to observe benthic patterns (Chapter 2). I then assess how mechanical disturbance (i.e. wave exposure) may affect the morphology of benthic habitat (Chapter 3) and how temperature disturbances (i.e. oceanographic, cold water pulsing) may affect the consumers of these habitats (Chapter 4).

The critical first finding centred on the effectiveness of alternate scales and metrics of taxonomic classification to detect the effects of water pollution (i.e. nutrient enhancement) as the largest disturbing agent on the benthos, and that this effect may be exacerbated by loss of grazers. While observations of the benthos as morphological groups detected the effects of enhanced nutrients, species diversity (as a measure of phylogenetic relatedness) was the only one of the chosen measures sensitive enough to detect the interaction of both top-down and

bottom-up stressors. This chapter highlights the importance of choice of classification (e.g. morphology *v*. species) and indices (e.g. Shannon index v. ABC curves and phylogenetic diversity) in their potential to predetermine our perception of ecological change and thereby predict future environments.

Mechanical disturbance (i.e. wave exposure) has been widely studied as a mechanism that creates new space for colonisation by alternate species, but is less well studied as a force that can change the shape of communities by mediating their morphology. Macroalgal morphology varies in response to wave exposure such that individuals at high exposures are often smaller than individuals in more sheltered environments. Observations not only confirmed these patterns for a general assemblage on a wave exposed southern coast, but reciprocal transplants of assemblages between exposures also revealed that morphological differences were likely to be a product of flexibility in morphological response of algae to local environments (Chapter 3). In contrast to the often multi-directional responses of a complex suite of morphological characters (e.g. smoothness, stipe length, frond width), overall size has the potential to be used as a broad and predictive tool to identify hydrodynamic stressors across an entire exposure gradient or geographic range.

Strong trophic interactions are often considered characteristic of aquatic systems and due to their perceived ubiquity on temperate rocky coasts, there has been an emphasis in the literature on the influence of herbivores in determining assemblages. Given the importance of the link between herbivores and assemblage structure, in my final chapter I investigated the potential for disturbance to act indirectly on benthos by affecting the survivorship of an herbivorous urchin (Chapter 4). I used observations of variable temperature regimes in a region of upwelling to design an experiment that tested whether this temperature variation could negatively affect the survivorship of settling sea urchins (*Heliocidairs erythrogramma*). When exposed to cold water, mortality increased by up to 70 %, within 12 h of settlement, representing a massive loss of benthic consumers within a very short time scale. This result was used to assess the potential of temperature to indirectly influence benthic habitats across several spatial scales, a process that may have been profoundly underestimated.

In summary, this thesis provides insight into environmental and trophic disturbances as shapers of benthic assemblage patterns, both as natural and human-induced phenomena. I show that our perception of ecological response to the combination of such disturbances can be contingent on the organisational scales and metrics used. Subtle differences in initial choice of such observational units may not only have large affects on the kinds of benthic patterns and disturbances ecologists detect, but also those that they pursue. I recognise that while some physical disturbances can appear subtle (e.g. morphological variation) or strong (e.g. high mortality rate of herbivores), their relative impacts on the broader assemblage (e.g. understorey flora and fauna) will often be dependent on biogeography. Integrating local-scale biological interactions with regional-scale physical processes, therefore, appears to be a potentially progressive line of future enquiry. Indeed, consideration of responses from the physiological through to physical and biogeographical scales will not only strengthen our understanding of the effects of alternate disturbance regimes, but also our predictive power to anticipate future change.

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