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Building Biodiversity

BUILDING SEAWALLS TO SUSTAIN INTERTIDAL BIODIVERSITY IN ALTERED AND URBANIZED ESTUARIES

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Competition between Grazing Limpets

Seawalls differ from natural rocky shores in New South Wales in many aspects. Natural shores have a gradual slope, whereas seawalls are usually vertical. This has an important but often ignored consequence because the extensive intertidal zone of natural shores is compressed into a very small area. Animals living separated from each other in different parts of the intertidal zone on natural shores may come into contact on seawalls. Thus, competitive interactions, unlikely on natural shores can become important on seawalls. Competitive interactions among individuals of the same species (intra-specific) and among individuals of different species (inter-specific) are important ecological processes influencing ecosystem structure and functioning. On seawalls, however, competitive interactions have seldom been studied.

The aim of the present research programme is to study the interactions between two species of grazing limpets commonly found on natural rocky shores in New South Wales, *Cellana tramoserica* and *Patelloida latistrigata*. Both species feed on micro-algae (also known as bio-film) growing as a thin film on the rocks. In Sydney Harbour, oysters are known to provide habitat for certain species, such as the predatory whelk. On bare smooth seawalls, oysters provide elaborate three-dimensional structures which may provide shelter from predators (see Newsletter October 2007).

A survey of seawalls in Sydney Harbour has shown that on seawalls with oysters, the large limpet *Cellana tramoserica* was less abundant than on seawalls without oysters. On the other hand, the smaller limpet *Patelloida latistrigata* was commonly found associated with oysters on seawalls than on bare seawalls when *Cellana tramoserica* was present. This observation raised the following questions:

1) Does *Cellana tramoserica* feed on bare rock more than on oysters (highly complex structure)?

2) Is *Patelloida latistrigata* found on oysters in the presence of *Cellana tramoserica* to escape competition, or does it feed on oysters preferentially?

In order to answer these questions, experimental plots have been fixed on seawalls at Careening Cove and at Cremorne Point, where the interactions between the two limpets in presence and absence of oysters are presently studied.

Experimental Plates at Careening Cove

JUDITH KLEIN, POST DOCTORAL RESEARCH FELLOW

A Perfect Opportunity

One of the greatest challenges in attempting to do ecological studies on the impacts of artificial structures on marine organisms is being able to do the necessary experimental manipulations at an appropriate scale. The difficulty is that structures such as seawalls, wharves, etc. represent considerable capital investment and so manipulations of these are impossible for researchers to fund .

The Wharves at Rushcutters Bay

The organising committee for the Sydney Olympics Games were in the process of removing infrastructure after the completion of the games, including four identical wharves, that had been built at Rushcutters Bay in Sydney Harbour for the yachting events. Previous studies had determined that there was a difference between patterns of distribution of organisms on seawalls where they were shaded by wharves versus where they were not shaded by wharves. Specifically, there was more cover of seaweeds and more mobile invertebrates, such as grazing limpets, in un-shaded areas and more cover of sessile invertebrates, such as sponges and tubeworms in shaded areas. To determine whether these differences were definitely due to the presence of the wharf itself rather than some other factor, it was necessary to do manipulative experiments. Three of these wharves were to be removed and the wall restored to its previous state. This allowed for a replicated experiment where identical wharves were removed from a single section of seawall, something that would not normally have been possible. By working with those responsible for this work, we were able to time sampling so that we could use the removal of the wharves in a before/after control/ impact assessment.

We designed an experiment to test whether the animals and plants on the seawall beneath the wharves would become similar to those on the un-shaded sections of seawall when the wharves were removed and to measure the rate at which such changes would occur. It was a perfect opportunity to examine the effect of restoration of a habitat that was potentially disturbed by the addition of the wharf to an already artificial habitat. There are few examples where tests of restoration of disturbed natural shores are possible and, in fact, there is little information about how theories of restoration apply to intertidal organisms.

Some changes were very rapid, occurring immediately after the wharves were removed, such as a reduction in cover of sponges, possibly due to the increase in light and desiccation. Others took a lot longer. Similarly, despite an increase in cover of mussels under the remaining wharf, there were no increases where the wharves were removed or on the walls that had never been shaded by a wharf. Oysters, in contrast, had more cover on the unshaded walls, but when the wharves were removed, cover of oysters increased to become even larger than that on walls that had always been un-shaded. Grazing molluscs such as *Chiton pelliserpentis* and the limpet *Siphonaria denticulata* also increased in abundance on walls once the wharves were removed and after a year, their abundances were similar to seawalls that had never been shaded. Not all taxa, however, responded, indicating that the patterns between shaded and un-shaded walls cannot simply be explained by the presence of the shading structure, or that more time is needed for the original pattern to emerge.

It is important that ecologists working in urban environments use large-scale management, such as this, to investigate ecological processes at scales that are not often available to ecologists. It was extremely fortunate in this case, that multiple wharves were built and removed; allowing replication of the treatment and that one wharf was left in place, allowing the necessary contrast.

David Blockley, Post Doctoral Research Fellow
Gee Chapman, Professor of Marine Ecology

Limpet performance measured by ' Tenacometer '

In Sydney Harbour, natural rocky shores are relatively scarce and, in some areas, more than half of the natural foreshore has been replaced by vertical seawalls. Introducing artificial structures into coastal areas can have major impacts. Simply recording the presence or absence of organisms and their densities is not adequate to determine the ecological consequences of replacing natural habitats with walls, on the fauna and flora which live in these habitats. Why are some species absent from walls and why are other species found in large numbers on these structures? Our research is investigating whether those species that can live on intertidal seawalls underperform in some way, e.g. in terms of foraging behaviour, growth or reproduction.

Cellana fitted with harness to measure tenacity

On natural rocky shores in NSW, limpets are abundant and play a key role affecting the abundance and distribution of other organisms, including seaweeds, sessile animals and other mobile animals. Some species of limpets are relatively sparse on most harbour walls and the occurrence of others varies with the material used to construct the walls. For instance, a major difference between sandstone and concrete walls is that *Patelloida latistrigata* occur in greater numbers on concrete walls than on those made of sandstone, whilst *Siphonaria denticulata* show the opposite pattern. The ecologically important limpet, *Cellana tramoserica*, is also sparse on many walls.

A possible explanation for these patterns is that the different species of limpets survive at different rates in different habitats, which may be related to how strongly they can cling to the surface in areas with different water flows. Limpets use suction and glue-like mucus secretions to attach to the substratum, to resist dislodgment and to avoid predators. When water passes over the shells of limpets, it can exert large lift and drag forces on them. Laboratory trials suggest that water flow is much faster on smooth surfaces, such as concrete, than on rougher surfaces like sandstone. Studies on limpets in Europe, have suggested that the strength of their attachment also varies with roughness of the substratum. It is not yet clear for any species how tenacity may vary with slope, but seawalls are much steeper sloping than the natural shores where these limpets live.

Dr Mark Browne, a Post Doctoral Fellow at the EICC is working with Professors Gee Chapman and Tony Underwood to measure the strength of attachment of different species of limpets on natural shores and sandstone and concrete walls, to test the model that their tenacity determines where they are most abundant. Mark glues special harnesses with wire loops to limpets and measures the amount of force required to detach them from the substratum using a specially designed *Tenacometer*, developed at the University of Sydney.

Recent, manipulative field experiments at Careening Cove and Cremorne Point have also shown that, on concrete and sandstone surfaces, large numbers of *Patelloida latistrigata* results in greater mortality of *Siphonaria denticulata*. Although this result cannot explain the original pattern of abundances of these species between concrete and sandstone walls, it suggests that competition is important for determining patterns of distribution of these species. It is also unclear how *P. latistrigata* results in the mortality of *S. denticulata*. Mark and Dr Bea Echavarri (another researcher at the Centre) are measuring the foraging movements and dispersion of these limpets on seawalls to try to identify how they interact and compete. The limpets are individually tagged and their position on the seawalls tracked over time using a digital photographs. Both these studies are providing important information for managing biodiversity within the harbour.

Mark Browne, Post Doctoral Research Fellow

This is the 6th and final issue of Building Biodiversity.

The ARC Linkage Grant has funded ground-breaking research and produced some exciting results, that we have enjoyed sharing with you.

We will continue to stay in touch and send you copies of any relevant papers that are produced by the Centre.

I have enjoyed meeting and working with you all and wish you every success in all your future projects.

Hester Jackson
Seawalls Project Officer