The effects of armoring the coastline on intertidal flora and fauna

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The extensive anthropogenic armoring of the shoreline along the California coast provides an unusual opportunity to determine the effects of variation in substrate type on settlement and post-settlement processes of sessile intertidal flora and fauna. Armoring is the addition of hard substrate, boulders or seawalls, to a zone where ephemeral rocks and sand once existed. Armoring is a biological disturbance, covering up native rocks and associated organisms. The interactions between intertidal organisms and substrates might play a significant role in structuring benthic communities influencing not only initial settlement, but also subsequent species assemblages.

Although soil type has been studied for terrestrial communities and sediment type for soft-substrate/infaunal communities, the importance of substrate type on community ecology in the rocky intertidal is difficult to study in the field because geologic differences generally occur over large spatial scales and transplantation studies are difficult. Physical properties of rocks (e.g., limestone vs. basalt) influence water absorption/evaporation, permeability, and surface temperature.

Implicit in studies of attached epibenthic organisms is the importance of larval settlement and later survival. Site selection is almost irreversible after metamorphosis onto hard substrate, which strongly influences post-settlement mortality. Substrate characteristics have been shown to attract or repel invertebrate larvae and algal spores. Much work has been done examining the mechanisms that determine intertidal zonation patterns, but the differences in these patterns with respect to substrate type have been largely neglected. It is important to understand how rock types affect settlement processes in sessile intertidal organisms to determine if rock type influences intertidal zonation patterns, explaining differences between shores.

Behavioral and physical adaptations to the environment influence the abundance and distribution patterns of intertidal species. The rocky substrate available to settling larvae likely influences the patterns of zonation and community structure on rocky shores. Rock type (e.g., basalt, mudstone) could be a key factor determining patterns of zonation in the intertidal by causing variable micro-climates for intertidal species, e.g., water retention and rock color affects surface temperature, surface texture affects flow. A species assemblage that is more attracted to a particular substrate type could affect succession by its subsequent interaction with later assemblages. Settlement and post-settlement mortality are affected by specific local physical conditions such as coastal morphology, currents, available space, wave action, and by the abundance of predators.

In a pilot study at 2 spatially separated sites, I performed a series of clearings on basalt, sandstone and mudstone rocks and counted all invertebrates and weighed dried algae from the cleared substrates. Canonical discriminant analysis led to a high degree of classification (MANOVA, $p<0.001$ site 1 and $p<0.01$ site 2) for different rock types with respect to community structure. Through a series of transplantation experiments, I am examining settlement and post-settlement processes on plates of different rock types with natural rugosity in the field. I am testing thermal effects on community structure by deploying settlement and post-settlement plates with temperature loggers in the high intertidal zone. The goals of this project are to: 1) determine if there is a difference in community assemblages relating to different rock types and if so, as seems likely, 2) demonstrate the mechanism responsible for these differences, and 3) link those patterns to life history characteristics.

Figure 1. Armoring of the coastline in Santa Cruz County. Basalt and sandstone boulders were added to protect the eroding mudstone cliffs. Photo by Dawn A. Osborn.