THE IMPACT OF MACROALGAL COVER ON THE SURVIVAL OF THE INTERTIDAL BARNACLE *SEMIBALANUS BALANOIDES* ON A SHELTERED AND EXPOSED ROCKY SHORE IN NAHANT, MA

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***Abstract* :** Barnacles are important members of rocky intertidal communities and their settlement and survival can be influenced by a number of factors including growth of macroalgae. Macroalgae can prevent desiccation of barnacles during low tides, but can also detrimentally impact barnacle survival through overgrowth or through whiplash caused by high wave action. Here, the impact of macroalgal cover on the survival of the barnacle *Semibalanus balanoides* was examined in a rocky intertidal community in Nahant, MA, and compared between an exposed and sheltered shoreline. Barnacle survival was assessed using quadrat sampling, counting the number of live and dead barnacles in each quadrat, and percent cover of macroalgae determined through the point-intercept method. The presence of algae significantly increased barnacle survival on the sheltered shoreline, but decreased survival on the exposed shoreline. This suggests that algae may prevent desiccation and therefore enhance barnacle survival on the sheltered shoreline, but with high wave action the whiplash of the algae on the barnacles may decrease survival on the exposed shoreline.

Key Words: *macroalgal cover,* Semibalanus balanoides, *survival*

Introduction

Barnacles are an important member of rocky intertidal communities, often dominating the benthic cover of the upper intertidal zones (Bertness et al. 1991), and are involved in a number of the complex interspecific interactions and competition that so characterize the intertidal. Recruitment, settlement and survival of barnacles are influenced by a number of factors including wave action, food availability, and competition for space with other members of the intertidal (Hancock & Petraitis 2001; Torneux & Borget 1988; Bertness et al. 1991). In particular, macroalgal cover has been shown to affect both recruitment and survival especially of early life stages of barnacles (Jernakoff 1985; Grant 1977; Bertness et al. 1999). Desiccation is a danger for many intertidal species, especially those that settle high in the intertidal. Cover by macroalgae has been shown to significantly prevent water loss and reduce variations in temperature (Bertness et al. 1999), which can enhance the survival of benthic intertidal invertebrates. However, past studies have shown that overgrowth by macroalgae can limit recruitment of benthic species such as barnacles, and can sometimes kill settled populations as well. Additionally, whiplash from macroalgae continuously hitting barnacles, caused by high wave action, has been shown to reduce survival of barnacles through damaging barnacle tests (Grant 1977). Still other studies have seen no effect of macroalgal cover on barnacle survival (Jernakoff 1985).

Here the effect of macroalgal cover by *Ascophyllum nodosum* and *Fucus vesiculosus* on the survival of the barnacle *Semibalanus balanoides* was examined in a rocky intertidal community in Nahant, MA. Additionally, survival of *S. balanoides* and the impact of macroalgae on survival was compared between a sheltered and exposed shoreline.

Materials and Methods

Study Organisms

The acorn barnacle, *Semibalanus balanoides* is common throughout rocky intertidal areas in the Northeast Pacific and the Northeast and Northwest Atlantic (Schmidt et al. 2000). *S. balanoides* occupy a variety of microhabitats throughout the intertidal zone, but tend to settle in lower intertidal zones to reduce the risk of desiccation (Torneaux & Bourget 1988). Like other barnacles, *S. balanoides* is a sessile filter feeder, feeding on plankton during high tide. Thus, the amount of food consumed by *S. balanoides* depends both on the density of plankton present in the surrounding water and the flow rate of water through their habitat, which can be affected by factors such as algal growth (Bertness et al. 1991). The most prominant predator of *S. balanoides* in the Northwest Atlantic is the dog whelk, *Nucella lapillus* (Dunkin & Hughes 1984).

Study Site

The study was conducted at East Point, Nahant, MA (42º25’9”N, 70º54’26”W). The rocky shoreline at this site faces north, and ranges from sheltered to mostly exposed. Two areas of the shoreline were examined; one in a sheltered area and one in a more exposed area (see Fig. 1). The intertidal zone at Nahant supports a variety of algae and invertebrates, the most dominant of which include the algae *Ascophyllum nodosum, Fucus vesiculosus,* and *Chondrus crispus*, littorine snails, barnacles, and mussels. *S. balanoides* are common especially in the higher reaches of the intertidal, growing in thick mats on exposed rock.

Observational Methods

Transect lines were laid perpendicular to the shoreline, spanning from the high tide line through to the water line. Every two meters on the transect line, a 25x25cm quadrat was sampled by randomly tossing the quadrat to one side of the transect line. Within each quadrat, percent cover was assessed using the point intercept method with a 5cm grid. The numbers of live and dead barnacles were counted, and the presence of mussels and dog whelks was noted. Five transects were sampled on both the sheltered shore and the exposed shore, for a total of 19 quadrat samples on the exposed shore and 18 quadrat samples on the sheltered shore.

Figure 1: Study area in Nahant, MA. The sheltered shoreline is outlined in red and the exposed shoreline in yellow. Five transects were sampled randomly spaced throughout each study area.

Data Analysis

Linear regression analyses were used to determine if there was a significant correlation between algal cover and barnacle survival in the sheltered and unsheltered areas. In the sheltered area, algal cover was broken down by species and regressions used to determine if there were interspecific differences between the effect of macroalgal cover on barnacle survival. Additionally, an ANOVA was run comparing the mean barnacle survival between areas where algae was present and absent, and between sheltered and non-sheltered areas.

Results and Discussion

On the sheltered shoreline there was no significant correlation between algal cover and barnacle survival (correlation coefficient r = 0.14, p = 0.58). This trend did not change when the algal cover was broken down by species; no specific algal species had a significant impact on barnacle survival (Fig. 2). However, there was a significant correlation between algal cover and barnacle survival on the exposed shore (r = -0.49, p = .034; Fig. 3). There were also significant differences in barnacle survival between areas where algae was present compared with areas where algae was absent in both the sheltered and exposed shorelines, however these two treatments showed different patterns. On the sheltered shoreline barnacles showed significantly highe survival where algae was present, while on the exposed shoreline there was higher barnacle survival with no algae present (Fig. 4). Past studies have shown that algae can increase barnacle survival by preventing desiccation (Bertness et al. 1999), and this interaction may explain the increased survival of barnacles when algae is present on the sheltered shoreline. On the exposed shoreline however, the increased wave action may produce the negative effects observed of increased algal cover on barnacle survival through the whip-lash effect. The whip-lash effect of larger algae species such as *A. nodosum* and *F. vesiculosus* repeatedly hitting sessile invertebrates such as barnacles due to strong wave action has been shown to decrease survival of *S. balanoides* in past studies (Grant 1977; Hancock & Petraitis 2001).

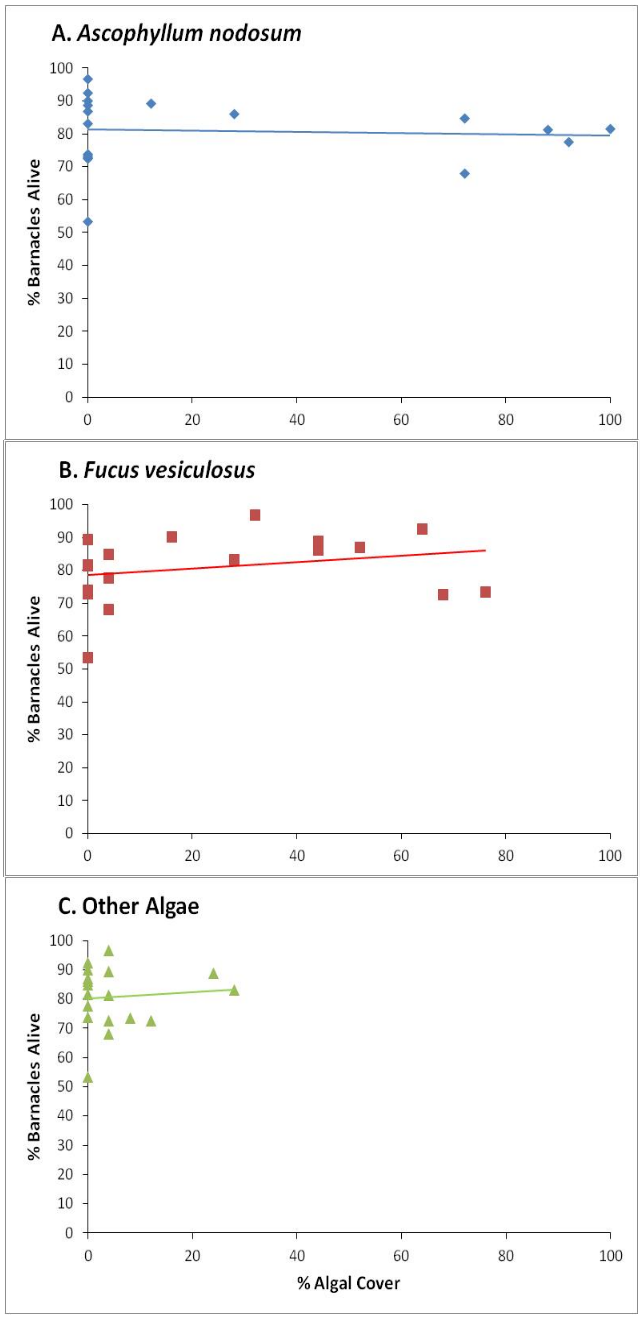

Figure 2: Percent barnacle survival as a function of cover by *Ascophyllum nodosum* (A), *Fucus vesiculosus* (B), and other algae (C) on the sheltered shoreline. None of the relationships between barnacle survival and algal cover showed significant correlations (*A. nodosum* correlation coefficient r = -0.072, p = 0.78; *F. vesiculosus* r = 0.25, p = 0.31; other algae r = 0.08, p = 0.74).

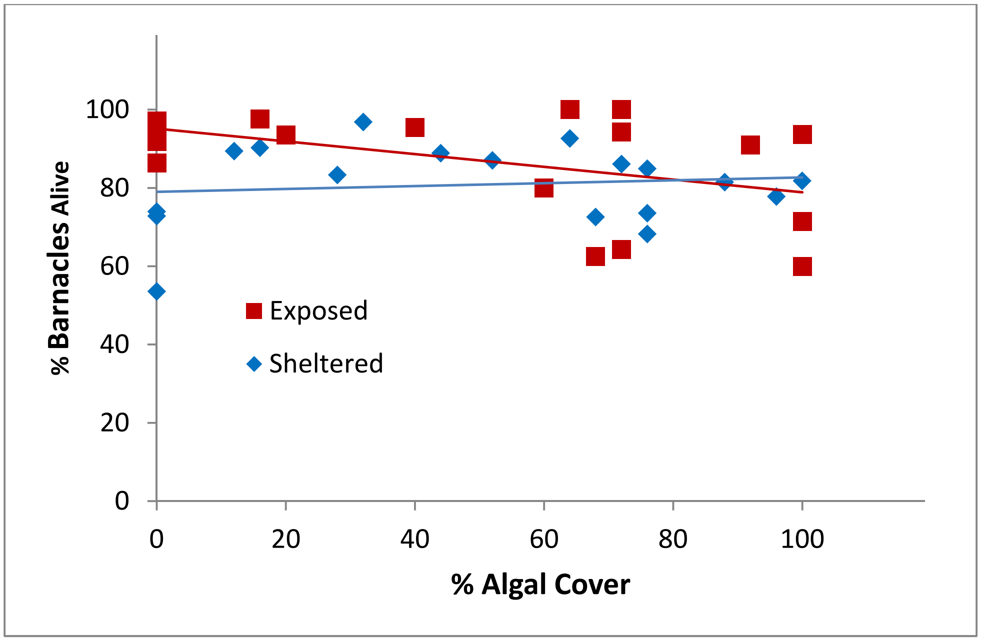

Figure 3: Percent barnacle survival as a function of total macroalgal cover on the sheltered and exposed shorelines. The correlation between barnacle survival and algal cover was non-significant for the sheltered shoreline (r = 0.14, p = 0.58), but was significant for the exposed shoreline (r = -0.49, p = 0.034).

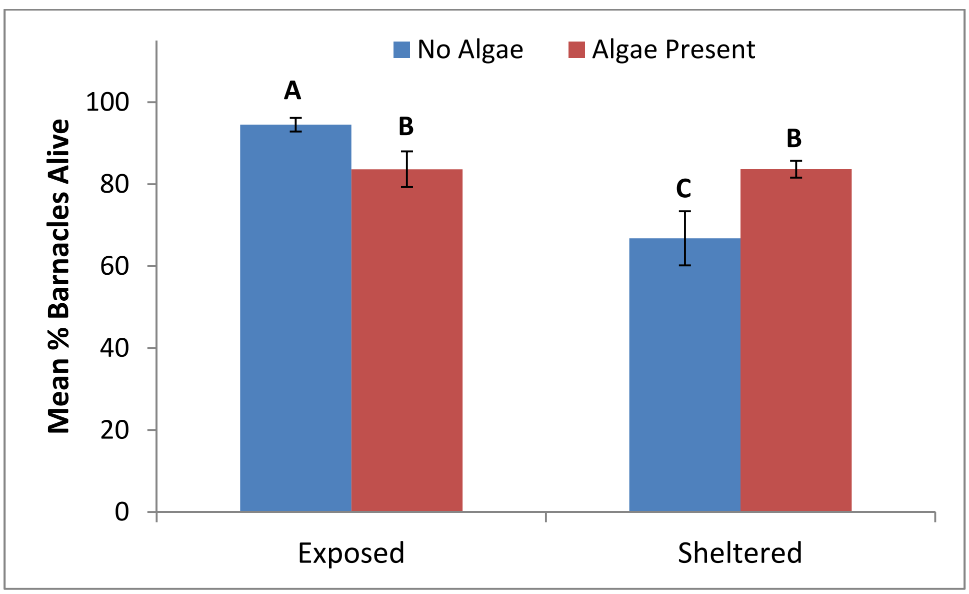

Figure 4: Mean barnacle survival in areas with and without algae on the sheltered and exposed shorelines. Letters denote significant differences between groups (p<0.05). Error bars show standard error.

While this justification may explain some of the relationships between barnacle survival and algal cover seen in this study, other variables may have also influenced these relationships. The most pressing of these other variables is likely the differences in benthic communities seen between the sheltered and exposed shorelines. On the exposed shoreline, there were widespread dense mussel beds, often covering a substantial portion of the quadrat sampled, whereas there were relatively few mussels present in the sheltered area of the shoreline and instead greater overall algal cover. The presence of these mussel beds could significantly affect the distribution of both the barnacles and macroalgae in the exposed area of the shoreline through overcrowding and increasing competition for food resources, which could have contributed to the differences seen in barnacle survival between the sheltered and exposed shores. Further studies should continue to examine differences in barnacle survival between exposed and sheltered shorelines, with emphasis on how the different conditions in the two habitats change the species composition of the intertidal zone and how these differences impact barnacle survival. Additionally, rather than quantifying barnacle survival by counting live and dead barnacles, conducting a long term study looking at barnacle survival in permanent quadrats over time would give a more thorough representation of barnacle survival, for example, looking at survival of barnacles for a year following recruitment. This could give a more accurate representation of how macroalgal cover and other environmental variables affect barnacle survival.

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