PROXIMITY OF FOUR SPECIES IN THE NEW ENGLAND INTERTIDAL

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Abstract

The tide pools of New England feature many species interactions. This study shows preliminary associations between the species *Clathromorphum circumscriptum*, *Acmaea testudinalis*, *Chondrus crispus*, and *Littorina littorea*. Quadrats were randomly placed throughout the rocky intertidal at East Point, Nahant, Massachusetts and the target species within each were recorded. This data was then used to conduct statistical tests to determine proximity between the species. Since relationships between all four species in these observations have been established through this study, their specific interactions can be further studied.

Keywords: Intertidal interactions, *Acmaea testundinalis, Chondrus crispus, Clathromorphum circumscriptum, Littorina littorea*

Introduction

Species interactions occurring in tide pools range from beneficial to detrimental. When sections of the rocky intertidal are wiped clean by storms or for experimental purposes, different species will be the first to colonize based on their adaptations and interactions with other species. For example, *Mytilus edulis* is dominant over *Chondrus crispus* and will therefore inhibit its growth. In addition, there are indirect interactions. *Littorina littorea* can suppress the growth the red algae *C. cripus* (Lubchenco and Mebge 1978), therefore inhibiting the growth of herbivores that feed on *C. crispus*. *C. crispus* also limits the growth of *Fucus sp*. (Lubchenco 1980), so if *L. littorea* is controlling the *C. cripus* population, it is also having an impact on the growth of *Fucus sp.*

Species that increase each other's fitness may have coevolved. An example is the interaction between limpets, *Acmaea testudinalis* and a crustose corraline, *Clathromorphum circumscriptum*. *A. testudinalis* is herbivorous, and mostly feeds on *C. circumscriptum*. Although the dead cells and debris on *C. circumscriptum* are its main source of food, *A. testudinalis* does not kill or clear patches of *C. circumscriptum*. While the limpet is obtaining its food, it is also cleaning off the surface of the crustose coralline without damaging it, which allows for better light absorption, nutrient uptake and gas exchange (Steneck 1982).

This study aims to investigate if any of the four species *Acmaea testudinalis*, *Chondrus crispus*, *Clathromoprhum circumscriptum* and *Littorina littorea* are commonly found in close proximity. Once proximity is observed, further research

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and studies can be conducted to determine what kind of interaction occurs between each and whether it is beneficial or detrimental to the species.

Materials and Methods

Study Organisms: *Acmaea testudinalis*, or the tortoiseshell limpet, is the only common limpet found in New England (National Audubon, 1981). They are herbivores that require a smooth surface to attach to and graze (Steneck 1982). They clean the surfaces of *Clathomorphum circumscriptum* of sediment and dead cells with specially adapted radula (Bertness 2007). *C. circumscriptum* has a calcareous skeleton that helps it to survive grazing by *A. testudinalis*. *C. circumscriptum* grows in sheet-like patches and is smoother than other crustal corallines which allows limpets to attach and feed. When limpets graze on other crustose corallines, they decreases the thickness of the coralline and reduce the defense of the coralline against competition from other encrusting algae (Steneck 1991). *C. circumspcriptum* is also susceptible to desiccation, which may limit where it is found in the intertidal (Steneck 1986).

Chondrus crispus, also known as irish moss, is found in sheltered regions of the lower rocky intertidal (Lubchenco 1978), mostly at the lower points in tide pools (Personal Obs.). While limpets could feed on *C. crispus*, they prefer *C. circumscriptum* and but are too sparse to have a major effect on the growth of either algae species. *Littorina littorea* does inhibit the growth of *C. crispus* by feeding on it (Lubchenco and Menge 1978). *L. littorea* is an invasive species from Europe that has been shown to have an overall drastic effect on the rocky intertidal, for example, inhibiting the effect of *C. crispus* (Lubchenco 1978). *Littorina littorea* was introduced to Nova Scotia, where it was introduced in the 1840s, to Cape Cod in the 1870s, and has since moved all the way to the Carolinas and farther south. *L. littorea*, like *C. crispus*, is more likely found in lower exposure areas of the intertidal (Bertness 1984).

Study site: The East Point of Nahant, Massachusetts houses the Northeastern University Marine Science Center. All data were gathered at the rocky intertidal just to the north of the science center. This area was a small beach sheltered from the east and the west.

Methods: Quadrats that measured 0.25^2, were randomly placed throughout the rocky intertidal, in and out of tide pools. Care was taken to obtain data from all levels of the intertidal area to account for interactions and proximity in all areas. Species found in each quadrat were recorded. If needed, algae or large area covering species were moved out of the way in order to identify the four species included in the study. On all days of the study, data were collected in the late afternoon within 2 hours of low tide. Version 7 of JMP software was used to determine the significance of proximity between species and to create contingency tables and mosaic plots (Figure 1).

Results and Discussion

All associations between species were significant (P < 0.0001, DF = 1; Chi-squared listed in Table 1). Based on the data collected, all of the species are found close to one another. The mosaic showing the proximity between A. testudinalis and C. circumscriptum is show in Figure 1. Similar mosaics and results were found when testing for proximity between all four of the species in this study. These results could show many different things. Mutualism, competition or even mechanisms such as symbiosis could be occurring, along with other types of interactions. Or both species in proximity to each other could be benefiting.

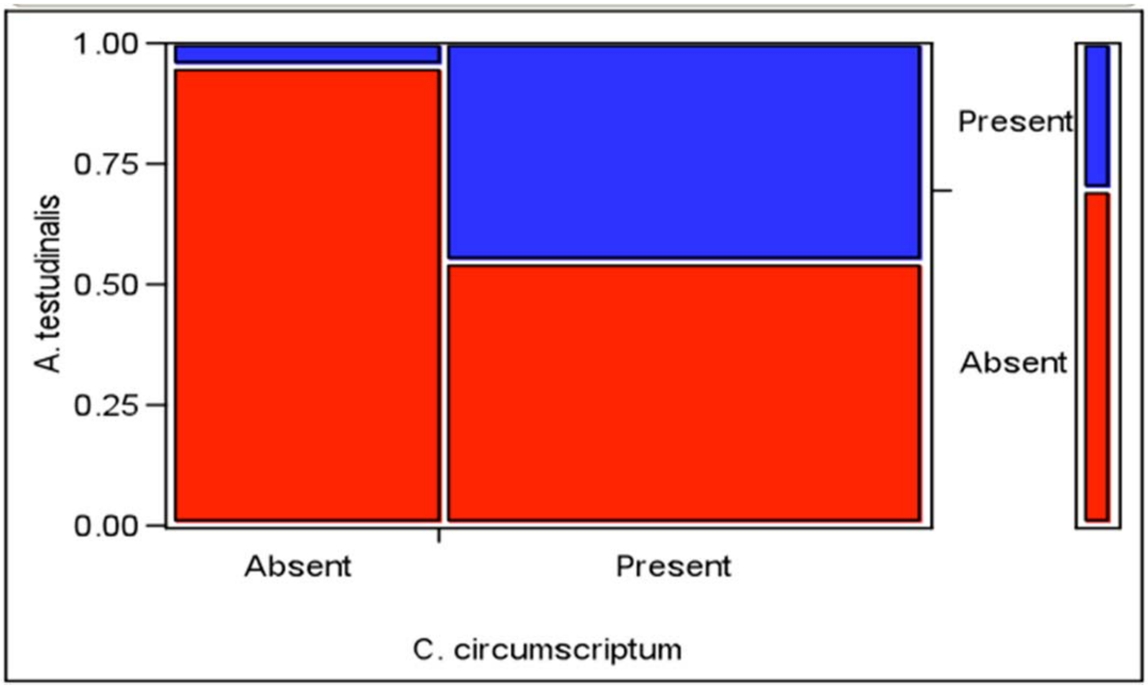

Figure 1) Proximity between A. testudinalis and C. circumscriptum was determined using a mosaic plot. On the x-axis, the absence and presence of C. circumscriptum is shown by labels; absent on the left and present on the right. The presence of A. testudinalis is shown on the y-axis with the colors blue (for present) and red (for absent). This mosaic shows that when C. circumscriptum is absent, A. testudinalis is almost always absent (small amount of blue in the left column indicates a small of amount of presences in quadrats where C. circumscriptum is absent). When C. circumscriptum is present, A. testudinalis is present just over 50% of the time. Based on P values and Chi-squared values, all mosaics showed species where residing in the same areas. (P > 0.0001).

Proximity of *Littorina littorea* to the three other species in the study could be detrimental. Bertness et al. (1984) determined that the introduction of *L. littorea* was detrimental to the establishment of algal canopies due to herbivory and competition for space. These snails are found in high densities, up to 800 snails per $^{m-2}$ in protected habitats. These protected habitats are also where *C. crispus* resides (Lubchenco 1978). They could be living in close proximity due to the low exposure to the elements, or they could be interacting in a plant-herbivore manner.

Table 1) P values and Chi-squared for all associations. All tests had DF = 1. Significant P values are in bold

IAssociations	P Value	Chi-squared
C. circumspcriptum and A. testudinalis	**> 0.0001**	46.012
C. crispus and C. circumscriptum	**> 0.0001**	171.286
C. cripus and A. testudinalis	**> 0.0001**	53.081
L. littorea and A. testudinalis	**> 0.0001**	27.147
C. crispus and L. littorea	**> 0.0001**	71.479
L. littorea and C. circumscriptum	**> 0.0001**	57.385

Species could also be found in proximity due to where they reside in the intertidal. Zonation of plants and animals in the intertidal can be due to physical factors in addition to biotic factors (Gendron 1977). Smaller quadrats could be used in studies similar to this to help eliminate this factor in results.

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