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Structural Comparison
Adaptations of Marine Animals

Tegula funebralis **Shell height variance in the Intertidal zones**

Introduction

The Pacific Coast of the United States is home to a great diversity of biota that populates both extremes, from the constantly battered rocks to the calm ocean floor. As a result of this diversity or because of this diversity there are distinct zones created by the physical, chemical, and biological constraints of the organisms. *Tegula funebralis* (*T. funebralis)* commonly called the Black Turban shell is found in the low to high intertidal zones of rocky shores on or under rocks grazing on macroalgae. *T. funebralis* can be purple to black in color with four whirls on top (usually worn down to a light color at the top), average 3cm in diameter, and can live up to 100 years (Sept 1999).

T. funebralis' density tends to be greater in the mid to high intertidal zone due to predation by octopus, *Pisaster ochraceous*, and crabs (Fawcett 1984). They also show a pattern of distribution where juveniles (those not of reproductive size ~14mm) stay in the mid intertidal zone because it is midway between the physical stress of desiccation and the biological stress of predation (Fawcett 1984). Generally larger snails are able to withstand desiccation more then smaller snails, but larger *Tegula* have a greater advantage living lower in the intertidal even at the risk of predation. They are kept at moderate levels in this zone because *Pisaster* feeds on them and reduces their density, which then increases the food abundance for those who remain (Doering and Phillips 1983). Byers and Mitton (1981) marked snails and monitored their behavior after they transplanted them to different areas of the tide pool. They found that the snails return to their original habitat, suggesting that they exhibit intraspecific variation in habitat preference based on occupying areas in which their fitness is highest so the severity of natural selection is balanced out and polymorphisms are maintained. According to this theory *T. funebralis* will be most fit for the are that it chooses to inhabit, the *Tegula funebralis* occupying areas of high wave action will have dimensionally flatter, while those in the low-intertidal will have taller shells.

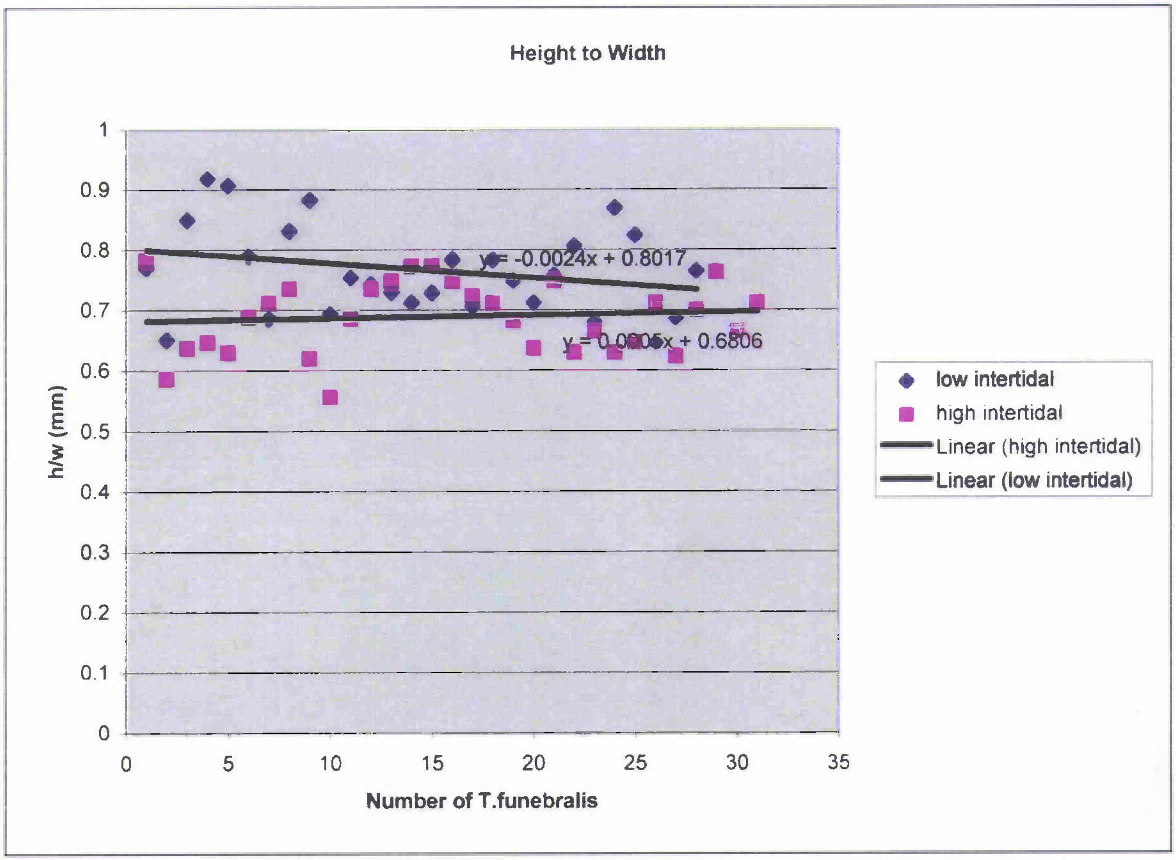
Methods and Materials

Field experiments were conducted at South Cove Cape Arago, Charleston, Oregon during the spring low tides. Specimens were acquired from their lowest occupancy (shells were found 10-20 meters from the water line but were all occupied by hermit crabs) 30m from the waterline, mostly under rocks or between rocks. Another groups of Specimens were taken from the high intertidal zone where (40m or more from water line) they were found on flat tops and corners. Using a millimeter caliper *T. funebralis* was measured from the maximum diameter across the umbilical region between the upper margin of the shell lip (as show in Figure1) to the other side (Fawcett 1984), next the height was measured by placing the shell flat then measuring to the topmost surface of the shell (Figure 2). To generalize these measurements due to variation in size, the height was divided by the width. Numbers closer to one equal a taller shell and those closer to 0.5 are shorter shells.

Results

Area collected from	*N*	Avg height (mm)	Avg width (mm)	Height to width ratio	Standard Deviation
High intertidal	31	11.8	17.6	**0.68**	**0.059**
Low intertidal	28	18.5	24.1	**0.76**	**0.073**

Table 1



Graph 1

X1.5 magnification

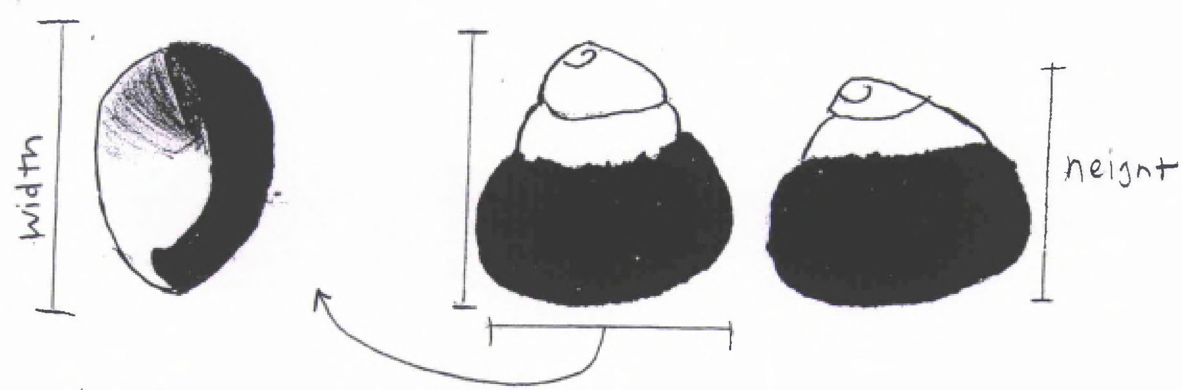


Figure 1

Figure 2

3

Once the data was combined and calculated (Table 1) it showed that the height to width ratio of the low intertidal *T. funebralis* was 0.76 (standard deviation of 0.073) versus the high intertidal ratio of 0.68 (standard deviation of 0.059), which was calculated by dividing the height of each shell by the width of each shell. The average height and width of the high intertidal snails were 11.8 mm and 17.6 mm respectively compared to 18.5 mm and 24.1 mm for the low intertidal snails as seen in table 1. Graph 1 shows the standard trend of the two locations, with the low intertidal being greater then the high intertidal shells.

Discussion

The height to width ratio of the *T. funebralis* collected from the low intertidal zone were significantly taller (0.76) than those collected from the high intertidal zone (0.68) suggesting that there is a difference in the structure within the species. Graph 1 shows the trend of the two shell ratios by a regression line. It appears to be advantageous to have a shell that is more streamlined and closer to surfaces in areas of high wave action to prevent being knocked off. From previous studies sited this could be considered a trait that increases the snails fitness in the high intertidal area and causes them to remain in that region, while those with taller shells are structurally better equipped for the low intertidal area. In the low inter-tidal area wave action is not a concern and there is no selection against those who have higher shells, but predation by sea stars, crabs and octopus are the major reducing factor. It would be interesting to extend this and duplicate Byers and Mitton 's (1981) experiment with those snails in the Cape Arago region and see if the high-intertidal snails do return to the upper zone if moved lower or vice versa.

As a result of the shells becoming more flattened, is was also noted that the spiral ridges on the top of the shell were located more posterior as opposed to directly on top of the shell. This also could be a result of the shell being more fit to the exposure of wave action because the spirals (which are worn away to the white underlying shell) being on top would produce more friction to wave action. A more evenly distributed curve with the spiral out of the path of the wave would be more streamline and have less surface area for the wave to pull down on.

The discovery of larger *Tegula funebralis* lower in the intertidal region (as shown by the data in table 1) correlates with Doering and Phillips (1983) finding suggesting that the Cape Arago region must have a higher predation of sea stars, inducing the larger snails to live lower down at the cost of being eaten, but the benefit of more food. Most of these specimens were found under rocks, so an alternative is that the smaller snails weren't as easily visible (they didn't stand out in the stand) and so weren't collected for the experiment. Another reason for the snails being found under rocks is that the larger snails shun light more then the smaller snails do, causing them to retreat during hours of increased light exposure (Doering and Phillips 1983) and exposing them to less wave action and predation from sea stars.

It would be interesting to test whether this difference in shell height is linked to genetics because all the juveniles and the young collect in the same area (Moran 1997) (the high intertidal snails don't reproduce in only that zone) then disperse as they get older. That would mean that as said before they utilize areas where their fitness is higher, or somehow the difference in height is plastic and changes with the movement of the snail. Collectively all these factors contribute to result of the higher intertidal *Tegula* *funerbrais* having lower shells for their size compared to the lower intertidal snails, which have a higher shell, causing the higher intertidal snails to be more structurally adapted to the wave action of the high intertidal region.

References

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