A Structural comparison of Zonation within Two Limpet Species: *Lottia digitalis* and *Tectura persona*

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BI 458: Marine Adaptations

Introduction

The high or supralittoral intertidal zone is the harshest climate within the rocky shores, that is controlled by chemical and physical factors. This habitat remains dominated by herbivorous species such as the limpet, but also contains organisms designed to withstand such hardships as desiccation. The midlittoral zone limits the distribution of organisms by biological factors such as predation and competition for space. Variation in physical conditions often leads to pronounced patterns of vertical zonation (Hobday 30).

Within this experiment, two species of limpet were focused on to determine whether shell height and length correlated with these zonation patterns of the intertidal. Limpets are of the Order Mollusca and Class gastropoda, which is characterized by having a muscular foot as well as a specialized radula for grazing (Sept 71). Their shell protects them from not only predation, but also from exposure to sunlight and extreme temperatures by covering their entire body as the foot remains attached to a substrate. It was hypothesized that limpet shell morphology would directly vary in correlation to vertical zonation patterning, where shell height and length would increase with an increase in vertical height. To determine if shell morphology differed among vertical heights, four separate data points were sampled within the mid and upper intertidal zones at South Cove, Cape Arago near Charleston, Oregon. The two species examined were *Lottia digitalis* and *Tectura Persona,* the ribbed and mask limpet (see Figure 1). These

species were chosen because both are commonly found among the high intertidal zone, but differ in where they reside on substrates. *T. persona* prefers to attach itself in dark crevices and overhangs where it is unexposed to sunlight. Its shell contains translucent portions on either side of the apex through which it can detect light (Eernisse 2002). *L. digitalis* is found on more exposed surfaces where spray from high tides will reach it. The ribbed limpet, also known as the finger limpet, has many distinguished ribs radiating down from the apex, creating a wavy edge to its elliptical shell. Although there are differences among these two species in shell morphology, they reside in similar enough habitats to determine whether this pattern of vertical zonation holds for more than just one special type of limpet.

Methods

To collect data, two 50m transect lines were placed perpendicular to the ocean surf on the northern side of South Cove, Cape Arago. Two points for each transect were picked at random within the supra- and mid-littoral tidal zones. At each data point, a $1m^2$ quadrat was placed along the transect line at each chosen point and members of both limpet species within it were recorded. For each individual limpet, the type of habitat (exposed or unexposed), type of surface (vertical or horizontal), shell height and length were noted. A scraper was needed to remove the limpets from the substrate and shell measurements were performed with calipers. Measurements were made directly after their removal so as to return the limpet to the substrate as soon as possible and avoid any harm to it. The experiment was performed during daylight hours when the limpets remained immobile.

Results

Data collection of 104 limpets, with 86 *L. digitalis* and 18 *T. persona* provided conclusive results to this study. Average body length increased in both species as tidal height increased (Appendix A). The correlation coefficient for *T. persona* was R^2=0.855, almost twice as strong a correlation for that of *L. digitalis* (Appendix B). A significant height increase occurred in *T. persona*, but not in *L. digitalis* (Appendix C). Possible ideas for why this occurred is to be explored within the discussion section. A comparison of limpet shell height to length (Appendix D) was made to determine whether both aspects of shell morphology increased in parallel (*L. digitalis* R^2=0.76; *T. persona* R^2=0.84). The average height to length ratio was also calculated for all individuals at each data point to determine if a significant increase in shell growth occurred between vertical tidal zones (Appendix E).

Discussion

As seen previously in results, *T. persona* had a strong correlation to tidal height that directly increased with body length (Appendix B). Since the mask limpet spends daylight hours within unexposed shaded areas, it may have advantageous access to microalgae where moisture can accumulate. Larger individuals of *L. digitalis* may have an advantage to inhabiting higher exposed areas because they wouldn't have to compete with smaller, more efficient grazing *L. digitalis* (Hobday 43). It was found that limpets with smaller radulae have a superior competitive ability over larger individuals, whom must forage past the upper limits of distribution set by desiccation and death of smaller individuals.

According to Harley, light plays an important role in the growth of high shore algae. The correlation between irradiance and production tend to be negative, making high shore algae more abundant in shaded crevices (Harley 1221). This may be why there is a stronger correlation between growth in limpet height and tidal height in *T. persona* than in *L. digitalis*. The height to length ratios calculated for both species are also associated to this idea of light availability (Appendix D). Growth of *T. persona* in height and length occurred more consistently with where it was distributed locally then *L. digitalis*. A possibility why *L. digitalis* has a lower correlation coefficient is that it resides on more exposed surfaces making it more susceptible to predation by oystercatchers and upper intertidal crabs, so a flatter shell would be more beneficial. Average height to length ratios for each point were calculated, showing that as tidal height increased, shell growth increased as well, especially in length. The ratio values decreased with tidal height because an increase in length was more common among both species combined. We can see that size distribution of larger individuals remained in the upper intertidal whereas smaller individuals tended to forage where mortality due to desiccation was low (Appendix E).

Bibliography

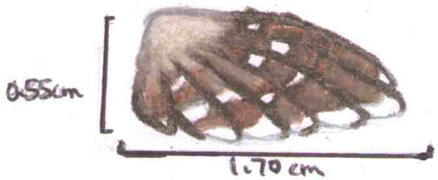
Eernisse, D.J. http://biology.fullerton.edu/courses/biol_317/Web/im/s02/ft/ft3-28.html. 2002. Date accessed: 7/11/05.

Harley. Light availability indirectly limits herbivore growth and abundance in a high rocky intertidal community during the winter. *Limnology and Oceanography.* year: 2002 vol: 47 iss: 4 pg: 1217.

Hobday. Body-size variation exhibited by an intertidal limpet: Influence of wave exposure, tidal height and migratory behavior. *Journal of Experimental Marine Biology and Ecology.* year: 1995 vol: 189 iss: 1-2 pg: 29.

Figure 1

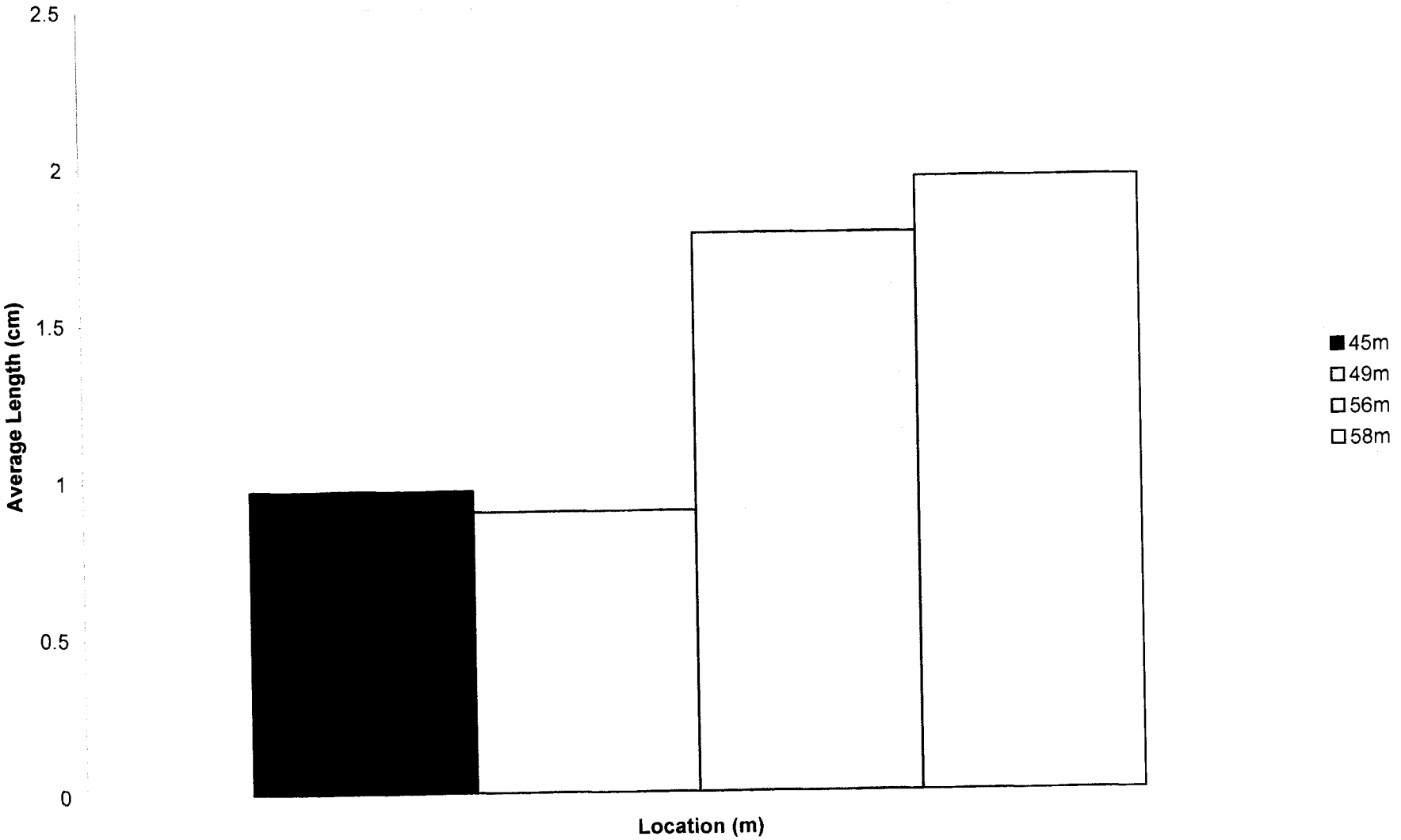
Tectura Persona
magnified 2.5 Times



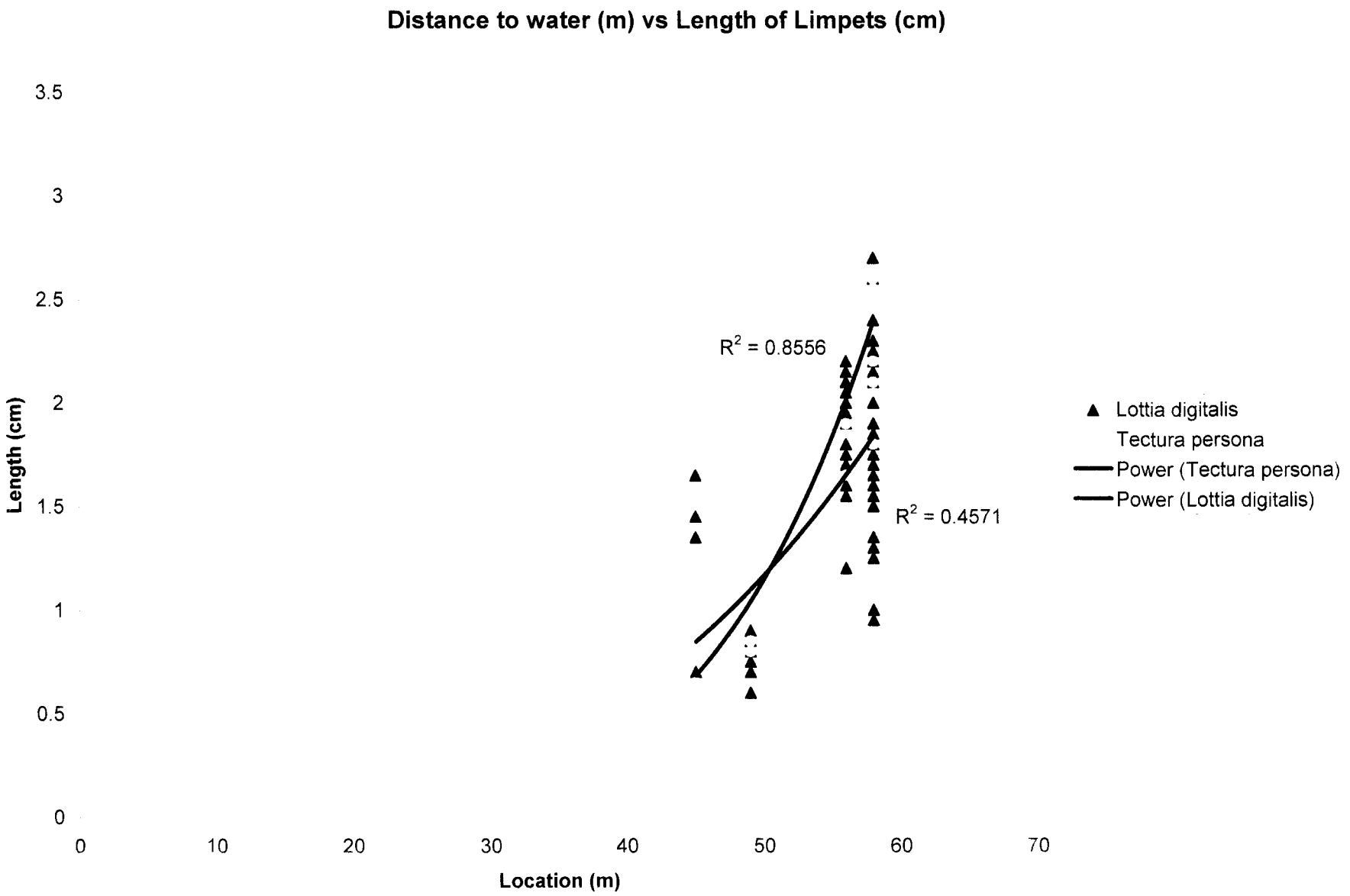
Lottia Digitalis
magnified 2.5 Times

Appendix A:

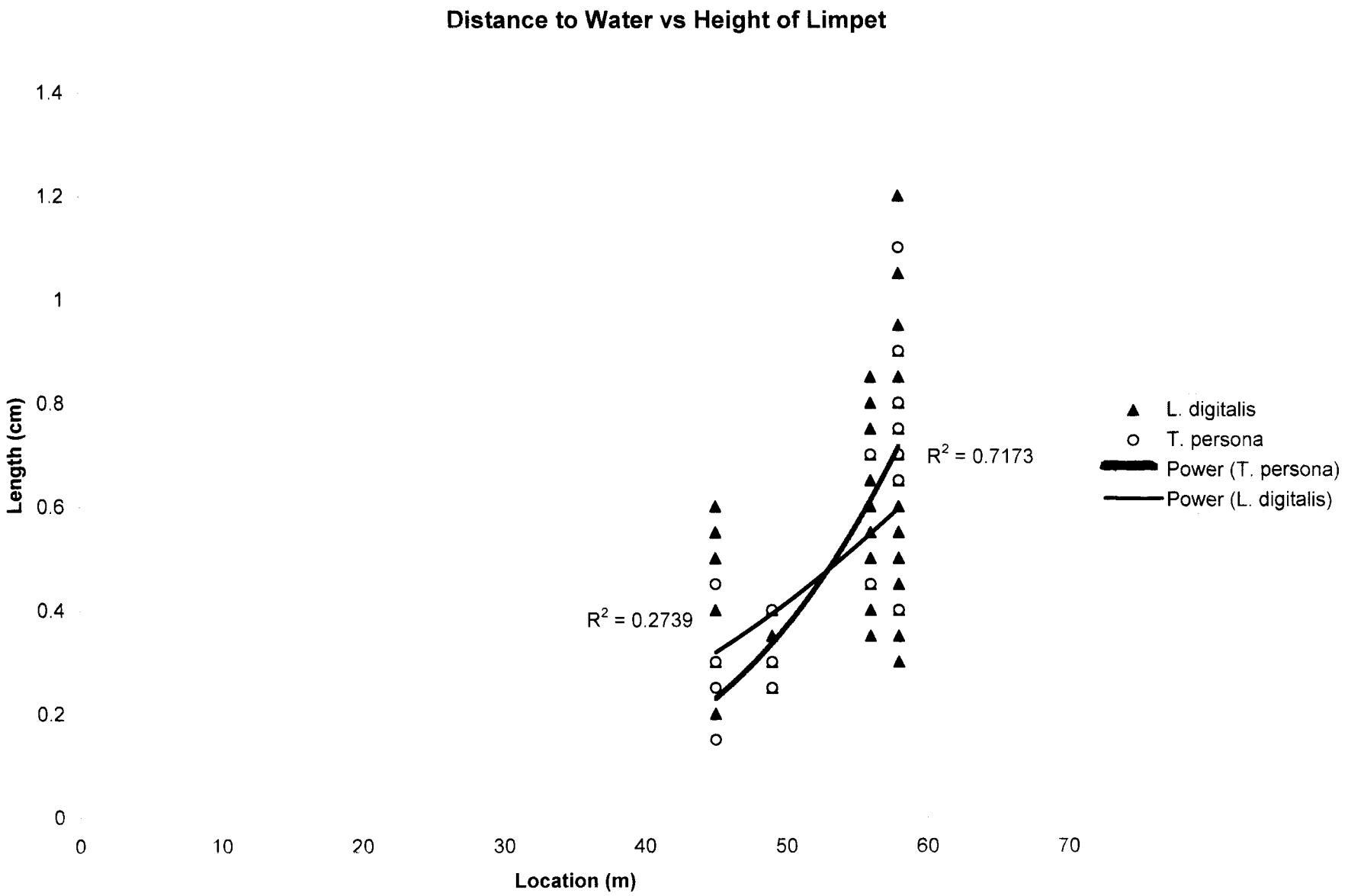
Location vs Average Length of Limpet



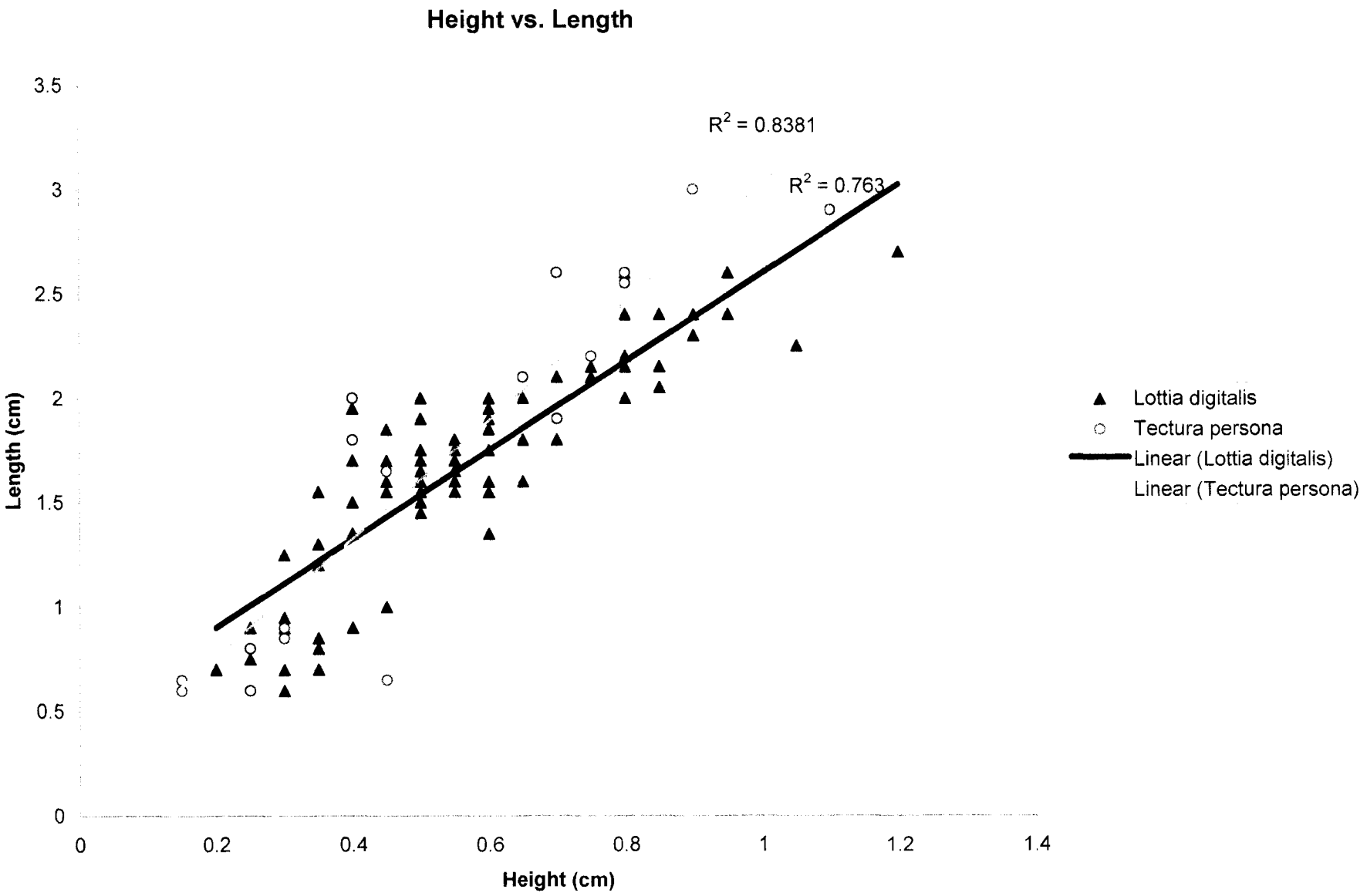
Appendix B


Distance to water (m) vs Length of Limpets (cm)
3.5
3
2.5
2
1.5
1
0.5
0
Length (cm)
0
10
20
30
40
50
60
70
Location (m)
R² = 0.8556
R² = 0.4571
Lottia digitalis
Tectura persona
Power (Tectura persona)
Power (Lottia digitalis)

Appendix C


Distance to Water vs Height of Limpet
Length (cm)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
10
20
30
40
50
60
70
Location (m)
R2 = 0.2739
R2 = 0.7173
L. digitalis
T. persona
Power (T. persona)
Power (L. digitalis)

Appendix D.


Height vs. Length
R^2 = 0.8381
R^2 = 0.763
Length (cm)
Height (cm)
0
0.5
1
1.5
2
2.5
3
3.5
0
0.2
0.4
0.6
0.8
1
1.2
1.4
Lottia digitalis
Tectura persona
Linear (Lottia digitalis)
Linear (Tectura persona)

Appendix E:

Distance to Water (m) vs Average Height to Length Ratio