Spring 2017

Effects of water quality on boldness and movement of the common periwinkle (Littorina littorea)

Sharon Mann
University of Southern Maine

Follow this and additional works at: http://digitalcommons.usm.maine.edu/thinking_matters

Part of the Marine Biology Commons

Recommended Citation
Mann, Sharon, "Effects of water quality on boldness and movement of the common periwinkle (Littorina littorea)" (2017). Thinking Matters. 74.
http://digitalcommons.usm.maine.edu/thinking_matters/74

This Poster Session is brought to you for free and open access by the Student Scholarship at USM Digital Commons. It has been accepted for inclusion in Thinking Matters by an authorized administrator of USM Digital Commons. For more information, please contact jessica.c.hovey@maine.edu.
ABSTRACT
Stomwater runoff and sewage seepage are sources of chemicals and pathogens that lower immunity of marine organisms such as the common periwinkle (Littorina littorea), which can increase susceptibility to parasites. Periwinkles infected with parasites are less bold and show altered movements. The purpose of my study was to identify pathogens in water that can affect marine organisms. 2) determine if water quality affects movement, and substrate choice in periwinkles. I predicted that water samples vary in levels of fecal indicator bacteria because samples were collected from areas at high risk of sewage seepage and stormwater runoff. Based on previous work, I also predicted that periwinkles exposed to higher contamination levels are less bold and move shorter distances. I collected periwinkles from the same location and assigned them to 1 of 3 water treatments. I tested water samples for E. coli and other bacteria. I measured boldness in periwinkles by latency to re-emerge from their shells, and I recorded rates of movement and choice of substrates. E. coli was present in 1 of the 2 expected contaminated samples. Periwinkles housed in water from the high sewage seepage area were less bold than those in the control tank and spent more time on substrate. Distance traveled did not differ among water treatments. In conclusion, bacteria may affect the behavior of marine organisms. My data add to research comparing water quality and behavior of marine organisms.

BACKGROUND INFORMATION
● Intertidal organsims are exposed to chemicaos and pathogens from stormwater runoff and sewage seepage, which can lower their immunity (Lerman, 1986; Fig. 1).

● Periwinkles (Littorina littorea) infected with trematodes are less bold (Seaman & Brattig, 2015) and show altered movements (O'Deyer et al., 2014).

● Studies have focused on parasite effects on periwinkle behavior; however, the relationship between periwinkle behavior and exposure to fecal borne bacteria remains unexplored.

● I used periwinkles as my study species because they are abundant, resilient (Lerman, 1986), and exposed to fecal borne bacteria in their natural habitat (Spruce Creek Association, 2008).

OBJECTIVES
1. To identify pathogens in water that can affect marine organisms.
2. To determine if water quality affects boldness in periwinkles.
3. To determine if water quality affects movement and substrate choice in periwinkles.

PREDICTIONS
5. Periwinkles vary in levels of fecal borne bacteria because one area has low risk of pollution; another has high risk of sewage seepage, and another has high risk of stormwater runoff.
6. Periwinkles exposed to high levels of bacteria are less bold because competition over resources reduces overall health of periwinkles, making them more susceptible to pathogens; therefore, they are more cautious and have reduced freedom from the shell (Seaman & Brattig, 2015).
7. Periwinkles exposed to higher levels of bacteria move shorter distances and choose different substrate than periwinkles exposed to low contamination because periwinkles infected with different parasites show different choice in habitat and have shorter distances (O'Deyer et al., 2014).

METHODS
I collected periwinkles and control water samples from Seapoint Beach, Kittery, ME (43°7′0″.70″N, 70°6′4″.68W, Fig. 2), which I designated as area 1. I collected 2 additional water samples from Spruce Creek, ME, which has a history of pollution (Spruce Creek Association, 2008). Area 2 has high exposure to stormwater runoff because it is adjacent to U.S. Route 1. Area 3 has high exposure to sewage seepage because it is situated next to a densely populated (1,712 ha) residential area (Fig. 3). I placed 10 periwinkles in each of 3 tanks (20 x 37.5 x 20 cm) equipped with air stones and filled with 5 cm of room temperature water from different sites (Fig. 3). I painted snails with different colored waterproof nail polish to distinguish individuals. Every other day, I added water from respective areas to tanks to account for evaporation.

To test water samples for fecal borne bacteria, I used the COLISURE kit produced by Idexx to test for E. coli and other bacteria. I used Kruskal-Wallis tests followed by pairwise comparisons to examine differences in water quality, substrate choice, and distance traveled. I used JMP 12.2 (SAS Institute, Inc., 2015) to analyze data using significance level of P < 0.05.

RESULTS
1. I found fecal borne bacteria in water with high risk of stormwater runoff; however, E. coli was not found in subsequent tests. Other, non-specified bacteria were found in all treatments (Table 1).

2. Boldness, measured as re-emergence times; different dependent samples (Fig. 4). Periwinkles exposed to E. coli in water at high risk of stormwater runoff (area 2) re-emerged faster than snails in control water (area 1; P = 0.01). Boldness did not differ between snails housed in water at high risk of sewage seepage (area 3) or high risk of stormwater runoff or between snails housed in control water and high risk of sewage seepage (area 2 vs. area 3; P = 0.07, area 1 vs. area 3; P = 0.54).

3. Distance traveled by snails housed in 3 different water treatments did not differ (χ² = 3.73, d.f. = 2, P > 0.15, Fig. 5).

4. Mean time on substrate differed significantly across sites (χ² = 11.94, d.f. = 2, P = 0.0025; Fig. 6). Snails in water from high risk of stormwater runoff spent more time on substrate than in control water and water from high risk of sewage seepage (area 2 vs. area 3; P = 0.0024; area 3 vs. area 2; P = 0.03). However, snails in control water and snails in water at high risk of sewage seepage did not differ (P = 0.062; Fig. 6).

CONCLUSIONS
Bacteria levels were high in areas at high risk of pollution. However, small amounts of fecal indicator bacteria were found in the area at high risk of stormwater runoff, which indicates that bacteria other than fecal borne bacteria may affect marine life.

The presence of bacteria appears to have adverse effects on periwinkles, possibly by increasing exposure to predators; however, the possible mechanisms by which E. coli and other bacteria manipulate snail behavior are unknown. More research is needed to determine whether bacterial presence directly affects behavior and boldness.

Bacteria levels were highest in areas exposed to stormwater runoff and sewage seepage; therefore, anthropogenic sources of pollution may alter the behavior of marine organisms.

ACKNOWLEDGMENTS
I am thankful to the Saint Joseph's University Marine Science Laboratory, Inc. for the free supplies donated to USM. R. Larsen for assistance with water quality analysis, A. Perry & K. Weber for laboratory access, and C. Maher for constructive criticism and revision.

REFERENCES
Maher for constructive criticism and revision.

Figure 2. Spruce Creek watershed. Maine. Area 1 has low pollution risk, area 2 has high risk of stormwater runoff, and area 3 has high risk of sewage seepage.

Figure 3. Tanks housing periwinkles. Each tank contained 10 periwinkles. 1, 2, and 3 represent tanks from respective water sample location. Periwinkles grazed freely off algae on rocks and seaweed.

Figure 4. Mean (±SD) time (s) to re-emerge from shell in different water treatments. Different letters above bars indicate statistically significant differences between samples (P = 0.05; n = 10 snails per treatment).

Figure 5. Mean (±SD) distance traveled by periwinkles in different water treatments. Same letters above bars indicate no significant differences (P = 0.05; n = 10 snails per treatment).

Figure 6. Mean percentage of time that periwinkles spent on substrate in different water treatments. Different letters above bars indicate statistically significant differences (χ² = 3.73; d.f. = 2, P > 0.15; Fig. 5).