

Long-distance Chemical Sensing of Home Quality

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Introduction

Subtidal hermit crabs exploit long-distance chemical cues to determine the availability of nearby gastropod shells that have been recently emptied. We utilized the Acadian hermit crab (*Pagurus acadianus*) to identify the gastropod shell characteristics that marine hermit crabs use to determine shell refuge quality—that is, which characteristics of gastropod shell architecture (e.g., shell diameter, wall thickness, aperture size, and weight) *P. acadianus* values in assessing the overall quality of a potential home. In addition, by releasing long-distance chemical cues simulating nondestructive predation, indicative to *P. acadianus* of the availability of an emptied gastropod shell, we determined a preference for a specific gastropod species shell—whether that be the shell of the dog whelk (*Nucella lapillus*) or of the common periwinkle (*Littorina littorea*).



Methods



Figure 1. Location of study site on Appledore Island, ME.

1. Quantification of Species Composition and Shell Availability

Random quadrat sampling was conducted to determine the quantity inherent to species composition and shell availability at the site.

Wover a series of five days, a metal quadrat (27 x 27 cm) was randomly tossed into the subtidal twenty times each day (n = 20) for a total of one hundred tosses (n = 100).

* Each time the quadrat landed in substrate, the number of shell predators (both destructive and nondestructive), hermit crabs, live gastropods, and empty shells within its metal boundary were counted and subsequently recorded on a diver's slate.

2. Determination of Resource Acquisition Preference in the Field

***** A series of chemical-cue trials were conducted to determine which

Figure 3. Average number of *P. acadianus* attracted to the quadrat before and after five minutes following the release of a chemical cue. Individuals were significantly more attracted to trypsin-treated *L. littorea* than trypsin-treated *N. lapillus* (**p*<0.05).



emptied gastropod species shell *P. acadianus* prefers to inhabit, whether it be *N. lapillus* or *L. littorea*. The chemical cues were (1) trypsin (control), (2) Pure *N. lapillus* flesh, (3) Trypsin-treated *N. lapillus* flesh, (4) Pure *L. littorea* flesh, and (5) Trypsin-treated *L. littorea* flesh.

- The quantity of hermit crabs (at least 1 but no more than 5) milling about in an area of substrate was used to determine the position of the metal quadrat in which the chemical cue condition would be placed and the trial would be run.
- Prior to the release of the chemical cue, the hermit crabs inside the situated quadrat were counted. Five minutes following the release of the cue, the hermit crabs in the quadrat were once again counted and that number was recorded. The trials were conducted within the same tidal cycle during the same day, randomly.
- The trials were executed over a series of thirty days for a total of 210 trials with 30 replicates for each of the five chemical cue conditions (see right).

3. Determination of Resource Acquisition Preference in the Lab

- Determination of relevant architectural comparison between shells of the two gastropod species in the laboratory regarding (1) shell diameter, (2) aperture diameter, (3) wall
- Figure 2. Bottle with mesh, ensuring emanation of flesh cues, containing condition weighted to the substrate.

Figure 4. Regression of Shell Diameter (B) on Shield Length (A) to determine optimal body-size-to-shell ratio for laboratory pair-wise test.

Areas for Further Exploration

1. The mechanism by which marine hermit crabs discern and discriminate chemical cues arising from flesh remains unknown.

- 2. Analyze architecture of emptied gastropod shells in more depth.
- 3. Extend preference testing to other locales on the island, specifically Halftide Ledges.

thickness, and (4) shell weight.

Weasured and weighed 60 shells (30 *L. littorea* and 30 *N. lapillus*) and then left quantified shells with an individual for 24 hours, providing each individual with a range of shell sizes determined by shell diameter for a total of 60 individuals.

Then, determined if individuals inhabited any of the shells and the specific size and species of the gastropod shells the crabs chose to inhabit.



Figure 3. Nucella lapillus (left) and Littorina littorea (right)

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References

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