Unwitting Accomplices: Do Isopod Bite Wounds Provide a Head Start for the Progression of Eelgrass Wasting Disease?

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Abstract

Eelgrass beds (Zostera marina) are a vital part of intertidal and estuarine ecosystems. These eelgrass beds provide food and shelter to a variety of marine species including small invertebrates, fish, and seabirds. In the 1930s an infectious wasting disease caused by the protist Labyrinthula zosterae swept through Atlantic eelgrass beds, wiping out most of the population along the entire North Atlantic coast. To prevent future decimations of eelgrass populations, it is important to understand the mechanisms of disease spread. Our research focused on whether there was a spatial correlation between bite marks left on the eelgrass blades by the isopod Pentidotea resecata (Figure 1) and the early lesions of wasting disease. The answer to this question may provide a better understanding of P. resecata’s potential role as a vector of disease spread among Z. marina.

Methods

Clean, disease-free eelgrass blades, diseased eelgrass blades, and isopods were collected from Padilla Bay, WA, and placed into running seawater tanks in the laboratory (Figure 3). One tank was used in the first round of experimentation and two were used in the second. The clean eelgrass blades were placed in a frame to allow inspection of their surface (Figure 4). Diseased blades were placed just upstream of the clean eelgrass but not allowed to touch it (Figure 3). 20 isopods were placed into the tanks with the task of roaming freely between the clean and diseased blades. Each experiment proceeded for 12 days, with the clean blades photographed each day to monitor isopod bite wounds and the presence of wasting disease lesions.

We observed photographs from each day and tallied up on analysis photographs that contained both bitemarks and lesions, while not being completely ravished by the disease. Thus, we selected photographs from day eight for the first round of experimentation and from day ten for the second round. From these photographs the number and location of bite wounds and wasting disease lesions were quantified on each blade, and the distance and occurrence of each lesion to the nearest bite mark was compared to the average distance that 20 points randomly chosen on the blade were from the nearest bite mark (Figure 5). These distances were normalized for each blade by dividing the distance between each random point and the nearest bite mark, to account for the varying amount of bite marks between the different blades. A chi-squared test was used to determine whether blades with bite marks were more likely to also have lesions, and a one-sample t-test was used to determine whether the lesions were significantly closer to the bite marks than the randomly selected points were. Distances were cube-root transformed before analysis to normalize the data.

We found a significant difference (p < 0.001; Table 4) between average lesion-bitemark and random point-bitemark distance. Non-transformed data indicates that the median and mean distances between lesions and the nearest bitemark were, respectively, 67% and 47% of the distance between lesions and random points. Of these two values, the median more closely resembles the value you would get from cubing the transformed data which would be 40% of the distance. Considering all these values, the lesions were about twice as close to bitemarks as would be expected if they were randomly distributed on the blade. Additionally, division of the bitemark-lesion distances into separate distance bins revealed that many more lesions were within a half centimeter of a bitemark than could be accounted for by chance. The points were randomly distributed (Figure 6). However, chi-square analysis (Table 2) found lesions to be slightly but not significantly more common on blades with bitemarks than on those without (χ² > 0.05). 72% of blades with bites had lesions, while only 62% of blades without bites had lesions.

Hypothesis & Predictions

Hypothesis: The isopods are facilitating the spread of wasting disease in the eelgrass by biting the eelgrass, thus breaking through the plant’s defenses and allowing L. zosterae to become established in the bite wound.

Prediction 1: L. zosterae lesions will be more prevalent on eelgrass blades that have been bitten.

Prediction 2: On eelgrass blades with both bites and lesions, there will be a positive spatial correlation between bites and lesions.

Results

Our statistical analysis demonstrated that there was a significant difference (p < 0.05; Table 1) between average lesion-bitemark and random point-bitemark distance. Non-transformed data indicates that the median and mean distances between lesions and the nearest bitemark were, respectively, 67% to 47% of the distance between lesions and random points. Of these two values, the median more closely resembles the value you would get from cubing the transformed data which would be 40% of the distance. Considering all these values, the lesions were about twice as close to bitemarks as would be expected if they were randomly distributed on the blade. Additionally, division of the bitemark-lesion distances into separate distance bins revealed that many more lesions were within a half centimeter of a bitemark than could be accounted for by chance. The points were randomly distributed (Figure 6). However, chi-square analysis (Table 2) found lesions to be slightly but not significantly more common on blades with bitemarks than on those without (χ² > 0.05). 72% of blades with bites had lesions, while only 62% of blades without bites had lesions.

Conclusions

- Statistical analysis using a t-test indicated that wasting disease lesions are significantly more likely to be nearer to a P. resecata bite mark than would be expected by chance. The results from this test support the idea that the oral cavity or bites of P. resecata may play a role in transmitting L. zosterae between diseased and healthy blades of eelgrass.

- Chi-square analysis demonstrated that lesions were not significantly more likely to occur on blades with bitemarks than those without. While it is still plausible that herbivory of Zostera marina by P. resecata provides a weakened entry point for the pathogen, this analysis suggested it is also likely that L. zosterae is able to infect a blade of eelgrass through other means.

- Our results confirmed our second prediction, that there is a spatial correlation between lesions and bitemarks, supporting the idea of the facilitative nature of the isopods in regards to the disease spread in Z. marina. However, the ambiguous results found in testing our first prediction leave some of our questions unanswered. Therefore, we aim to continue this research, possibly exploring other methods of data analysis.

References


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