Water Flowing Through Coastal Megaripples Controls Meiofauna Distribution in the Sediment Thereby Influencing Organic Matter Degradation

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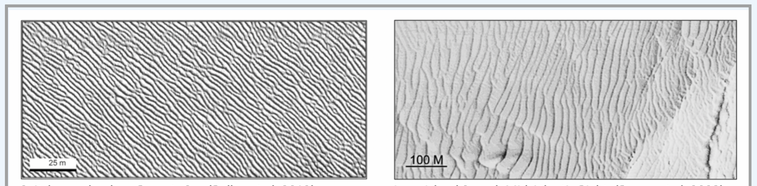
Background

- Sedimentary material on the shelf floor can form megaripples with strong bottom currents.
- Megaripples are abundant in coastal and shelf environments, typically by well-sorted sand or gravel, and reach up to 2 m in height.
- Water column production and sediment mineralization are tightly linked in these shallow zones.
- Marine meiofauna is typically smaller than 1 millimeter (0.04 inches) and larger than 32 micrometers (32/1000 of a millimeter) [1].



Spitsbergenbanken, Barents Sea (Bellec et al. 2019) Long Island Sound, Mid Atlantic Bight, (Poppe et al. 2008)

Figure 1: Megaripples are produced by oscillating and unidirectional currents.

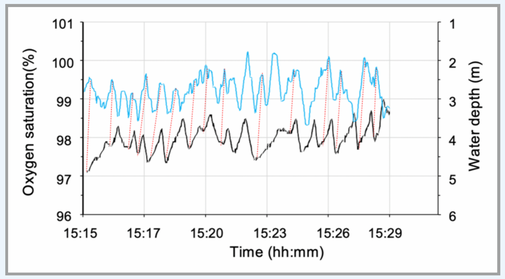
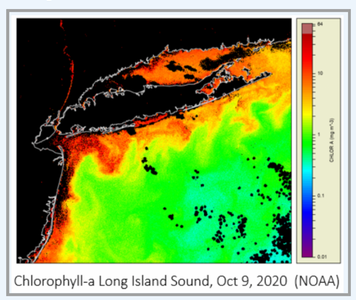


Figure 2: High water oxygen in troughs supports low oxygen water release at crests.

Open Research Questions

I. How do megaripples influence the distribution of meiofauna?

II. Will there be a link between pore water flow and meiofauna distribution within megaripples?



Chlorophyll-a Long Island Sound, Oct 9, 2020 (NOAA)

Figure 3: Megaripples occur, for example, under the highly-productive water column in Long Island Sound.

Hypothesis

We tested the null hypothesis that megaripples do not influence the distribution of meiofauna in permeable marine sediments.

Methods

Figure 4: Sampling site megaripple field in Destin, Florida inlet.

Sediment Coring

- Syringe cores (38 mm in diameter, 150 mm in length) were used to extract surface sediment samples of the slope, crest, and trough of a megaripple.
- Sediment cores were sliced into 5 mm sections.
- Particles from each section were extracted by resuspending the sediment of each slice in 100 mL of water and filtering an aliquot onto a 0.45 um filter.
- The filters were photographed under a magnification camera to get an overview of the particle's nature and abundance.
- Filters were then photographed under an EPI-fluorescence microscope. Organisms glowed due to UV illumination allowing for counts to be made.
- Counts were plotted over depth and extrapolated to one square meter reference area.

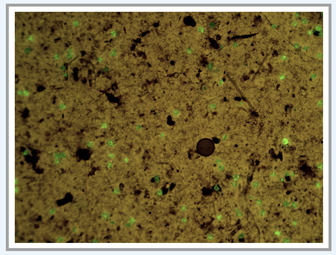


Figure 5: Presence of pollen at 0-5 mm of the Trough filter captured under the EPI-fluorescent microscope.

Conclusion

- Pore water flow in megaripples controls the distribution of meiofauna.
- Water filtering through megaripples disperses oxygen and food particles where organisms, like meiofauna, feed.
- The consumption of organic particles by meiofauna returns nutrients to the pore water which is then released from the sediment to nourish phytoplankton.
- Through this biomineralization in megaripples, meiofauna contributes to the cycling of organic matter and nutrients[3].
- Based on our results, we can reject the null hypothesis that megaripples do not influence the distribution of meiofauna in permeable marine sediments.

References

[1] Ridall, A., & Ingles, J. (2022, May 19). What are "marine meiofauna"? What are "marine meiofauna"?: Ocean Exploration Facts: NOAA Ocean Exploration.

[2] Schmidt-Rhaesa, A. (2020). Guide to the identification of Marine Meiofauna. Verlag Dr. Friedrich Pfeil.

[3] Schratzberger, M., & Ingels, J. (2018). Meiofauna matters: The roles of meiofauna in benthic ecosystems. Journal of Experimental Marine Biology and Ecology, 502, 12–25.

Results

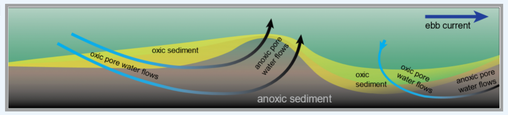


Figure 6: Oxygen-saturated water is pushed into the upstream (gentle) slope of the megaripple. The water travels on a curved path to the crest of the ripple where it emerges as anoxic water. Likewise, water penetrates into the trough of the ripple and moves towards the crest.

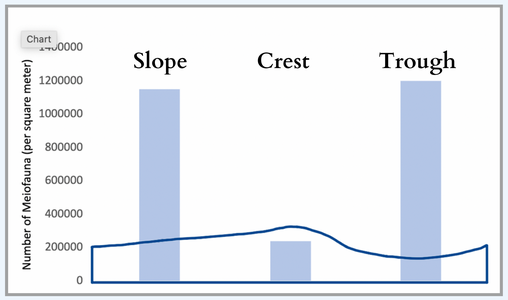


Figure 7: Abundance of meiofauna within the first 15 mm per square meter. The number of meiofauna is highest in the slope and trough.

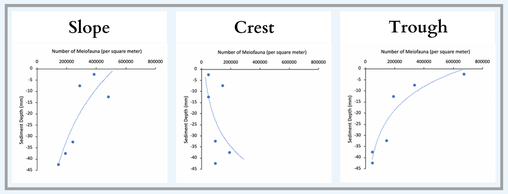


Figure 8: The number of meiofauna decreases with depth in slope and trough. Under the crest, meiofauna is numerically higher in the lower layers.

- Meiofauna distribution corresponds to oxygen availability in the sediment that is transported by the pore water flow.
- Water penetrates into the slope and into the trough surface layer sediment where it sustains high oxygen concentration.
- Under the crest, anoxic pore water is pulled to the surface reducing oxygen availability within the surface layer.
- When looking at the sum of meiofauna per square meter in the upper 15 mm of the sediment, the slope and trough had about five times greater abundances than in the crest.

Meiofauna Identification

Magnification camera & EPI-fluorescence microscope

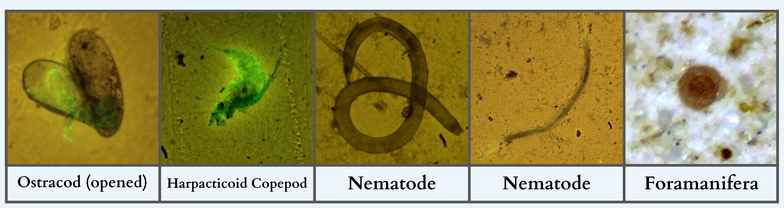


Figure 9: Meiofauna identified [2] within various megaripple filters.

- Crustaceons (Harpacticoids and Ostracods) were observed to be the most abundant.
- Also observed were: Foramaniferas, Oligochaetes, Molluscs, & Nematodes.