

Oysters Lit Review - Miller, K

Kelly Miller

2024-12-19

Introduction to the microbial world

Walking into the Schmidt Aquatic Microbiology Lab at Cornell University, I had an idea of how nutrients flowed through ecosystems; I knew it all began with plants performing photosynthesis to turn sunlight energy into sugar: an energy form usable for their own growth and reproduction, as well as for organisms higher up the food chain.

As it turns out, autotrophic plant production is not the whole story. Let's zoom out from the macroscopic world for a moment to meet the three domains of life: Bacteria, Archaea, and Eukarya. As humans, we belong to the domain Eukarya, which contains all life forms whose cell(s) have membrane-bound nuclei. As in, not only are all multi-celled organisms Eukarya, but so are some single-celled organisms. In contrast, all organisms belonging to Bacteria and Archaea are made up of one cell and are prokaryotes.¹

In other words, all of the life forms recognizable to our eyes make up only a humble fraction of the living community on Earth. In each breath we breathe, about one half of the oxygen has been produced by oceanic bacteria (Pomeroy et al., n.d.). (Thanks bacteria!) [The human hand and chemical fertilizers are not growing our food; microbes are, albeit with the optimization of good land husbandry practices.]

So when we talk about the factors at play regulating ecological systems, when we talk about the cycling of nutrients between earth, water, and sky, it does us well to acknowledge that the drivers of biological processes are microorganisms. It's a microbial world; we're just living in it.

Introduction to oyster farming

Oyster aquaculture has been practiced globally since ancient civilizations—the likes of Greece, Rome, and the Han Dynasty (Botta et al. 2020). [quote about oyster abundance in the Hudson Bay in the 1800s?] While we face the deleterious ecological impacts of current industrial and agricultural production methods, oyster farming has been proposed as part of a re-imagined, more sustainable food system. Not only does oyster cultivation bypass certain agricultural issues like land scarcity; common scientific thought has it that farming oysters can provide benefits to the health of the ecosystem. These potential benefits include enhanced water quality, habitat provision to other marine species, and storm surge protection (Stevens et al. 2024).

benefits: promote biogeochemical cycling, storm surge protection

¹Prokaryotes: single-celled organisms who generally do not have specialized organelles. They are like genetic material-cytosol soup.

Theory #1: Oysters promote the conditions for a diverse community of sediment microbes.

Theory #2: Oyster aquaculture increases the cycling of nutrients in the ecosystem.

Summary of Ray & Fulweiler paper, “Meta-analysis of oyster impacts on coastal biogeochemistry”

Oyster aquaculture increases the cycling of nitrogen in marine systems by stimulating denitrifying bacteria and archaea. This improves water quality, with the trade-off of releasing a small amount of nitrous oxide (N₂O) into the atmosphere (Ray and Fulweiler 2021).

Testing another citation (Feinman et al. 2018).

Citations

- Botta, Robert, Frank Asche, J. Scott Borsum, and Edward V. Camp. 2020. “A Review of Global Oyster Aquaculture Production and Consumption.” *Marine Policy* 117: 103952. <https://doi.org/https://doi.org/10.1016/j.marpol.2020.103952>.
- Feinman, Sarah G., Yuna R. Farah, Jonathan M. Bauer, and Jennifer L. Bowen. 2018. “The Influence of Oyster Farming on Sediment Bacterial Communities.” *Estuaries and Coasts* 41 (3): 800–814. <https://doi.org/10.1007/s12237-017-0301-7>.
- Pomeroy, Lawrence R., Peter J. leB Williams, Farooq Azam, and John E. Hobbie. n.d. “The Microbial Loop | Oceanography.” <https://tos.org/oceanography/article/the-microbial-loop>.
- Ray, Nicholas E., and Robinson W. Fulweiler. 2021. “Meta-Analysis of Oyster Impacts on Coastal Biogeochemistry.” *Nature Sustainability* 4 (3): 261–69. <https://doi.org/10.1038/s41893-020-00644-9>.
- Stevens, Joshua T. E., Nicholas E. Ray, Alia N. Al-Haj, Robinson W. Fulweiler, and Priyanka Roy Chowdhury. 2024. “Oyster Aquaculture Enhances Sediment Microbial Diversity: Insights from a Multi-Omics Study.” *Aquaculture Environment Interactions* 16 (December): 283–301. <https://doi.org/10.3354/aei00484>.