贝类养殖活动通过改变沉积物理化性质影响沉积物微生物碳循环

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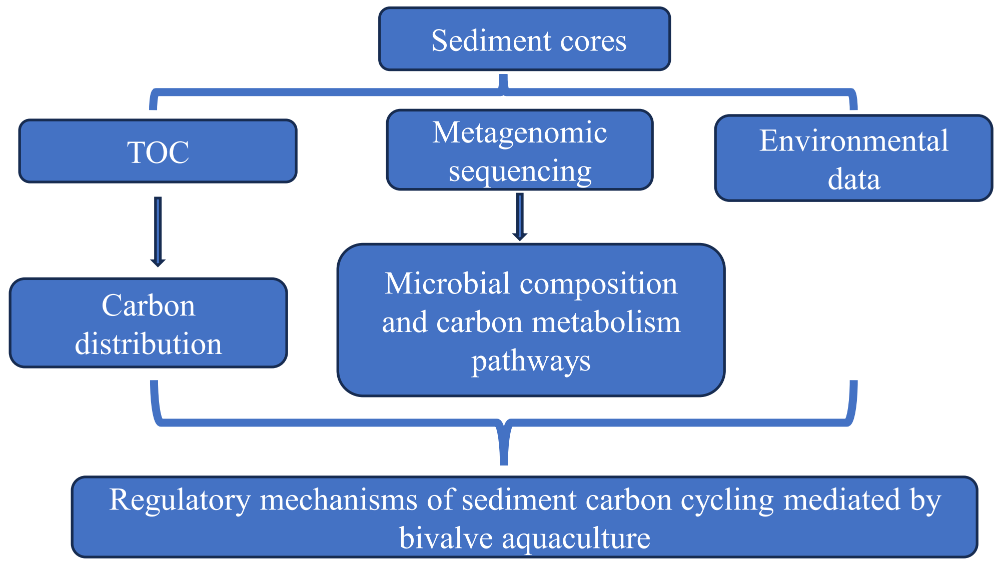
INTRODUCTION

- Shellfish aquaculture is an important component of coastal ecosystems, offering significant economic and ecological benefits.
- Shellfish farming activities increase the input of organic carbon into sediments, alter the sedimentary environment, and consequently affect the structure of microbial communities and their metabolic pathways. Sediment microbial carbon metabolism represents the final process in the decomposition and transformation of organic carbon, playing a key role in the carbon cycle of coastal ecosystems.
- However, its specific impacts on sediment microbial communities and carbon pathways remain unclear.
- This study investigates these effects and underlying mechanisms in the Changli Bay scallop farming area, a major production area in northern China.

METHOD



RESULTS

Carbon distribution

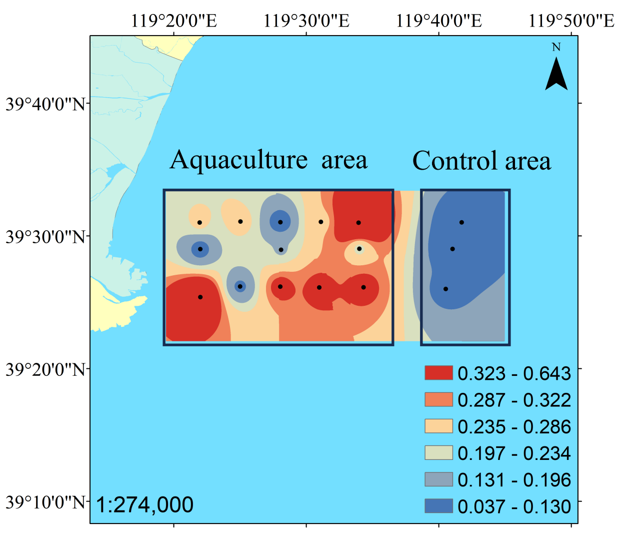


Figure 1. Distribution of sediment organic carbon in the aquaculture and control areas.

- The total organic carbon (TOC) content in the sediments differed between the aquaculture area and the control area.

Microorganisms in sediment

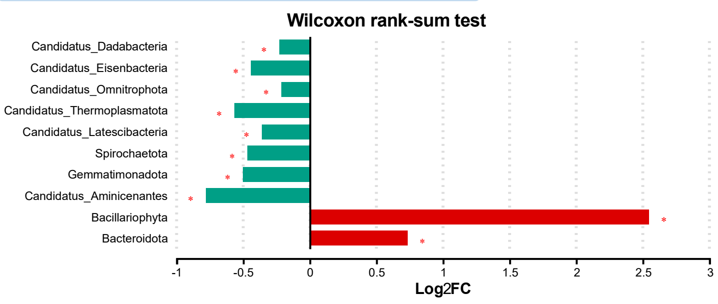


Figure 2. Differentially abundant microbial taxa at the phylum level between the aquaculture and control areas. Y: Aquaculture area; D: Control area

- The significantly enriched Bacteroidetes in the aquaculture area are key degraders of complex organic carbon.

Sediment microbial carbon metabolic pathways

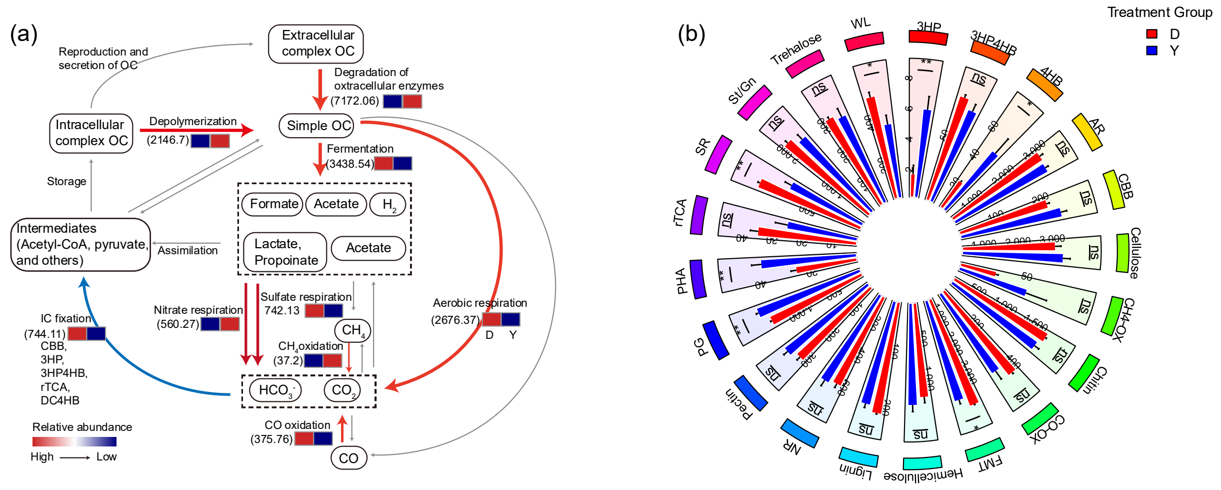


Figure 3. Sediment microbial carbon metabolic pathways (a) and their relative abundance (b). Y: Aquaculture area; D: Control area

- The aquaculture area had higher abundances of pathways for organic carbon degradation, methane oxidation, and nitrate respiration, while lower abundances for aerobic respiration, inorganic carbon fixation, fermentation, carbon monoxide oxidation, and sulfate respiration.

Mechanisms of sediment microbial carbon cycling in bivalve aquaculture area

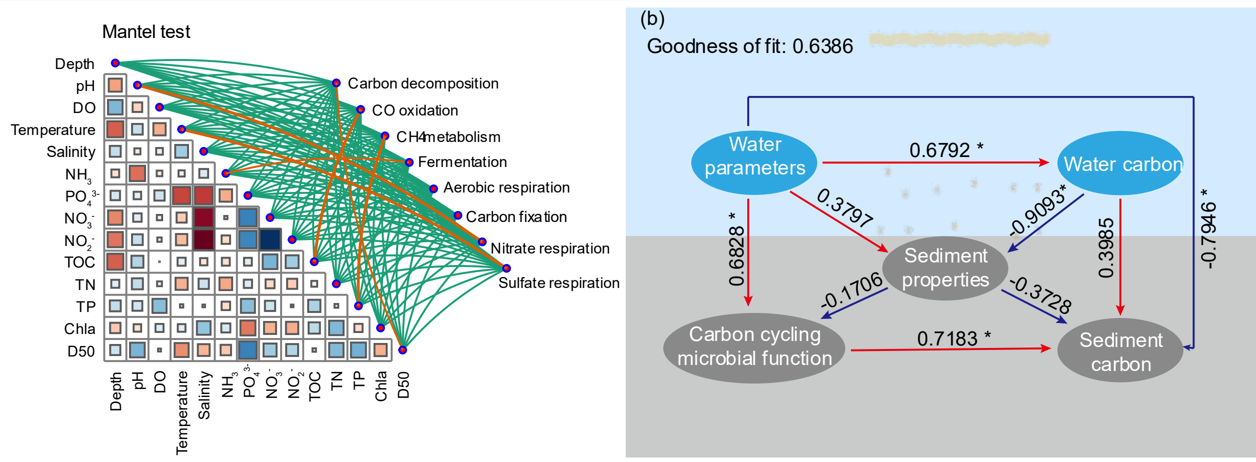


Figure 4. Mantel test between sediment microbial carbon metabolic pathways and environmental factors (a) and the Partial Least Squares Path Modeling (PLS-PM) for the aquaculture area (b).

- The effects of sediment grain size (D50), total phosphorus (TP), ammonia nitrogen (NH_3), total organic carbon (TOC), and pH on the microbial carbon cycle were indirect, mediated by the regulation of microbial metabolic pathways.
- The PLS-PM results further revealed the cascading effects between environmental factors and microbial functions at the systemic level.

SUMMARY

- Herein, we systematically assessed the coupling effects of bay scallop (*Argopecten irradians*) aquaculture on sediment carbon storage, microbial community structure, and carbon metabolic pathways using metagenomics.
- Bay scallop farming modified the water and sediment conditions in the aquaculture area, resulting in the enrichment of some microorganisms and the decline of others, thereby restructuring the microbial carbon metabolism.
- This restructuring was characterized by an enhancement of organic matter degradation pathways and a transition in carbon fixation pathways, which subsequently altered the sediment microbial carbon cycle. Environmental factors were identified as the key drivers in this process.

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