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Perspective

Role of Climate Resilience in Aquatic Crust Communities

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DESCRIPTION

Aquatic crusts, often overlooked yet significant ecosystems in aquatic environments, harbor diverse biological communities that play significant roles in nutrient cycling, habitat provision, and ecosystem stability. These communities, composed of microorganisms, algae, invertebrates, and other organisms, form different networks that contribute to the functioning and resilience of aquatic ecosystems. This article delves into the structure, functions, and ecological significance of biological communities in aquatic crusts, highlighting their importance in sustaining aquatic life and ecosystem services. Aquatic crusts, also known as periphyton or biofilms, consist of a complex matrix of microorganisms, algae, bacteria, fungi, and other organisms attached to submerged surfaces such as rocks, sediments, and aquatic vegetation. These communities thrive in a wide range of aquatic habitats, including rivers, streams, lakes, ponds, and estuaries, where they form slimy or mucilaginous layers visible to the naked eye.

Microbial components

Microorganisms, including bacteria, archaea, and protists, constitute the foundational components of aquatic crusts. They form biofilms, adhering to submerged surfaces and secreting Extracellular Polymeric Substances (EPS) that provide structural support and facilitate nutrient exchange. Algae, particularly diatoms, green algae, and cyanobacteria, are primary producers in aquatic crusts, resolve sunlight through photosynthesis to synthesize organic matter. Their diversity and abundance vary with environmental conditions, including light availability, nutrient levels, and water flow. Invertebrates such as insect larvae, crustaceans, mollusks, and worms inhabit aquatic crusts, contributing to nutrient cycling and organic matter decomposition. These organisms play essential roles in food webs, serving as prey for higher trophic levels and contributing to ecosystem functioning. Aquatic crusts facilitate nutrient cycling by assimilating and recycling organic and inorganic nutrients, including nitrogen, phosphorus, and carbon. Microorganisms and algae assimilate nutrients from the water column and sediment, incorporating them into biomass and releasing them back into the environment through decomposition. Algal photosynthesis in aquatic crusts generates organic matter, fueling primary production and supporting higher trophic levels. The diverse assemblage of algae contributes to the productivity and biodiversity of aquatic ecosystems, serving as a vital food source for grazers and filter feeders. Aquatic crusts provide microhabitats and refuge for a variety of aquatic organisms, including larvae, juveniles, and small invertebrates. The complex structure of biofilms offers attachment sites, shelter, and food sources, enhancing habitat heterogeneity and promoting species diversity.

Biofiltration and water quality improvement

Biological communities in aquatic crusts play a vital role in water filtration and purification, removing pollutants, excess nutrients, and suspended solids from the water column. This biofiltration process helps improve water quality, reduce eutrophication, and mitigate the impacts of anthropogenic pollution on aquatic ecosystems. Aquatic crusts stabilize submerged substrates such as rocks, sediments, and woody debris, preventing erosion and sedimentation. The cohesive matrix of biofilms enhances substrate cohesion, reducing the loss of fine particles and maintaining habitat structure and integrity. Anthropogenic activities such as urbanization, agriculture, deforestation, and pollution degrade aquatic habitats, impairing the growth and functioning of aquatic crusts. Habitat loss, fragmentation, and alteration disrupt the integrity of biofilm communities, compromising their ecological functions and resilience.

Excessive nutrient inputs from agricultural runoff, wastewater discharge, and industrial activities promote algal blooms and alter the composition and structure of aquatic crusts. Nutrient enrichment can favor opportunistic species, such as filamentous algae and cyanobacteria, leading to ecosystem imbalances and water quality deterioration. The introduction of invasive species, including exotic algae, mussels, and snails, poses a significant threat to native biological communities in aquatic crusts.

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Invasive species can outcompete native species, disrupt food webs, and alter ecosystem dynamics, leading to biodiversity loss and ecological homogenization. Climate change impacts, including rising temperatures, altered precipitation patterns, and increased frequency of extreme events, affect the distribution and functioning of aquatic crusts. Changes in temperature and hydrological regimes can shift community composition, disrupt species interactions, and exacerbate the effects of other stressors on aquatic ecosystems.