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Particulate Organic Matter (Pom): Ecological Roles and Biogeochemical Significance

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Abstract

Particulate Organic Matter (POM) represents the fraction of organic material suspended in aquatic and terrestrial ecosystems that is larger than the dissolved phase. POM includes detritus, fragments of organisms, microbial biomass, and other coarse organic particles that serve as essential substrates for microbial decomposition, nutrient cycling, and energy flow. In aquatic environments, POM influences carbon export, food web structure, and pollutant transport. In soils, POM contributes to soil quality, fertility, and carbon sequestration. This article reviews the sources, composition, ecological functions, and biogeochemical roles of POM, highlighting its importance in ecosystem processes and responses to environmental change.

Keywords: Particulate Organic Matter (POM), Carbon Cycling, Aquatic Ecosystems, Soil Organic Matter, Biogeochemistry, Food Webs, Microbial Decomposition

Introduction

Particulate Organic Matter (POM) is a fundamental component of organic matter pools in both aquatic and terrestrial ecosystems. Operationally defined as the fraction of organic material that does not pass through a filter of a given pore size (often >0.45 µm), POM comprises a broad range of biological remnants — from dead plant material and phytoplankton to microbial cells and fecal pellets — that have not yet fully decomposed. In contrast, Dissolved Organic Matter (DOM) represents the smaller, soluble fraction.

POM emerges from allochthonous sources, such as terrestrial runoff delivering soil and plant debris into water bodies, and autochthonous production, such as in situ phytoplankton blooms. Once present in ecosystems, its dynamics — including deposition, transport, aggregation, and decomposition — influence nutrient availability, food web support, and ecosystem resilience. Understanding POM dynamics is critical for elucidating organic matter cycling, evaluating carbon budgets, and managing ecosystem health in the face of anthropogenic pressures such as land-use change, eutrophication, and climate change [1].

Ecological and Biogeochemical Roles of POM

Particulate Organic Matter originates from **diverse sources**: in aquatic ecosystems, POM includes planktonic detritus, zooplankton fecal pellets, and soil organic particles delivered by runoff; in soils, it consists of partly decomposed plant litter, root debris, and microbial residues. The physical nature and size of POM — often determined by filtration or sieving — reflect its mixed composition and variable lability.

POM is often distinguished from DOM by size: organic particles retained on filters (e.g., >0.45 µm) are considered particulate, whereas DOM passes through. Particulate Organic Carbon (POC), a related concept, refers specifically to the carbon content of POM and serves as an important metric for biogeochemical studies of carbon flux [2].

Once formed, POM undergoes **dynamic exchanges with DOM** through aggregation and dissolution processes. These POM–DOM interactions are central to organic matter cycling in water bodies, where sunlight, microbial activity, and physical turbulence can convert particles between dissolved and particulate forms, affecting bioavailability and transport.

In aquatic systems such as rivers, lakes, and oceans, POM represents a key pathway for the movement of carbon and nutrients. Organic particles produced in the surface waters are consumed or decomposed by heterotrophic microbes and zooplankton, releasing nutrients and CO_2 back into the system [3]. A portion of POM, especially refractory organic matter and mineral-associated particles, sinks through the water column and contributes to **carbon export** to deep waters and sediments. This vertical flux, often termed the **biological pump** in marine science, plays a major role in Earth's carbon cycle and long-term carbon sequestration.

POM also fuels **food webs** by providing a substrate for microbial decomposers, which in turn support higher trophic levels. Microbial colonization of particles is a critical step in POM degradation and nutrient recycling, influencing ecosystem metabolism and productivity [4]. Because POM is composed of organic materials that can bind nutrients and contaminants, it affects the **biogeochemistry of essential elements** like nitrogen and phosphorus. For example, POM degradation releases phosphate, a key nutrient in aquatic ecosystems, influencing algal blooms and eutrophication.

Similarly, particulate organic particles can **transport pollutants**, including hydrophobic organic compounds and trace metals, through water and soil matrices. These associations can alter the mobility, bioavailability, and ecological impact of contaminants, making POM a vector for pollutant cycling and ecosystem exposure. In soils, POM is a critical fraction of Soil Organic Matter (SOM). It provides a **labile carbon and nutrient source** for soil microbes and contributes to soil structure by enhancing aggregation, water infiltration, and aeration. Because POM is more readily decomposable than mineral-associated organic matter, it serves as an important indicator of soil quality and fertility [5].

Conclusion

Particulate Organic Matter (POM) is a pervasive and dynamic component of terrestrial and aquatic ecosystems. Its heterogeneous composition — ranging from detrital plant fragments to microbial biomass — makes it central to organic carbon storage, nutrient cycling, food web support, and pollutant transport. POM's interactions with dissolved organic matter (DOM), its role in carbon export, and its influence on biogeochemical processes highlight its importance in ecosystem functioning and global nutrient dynamics. As environmental change accelerates, continued research on POM dynamics, sources, and transformations is crucial for improving carbon cycle models, ecosystem management, and environmental monitoring efforts.

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