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Vascular Plants in Aquatic Ecosystems as Oxygen Producers

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Editorial

The chemistry of the Earth has been drastically altered by organisms. Organism-driven chemical changes include those that occur on short time spans within whole ecosystems or isolated habitats within ecosystems, as well as those that occur across geologic time scales. Regardless of the magnitude of the impact, organism-induced chemical changes can alter habitat quality and resource availability for other creatures. These chemical alterations caused by creatures, like the more often recognised structural changes caused by species, are unambiguous examples of ecosystem engineering.

The historical and current effects of creatures on oxygen levels in the atmosphere, soils, and aquatic ecosystems are possibly the most important of the many chemical changes made by species. Oxygen has been crucial in the respiratory pathways of eukaryotic species, as well as many prokaryotes, since the introduction of oxygenic conditions in the atmosphere about 2 billion years ago. Many species cannot tolerate anoxic or even hypoxic circumstances for long periods of time due to this oxygen need. Furthermore, the presence of oxygen allows for the juxtaposition of oxic and anoxic habitats, as well as the formation of an interface where chemosynthetic organisms can live by oxidising reduced inorganic compounds produced by biological and geological processes.

Aside from habitat considerations, the presence of oxygen influences the decomposition or preservation of some organic compounds, and chemical processes at the oxic–anoxic interface can have a significant impact on the cycling of limiting nutrients for autotrophic and heterotrophic production, such as nitrogen, phosphorus, and iron. Because oxygen has a poor solubility in water, severe oxygen depletion and anoxia have been restricted to aquatic systems and water-saturated soils for the last billion years. Even when oxygen concentrations in the overlying atmosphere are at equilibrium, there is often fewer than 300 micromoles oxygen per litre of water, compared to 8000 micromoles oxygen per L of air in the overlying atmosphere. Furthermore, gas transport in water, including dissolved oxygen, is many orders of magnitude slower.

Because of these two characteristics, organisms in aquatic systems can have a significant impact on oxygen conditions not just on long time scales but even on time scales as short as a day. The net ecosystem production of a system is a fundamental driver of oxygen levels in that system. The difference between gross primary output and the respiration of all species in an ecosystem is known as net ecosystem production. Average NEP is normally positive in the absence of considerable organic matter loading from outside the system, and there is a net oxygen release from metabolism. NEP may be enormous if such a system contains significant organic carbon burial or export, and these systems can operate as important carbon dioxide sinks and oxygen suppliers.

However, in systems with external organic carbon inputs, respiration can surpass GPP, lowering oxygen concentrations to levels where additional sources of oxygen balance oxygen depletion. External oxygen and organic carbon supplies are heavily influenced by hydrological and physical factors. Organisms can, however, have a significant impact on these transfers by altering the hydrological and physical characteristics of a system and by directly transporting organic carbon or oxygen, or both, across habitat or ecosystem borders. These organism-mediated changes have significant impacts on oxygen levels at ranges ranging from huge ocean basins to millimeter-thick patches in aquatic soils and sediments.

A large number of organisms are responsible for altering organic matter and oxygen transfers across ecosystem or habitat boundaries and, thus, engineering the oxygen balances of the system. We focus here on the effect of vascular aquatic plants, with a focus on comparisons between totally submerged VAPs and those with floating-leaved growth types. The shallows of many lakes, rivers, and estuaries are dominated by a varied collection of organisms known as vascular aquatic plants. They serve as metabolic "hot spots" and habitat for animals, algae, and bacteria. The group as a whole developed from terrestrial cousins, encompasses 33 families, and exhibits a wide range of physiological and morphological characteristics. The overall growth form and the amount to which the lacunal system is established are two critical limits on VAPs' influence on oxygen in aquatic environments.

In aquatic plants, the lacunal system is made up of a network of interconnected gas-filled canals and gaps that may be found in most submerged tissue. This air-filled system is essential for oxygen storage and transport between the plant's oxygen-producing and oxygen-consuming sections. Aquatic plants range in size from those whose whole growing habitat is submerged to those whose photosynthetic tissue is nearly entirely exposed to the surrounding atmosphere. The capacity of plants to transmit oxygen and organic matter across the ecological barrier of the air–water interface is dependent on this differentiation [1-5].

Conflict of Interest

None.

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