ABIOTIC FACTORS

NONLIVING CONDITION OR THING THAT INFLUENCES AN ECOSYSTEM

Description: An ecosystem consists of not just living organisms and biotic interactions; abiotic factors, defined as all the non-living parts of an ecosystem, are equally important to biotic components. Both physical conditions and chemical nutrients are critical because they interact with living organisms and determine the community structure. Physical conditions and **nutrient** availability are two primary abiotic factors. In the ocean, physical conditions, such as temperature, **salinity**, depth, and **dissolved oxygen** provide structure for the habitat for marine microbes. A change in physical conditions within an ecosystem can result in a shift of microbial **community structure**. For example, in winter when the temperature is lower and the wind above the sea surface is stronger, the water is colder and more turbulent compared to summer, resulting in a clear seasonal change in the microbial community structure. Nutrient availability can influence the growth of microbes, because each microbe has its own requirements to grow and survive, and nutrients are rarely present in high enough concentrations to prevent competition between organisms. Sunlight is an energy source for phytoplankton via the process of photosynthesis. By taking up the available nutrients (like nitrogen, phosphorus, iron, etc.) into their cells, phytoplankton can increase their biomass. Sometimes an **algal bloom** can be found when temperature is warm, light intensity is increased, and high concentrations of nutrients are available. Heterotrophic Bacteria grow by using **dissolved organic matter (DOM)** which is produced by phytoplankton.

Carbon Cycle: Nutrients are the base of the trophic pyramid. Phytoplankton require light, CO_2, and nutrients in order to grow using photosynthesis. The biomass they produce can be consumed by bacteria or protists. Bacteria can take up the dissolved organic matter which is easily absorbed (**labile DOM**), leaving the less absorbed part of DOM (called **recalcitrant DOM**) in the ocean, a process called **microbial carbon pump**. When the microbes in the surface ocean dies, the cell debris may aggregate into particles and sink into the deep ocean. These sinking particles are called **marine snow** and are important transport of carbon from surface into deep ocean.

Ecosystem Role: In an ecosystem, abiotic factors not only provide what the living organisms need to grow, but also impose a pressure on them. When the abiotic factors change, the life has to respond to such a change, either changing the size of their population, or changing the community structure. Therefore, the dynamics of abiotic factors is important in shaping the composition of living organisms in an ecosystem.

Key Terms

Nutrients: the chemicals required by living organisms to support their growth, survival, and reproduction. These chemicals include Carbon, Nitrogen, Phosphorus, Sulfur, and Iron. In the ocean most of these nutrients aren't present in a surplus, so living organisms must compete with each other to acquire the nutrients they require.
Salinity: the content of salts in seawater. Salinity is important to microbes because they may not tolerate a large change of salinity, since the cells may shrink (or burst).
Dissolved oxygen: the content of oxygen dissolved in water. oxygen is necessary by many bacteria and protists due to its role for energy generation.
Community structure: the composition of all the living organisms in a given locale and at a specific time.
Algal bloom: a rapid increase of algal cells in freshwater or seawater systems. An occurrence of algal bloom may be associated with high input of nutrients and/or an optimal temperature for the algae. Algae bloom may be identified by a change of color in the water, or sometimes even can be seen by satellite images.

Dissolved organic matter (DOM): the fraction of organic matter that is solubilized (usually < 0.7 μm in their sizes) in water. The amount of carbon in the marine DOM is nearly comparable to the amount in the atmospheric CO_2.
Labile DOM: the fraction of DOM that is easily used by bacteria. Labile DOM can often stay in the ocean from days to weeks.
Recalcitrant DOM: the fraction of DOM that is less easily used and hard to be degraded by bacteria. Recalcitrant DOM often stay in the ocean for more than thousand years.
Microbial carbon pump: a way of carbon storage from the atmosphere to the recalcitrant DOM in the ocean. Photosynthesis by phytoplankton can draw down CO_2 from the atmosphere. DOM can be produced by phytoplankton exudation, zooplankton grazing, and viral lysis. The labile fraction of the DOM will be degraded first by bacteria. The recalcitrant DOM remains intact in the ocean and the carbon inside can be regarded as a storage for the atmospheric carbon.
Marine snow: the cell debris and aggregates of organic matter sinking from surface to the deep ocean. Marine snow is a way to transport carbon into the deep ocean. It is also a food source for a lot of bacteria in the deep.
Light: an energy source for phytoplankton via photosynthesis. Light in the ocean is rapidly absorbed by seawater so light can only reach a top layer of the ocean less than ~100 m.
Ultraviolet light (UV): a light with a high energy power and can damage cells.
Nitrogen (N): a nutrient and is the constitute of biochemical molecules like proteins or DNA.
Phosphorus (P): a nutrient and is the constitute of biochemical molecules like cell membranes or DNA.
Iron (Fe): a nutrient and is an important constitute by many enzymes in cells.
Arsenic (As): a toxin that can damage or kill cells.

More Resources

Abiotic & biotic factors in ecosystems: https://sciencing.com/abiotic-biotic-factors-ecosystems-7146052.html
Coexisting in a sea of competition: https://www.sciencedaily.com/releases/2015/04/150413161543.htm
Marine Snow and Fecal Pellets: The spring rain and food to the abyss: https://www.whoi.edu/oceanus/feature/marine-snow-and-fecal-pellets/
What is a harmful algal bloom: https://www.noaa.gov/what-is-harmful-algal-bloom
Microbial carbon pump in a changing ocean: building models for the future: https://www.youtube.com/watch?v=3X1fA4sQVdc