

10.2 Classification of Soil Organisms

Definitions

Phototroph: An organism that obtains its energy from sunlight, in most cases by photosynthesis.

Photo-autotroph: A phototroph that uses carbon dioxide compounds as its main or sole source of carbon. Examples: algae and plants.

Photo-heterotroph: A phototroph that uses organic compounds as its main or sole source of carbon. Examples: Green and purple bacteria.

Chemotroph: An organism that obtains its energy from chemical reactions.

Chemo-autotroph: A chemotroph that uses carbon dioxide as its main or sole source of carbon. Example: Nitrifying or S oxidizing bacteria.

Chemo-heterotroph: A chemotroph that obtains its carbon chiefly or solely from organic compounds. Examples: Most bacteria, fungi, protozoa, and larger fauna.

Concepts

All organisms need organic carbon to build their cells. Chemoheterotrophs obtain the organic carbon from organisms which convert carbon dioxide to organic compounds with either light energy (photoautotrophs) or chemical energy (chemoautotrophs). Photoheterotrophs utilize light energy and also utilize organic carbon. Organisms can be classified based on the energy and carbon sources that they use (Table 10.1).

Table 10.1. Grouping of organisms according to energy and carbon sources.

Energy source	Carbon Source	
	Autotrophs (fix CO ₂)	Heterotrophs (utilize organic C)
Light (Photo-)	Photoautotrophs	Photoheterotrophs
Chemical (Chemo-)	Chemoautotrophs	Chemoheterotrophs

Photoautotrophs conduct photosynthesis, a process in which they utilize atmospheric CO₂ and water to produce organic C and oxygen in the presence of light. Photosynthesis is conducted by bacteria, algae and the higher plants, and is the foundation of food webs in diverse ecosystems. Photosynthesis is a biological process of converting CO₂ from the atmosphere and is a link to terrestrial and aquatic ecosystems. The equation for this reaction is:



Photoheterotrophs can also conduct photosynthesis, but they also utilize organic carbon compounds. Therefore, it is possible for organisms, such as green and purple bacteria, to utilize organic and inorganic forms of carbon.

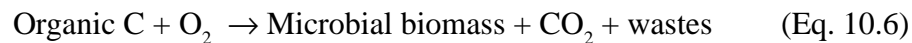
Chemoautotrophs generate energy through the oxidation of inorganic compounds. Nitrifying bacteria can oxidize ammonium to nitrate under aerobic conditions and use the energy to convert CO_2 to organic carbon. The equations for these processes are:



Sulfur oxidizing bacteria oxidize inorganic S compounds and also use energy to convert CO_2 to organic carbon. The equations for these processes are:



Aerobic chemoheterotrophs, most bacteria, fungi, protozoa and soil fauna, utilize organic carbon compounds for biomass and energy production. The equation for this reaction is:



This process results in the conversion of organic compounds into carbon dioxide under aerobic conditions. Oxygen is the terminal electron acceptor resulting in the formation of water.

Anaerobic chemoheterotrophs, mostly heterotrophic bacteria, utilize organic carbon compounds for biomass and energy production but use other inorganic compounds, such as nitrate, as terminal electron acceptors. The equation for denitrification is:



This process utilizes nitrate as a terminal electron acceptor, resulting in the formation of nitrous oxide (N_2O) and dinitrogen gas (N_2). As nitrous oxide is a greenhouse gas, this microbial process has a significant impact on radiative forcing of the troposphere.

Soil organisms constitute the living organic component of soil and range in size across five orders of magnitude (viz. 10^{-7} to 10^{-2} m). The soil biota consist of microflora, such as bacteria and fungi; microfauna, such as protozoa and nematodes; mesofauna such as enchytraeids, acari and collembola; and macrofauna such as earthworms, millipedes, woodlice, slugs and snails (Brussaard and Juma, 1995). Soil organisms can be classified based on their size (Table 10.2). Sizes for soil organisms range from 1 μm to 20 mm.

Table 10.2. Classification of soil organisms
(adapted from Swift et al., 1979).

Classification	Body Width	Examples
Microflora	<10 μm	bacteria fungi
Microfauna	<100 μm	protozoa nematode
Mesofauna	100 μm to 2mm	enchytraeids acari collembola
Macrofauna	2 mm to 20 mm	earthworms millipedes woodlice slugs snails

NOTE: Clay size particles are < 2 μm

Soil organisms inhabit the surface layers of soil and litter, or deeper soil horizons, or move throughout the soil. The vertical and horizontal distribution of soil biota is generally limited by temperature, water content, and soil texture. In addition to this, soil organic matter content and distribution control soil biotic processes. The distribution of soil organisms and its relationship to soil pores, particles and plant roots is shown in Fig. 10.2. The impact of fauna on important ecological functions is presented in Section 10.3.

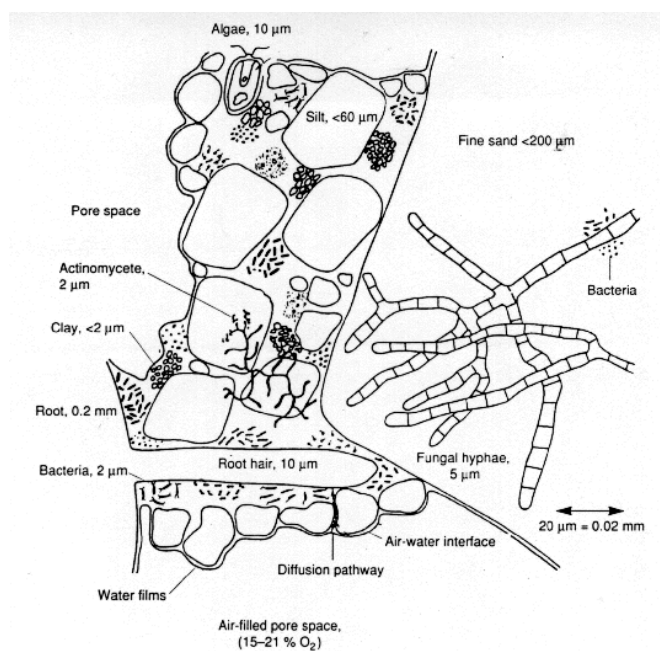


Fig. 10.2. The relationship between organisms, mineral particles, pores and plant roots in soil (Rowell, 1994). Reproduced with permission from Longman, Harlow.