Ecology: Soil and its Formation

Lesson 18, Chapter 3

Text Book Reference, Section 3.3, page 97 - 99

Earth is ~ 70 % H_2O and 30 % Land, a small percentage of which is covered with layers of soil.

All life on land depends on soil. Land plants need it for support , water and minerals. Land animals need it because they eat plants or other animals eat plants.

Soil is formed through the erosion of rock by water, wind, ice or living things, rock is broken into pieces by the weather, this is called **WEATHERING.** Particles are broken off and mixed with organic matter to form the first soil. It is gradually enriched as more and more organic matter is added.

The three main functions of soil are to provide:

1. essential medium for plant growth
2. regulate the flow of water through the environment, and
3. serve as an environmental buffer

Soil is a complex collection of mineral and organic particles. The mineral part comes from rock broken down by weathering and erosion.

The characteristics of the soil depend on the nature of the bedrock, the weather, and the early plants established on it. These natural factors take many years to produce a wide variety of soils.

The 5 components of soil are:

1. the particles from the rocks,
2. available nutrients,
3. living and dead organic matter,
4. water and
5. gases.

Particle size determines the porosity of the soil. Sandy soils have the largest particles and clay soils have the smallest, while in between are soils known as **SILT**.

The amount of organic matter mixed with the particles determines the **fertility of the soil**. **Soil fertility** –the ability of soil to produce vegetation determined by the organic content

The organic matter in the soil is composed of undecayed plant and animal material plus **Humus:** this is decayed plant and animal material including waste materials and dead organisms.

The organic content of soil affects plant growth because it is composed of such nutrients as nitrogen, phosphorus, particles of weathered rock and decomposing plant and animal matter.

Soil organisms maintain the organic composition of the soil: worms, bacteria, snails, slugs, fungi, ants, protozoa ...

Peat is mainly plant material that is decaying with little oxygen present; it is the earliest stage of coal formation; used as heating and cooking fuel in some contries.

Scientists who study soil (called **Agronomists**) divide soil into several classes based on their

colour, texture, chemical composition, structure and depth.

Soil can be regarded as a series of layers, each of which can be identified by its distinct colour and texture:

1. The top layer of a soil, known as the **LITTER** is made up mostly of partially decomposed leaves or grasses, this layer maintains the temperature in the soil and reduces H_2O evaporation.

2. Beneath the litter is the **TOPSOIL** layer, consisting of small rocks mixed with humus. Humus is black, so often topsoil is black, and contains a rich supply of minerals and nutrients (from dead and decaying plant and animal matter) for plant growth, also oxygen (required by microbes for respiration) and water. Many plants grow best in soils with large air spaces because the soil is less likely to be waterlogged and their roots can penetrate loose soil easily.
3. Below the topsoil is **SUBSOIL**, consisting of more rocks and small amount of organic matter, generally lighter in colour, due to the lack of humus; and containing large amounts of minerals such as Al, Fe, P.
   There is a relationship between soil colour and organic content, organic matter is a dark colour, the darker the soil, the greater its organic matter.

4. Beneath the soil is a layer of rock, the **BEDROCK**, the end of soil.

SUMMARY

Formation of Soil:

1. Soil begins as bedrock
2. The process by which soil is broken down is called weathering
3. Bedrock ⟶ thin layer of soil ⟶ small plants ⟶ enriched top soil ⟶ larger plants

Soil texture can affect the growth of plants, as space around particles is used for the flow of air, water, and nutrients, as well as for root penetration and expansion. The greatest plant growth occurs where the soil texture consists of a variety of particle sizes.

The best soil for growing crops are found in grasslands and deciduous forests.

Water Beneath the Soil

Water seeps into the soil and porous rock, **percolating** (i.e. the process by which ground water, pulled by gravity, flows downward through the soil), until it reaches the saturated layers just above the bedrock.

The boundary, found either in the soil or in bedrock, between the area where the ground water is percolating down and a layer saturated with water is called the **Water Table**.

The amount of ground matter in an area depends on the depth of the bedrock and the amount of precipitation.

As water seeps through the soil, it can dissolve salts and nutrients, carrying them deeper into the soil. This is called **LEACHING.**

Plants with long roots can transport nutrients from deeps in the soil up into the plant stem and leaves.

Two factors that would alter the amount of ground water in an area include the depth of the bedrock and the amount of precipitation; also if the ground water is from flowing to a lake or river.

Soil pH

Soil can be acidic, neutral or basic (aka: alkali).

Most plants do not do well in alkaline soils, they require soils that are slightly acidic, (pH of 5.5 - 6.5), except prairie grass. Conifers do poorly in strongly acidic soils, but mosses flourish in acidic soils.

The pH of the soil is dependant on:
1. the nature of the rock from which the soil was formed, and
2. by the nature of the plants that grow on it.

Limestone rock might produce soils with a neutral or high pH.

Combustion of fossil fuels releases acidic gases, such as sulphur dioxide and nitrogen oxides. These gases form acid rain or snow, that fall to earth as **Acid Deposition**; thus increasing the acidity of the soil.

Acidic water increases the problem of leaching by causing more nutrients such as K, Ca, Mg, and ammonium from the soil to be removed.

If the soil is acidic, **lime** (crushed limestone) can be added to raise the pH of the soil i.e., to reduce its acidity and if the soil is alkaline.
Sulphur can be added to lower the alkalinity of the soil, as sulphur is converted into acids by soil bacteria.

Soils can be permeable, semi-permeable or not permeable.

The size and composition of soil particles determine its degree of permeability and the resulting rate of percolation of air and water through the layers.

Good permeability increases water and oxygen flow to organisms inhabiting soil and to the plant roots.

Soils can be thick or thin, depending on the amount of organic matter. Soils that have little organic matter support relatively few plant species in low numbers.

Soils differs from one area to another because the climate conditions also vary.

Fertile soils have high organic composition, varying particle sizes that allow for good permeability, and a diversity of healthy organisms and micro-organisms; such soils yield abundant productivity in crops, support seed germination and extend root growth.

The soil profile of different ecosystems will have different biodiversity, example:

1. Desert soils have the thinnest soil, with the lowest biodiversity.
2. Grassland soils have deep layers of fertile soil, with high biodiversity.
3. The soil profile of a tropical rain forest– where most of the organic matter is massive trees and lush undergrowth– is often as poor as ones found in desert ecosystems; the small amount of detritus that falls onto the soil surface is quickly decomposed and taken up again by the vegetation.

Soil erosion is the gradual loss of soil by wind and water movement or by removal through human activities.

Soil erosion may be increased by seasonal flooding and by the removal of plants and trees, the roots of which hold soil in place. It is difficult for trees to grow back when soil has eroded because there are fewer places for root systems to become established.

Homework:

1. Read section 3.3 Pages 97 - 99
2. Worksheet: Soil and its Formation
3. Answer: Text Book: Page 99, # 1,2, 3, 6, 8