



RHS Level 3 Certificate Principles of Plant Growth, Health and Applied Propagation

2 The Root Environment, Plant Nutrition and Growing Systems

Courses for
Royal
Horticultural
Society
Qualifications

Outcome 3.1 Summarise the biological activity that takes place in soils and growing media during the production of humus from organic matter.

Organic matter has a profound effect on:

- **crop nutrition**
- **soil structure; and**
- **cultivations**

Living organic matter (biomass) consists of living plant and animals and micro-organisms.

As they die, the recognisable organic matter (we will confine ourselves to plants here, rather than getting morbid... but animal tissues also decompose) consists of **plant residues** from leaf litter and roots to tree trunks.

Humus is a collection of complex organic substances no longer identifiable as tissues. The dead organic matter is gradually decomposed by active micro-organisms until it consists of finely divided plant and micro-organism remains.

The process of **humification** leads to the formation of humus, which is *the slowly decomposing residue of soil organic matter*. It is a black colloidal material which coats soil particles, derived mainly from the decomposition of fibrous vegetation. It has a high cation exchange capacity and makes a contribution to the retention of exchangeable cations (more detail later).

Recap – the trophic pyramid

In the ecological hierarchy of the planet, plants are **primary producers**. They utilise the sun's energy, synthesising their own food by photosynthesis. Only plants and some algae can manufacture food in this way: all other forms of life depend on them.

Primary consumers are organisms which feed directly on this plant material - the herbivores.

Secondary consumers feed on primary consumers (animal material) – the carnivores. (A few organisms feed on both plant and animal material - omnivores.)

In this hierarchy the **decomposers** are a very important group, fulfilling the specialised function of breaking down dead or decaying matter into simpler substances.

This makes them available to the **primary producers** once more.

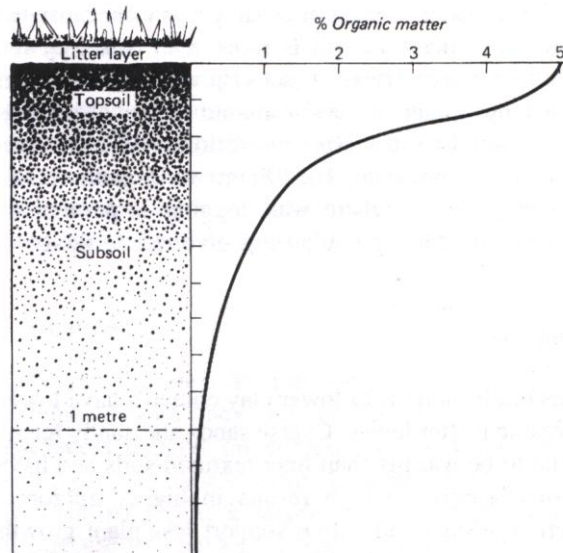
The **primary decomposers** are the organisms that attack freshly dead organic matter: the insects, earthworms and fungi.

Fungi are particularly important in the initial decomposition of fibrous and woody material. The **secondary decomposers** are the organisms which live on the waste products of the primary decomposers; they include bacteria and specialist species of fungi.

Plant roots are important contributors to the organic matter levels in the soil. Apart from shifting and moving soil particles and re-arranging soil aggregates, when they die and decompose they leave channels in the soil which provide aeration and drainage.

Organic matter levels in the soil depend on how much fresh material is added, compared with the rate of decomposition. It is stable when these two processes are balanced. This is determined by

- **climate**
- **soil type**
- **and cultivation**



The organic matter content decreases from the soil surface downwards; the topsoil is significantly richer in organic matter, therefore is darker.

Most topsoil contains between 1% and 6% of organic matter, whereas subsoil contains less than 2%. The diagram shows the distribution of organic matter in a grass ley. The soil organic matter is distributed in the topsoil because this is the area where most root activity has taken place, and plant residues are generally added to the surface.

Details of the activities of macro- and micro-organisms in the soil are given in elsewhere in this outcome and in the powerpoint summary.

Stages in the production of humus (humification):

- **Plant residues begin to decompose.**

Primary decomposers, the insects, fungi and bacteria, work on the recognisable plant material.

- **Secondary decomposers work on the residues**

Bacteria and fungi work on the residues of primary decomposition, as well as breaking down cellulose and lignin which have resisted earlier decomposers.

- **humic acids (humic acid & fulvic acid) and humin** are formed.

Humic Acids - the major humic component of soil and although water insoluble under very acidic conditions ($\text{pH} < 2$), are readily soluble at higher pH's. They are dark brown to black in colour.

Fulvic Acids – water soluble in all pH conditions, and are yellow to yellow-brown in colour.

Humin - the fraction of humic substances that is not soluble in water at any pH value and in alkali.

OM includes all organic material as it breaks down, from soil biomass to partially decomposed tissues; **humus** is only the humic substances present at the end of the biological degradation of organic matter.

Humic acids are the main constituent of humus; they

- help with the physical modification of soil by improving soil texture and structure and with soil chemistry by altering cation exchange capacity and buffering properties;
- convert nutrients to forms that are available to plants and hold them ready – this 'mineralisation' releases nitrogen and other nutrients for plant growth
- and allow soil organisms (microbes and animals) to feed and reproduce.

Once it is fully humified, organic matter becomes more uniform in appearance (a dark, spongy, jelly-like substance) and amorphous in structure. It is called a **colloid**.

Coal represents a number of humus types in an advanced state of decomposition, produced from various plant residues at different periods during prehistoric times, and later stratified and compressed by superimposed layers of mineral matter.

Humic substances are actively involved in the decomposition of rocks and minerals. The character of the action depends on the nature of the humic substances, as well as on the resistance of the minerals.