**Indicators of fire** – *Pteris* ( fern ) and *Pyronema* (fungus) indicates the burnt up and fire disturbed areas. So they are called indicators of fire.

**Fire break** – It is a gap made in the vegetation that acts as a barrier to slow down or stop the progress of fire.

A **natural fire break** may occur when there is a lack of vegetation such as River, lake and canyon found in between vegetation may act as a natural fire break.

**Rhytidome:** It is the structural defense by plants against fire .The outer bark of trees which extends to the last formed periderm is called Rhytidome. It is composed of multiple layers of suberized periderm, cortical and phloem tissues. It protects the stem against fire , water loss, invasion of insects and prevents infections by microorganisms.

## 6.2.2 Edaphic factors

Edaphic factors, the abiotic factors related to soil, include the physical and chemical composition of the soil formed in a particular area. The study of soils is called **Pedology.**

### The soil

Soil is the weathered superficial layer of the Earth in which plants can grow. It is a complex composite mass consisting of soil constituents, soil water, soil air and soil organisms, etc.

### Soil formation

Soil originates from rocks and develops gradually at different rates, depending upon the ecological and climatic conditions. Soil formation is initiated by the weathering process. Biological weathering takes place when organisms like bacteria, fungi, lichens and plants help in the breakdown of rocks through the production of acids and certain chemical substances.

### Soil types

Based on soil formation (**pedogenesis**), the soils are divided into

1. **Residual soils** –These are soils formed by weathering and **pedogenesis** of the rock.
2. **Transported soils** – These are transported by various agencies.

The important edaphic factors which affect vegetation are as follows:

**1. Soil moisture:** Plants absorbs rain water and moisture directly from the air

**2. Soil water:** Soil water is more important than any other ecological factors affecting the distribution of plants. Rain is the main source of soil water. Capillary water held between pore spaces of soil particles and angles between them is the most important form of water available to the plants.

**3. Soil reactions:** Soil may be **acidic** or **alkaline** or **neutral** in their reaction. pH value of the soil solution determines the availability of plant nutrients. The best pH range of the soil for cultivation of crop plants is **5.5 to 6.8.**

**4. Soil nutrients:** Soil fertility and productivity is the ability of soil to provide all essential plant nutrients such as minerals and organic nutrients in the form of ions.

**5. Soil temperature:** Soil temperature of an area plays an important role in determining the geographical distribution of plants. Low temperature reduces use of water and solute absorption by roots.

**6. Soil atmosphere:** The spaces left between soil particles are called pore spaces which contains **oxygen** and **carbon-di-oxide**.

**7. Soil organisms:** Many organisms existing in the soil like bacteria, fungi, algae, protozoans, nematodes, insects, earthworms, etc. are called soil organisms.

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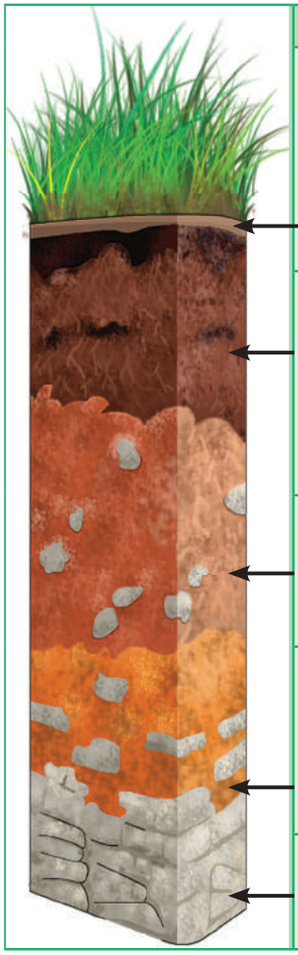

| Horizon | Description |
|---|---|
| O–Horizon (Organic horizon) Humus | It consists of fresh or partially decomposed organic matter. O1 – Freshly fallen leaves, twigs, flowers and fruits O2 – Dead plants, animals and their excreta decomposed by micro-organisms. Usually absent in agricultural and deserts. |
| A–Horizon (Leached horizon) Topsoil - Often rich in humus and minerals. | It consists of top soil with humus, living creatures and in-organic minerals. A1 – Dark and rich in organic matter because of mixture of organic and mineral matters. A2 – Light coloured layer with large sized mineral particles. |
| B-Horizon (Accumulation horizon) (Subsoil-Poor in humus, rich in minerals) | It consists of iron, aluminium and silica rich clay organic compounds. |
| C - Horizon (Partially weathered horizon) Weathered rock Fragments - Little or no plant or animal life. | It consists of parent materials of soil, composed of little amount of organic matters without life forms. |
| R – Horizon (Parent material) Bedrock | It is a parent bed rock upon which underground water is found . |

**Figure 6.7:** Soil Profile

### Soil Profile

Soil is commonly stratified into horizons at different depth. These layers differ in their physical, chemical and biological properties. This succession of super-imposed horizons is called soil profile.

### Types of soil particles

Based on the relative proportion of soil particles, four types of soil are recognized.

| | Soil type | Size | Relative proportion |
|---|---|---|---|
| 1 | Clayey soil | Less than 0.002 mm | 50% clay and 50% silt ( cold / heavy soil ) |
| 2 | Silt soil | 0.002 to 0.02mm | 90% silt and 10% sand |
| 3 | Loamy soil | 0.002 to 2mm | 70% sand and 30 % clay / silt or both (Garden soil) |
| 4 | Sandy soil | 0.2 to 2 mm | 85% sand and 15% clay ( light soil ) |

**Table 6.3:** Types of soil particles

**Loamy soil is ideal soil for cultivation.** It consists of 70% sand and 30% clay or silt or both. It ensures good retention and proper drainage of water. The porosity of soil provides adequate aeration and allows the penetration of roots.

Based on the water retention, aeration and mineral contents of soil, the distribution of vegetation is divided into following types.

1. **Halophytes:** Plants living in saline soils
2. **Psammophytes:** Plants living in sandy soils
3. **Lithophytes:** Plants living on rocky surface
4. **Chasmophytes**: Plants living in rocky crevices
5. **Cryptophytes**: Plants living below the soil surface
6. **Cryophytes**: Plants living in ice surface
7. **Oxylophytes**: Plants living in acidic soil
8. **Calciphytes**: Plants living in calcium rich alkaline soil.

**Hollard** –Total soil water content
**Chresard** –Water available to plants
**Echard** – Water not available to plants

### 6.2.3 Topographic factors

The surface features of earth are called **topography**. Topographic influence on the climate of any area is determined by the interaction of solar radiation, temperature, humidity, rainfall, latitude and altitude. It affects the vegetation through climatic variations in small areas (micro climate ) and even changes the soil conditions. Topographic factors include latitude, altitude, direction of mountain, steepness of mountain etc.

#### a. Latitudes and altitudes

Latitudes represent distance from the equator. Temperature values are maximum at the equator and decrease gradually towards poles. Different types of vegetation occur from equator to poles which are illustrated below.

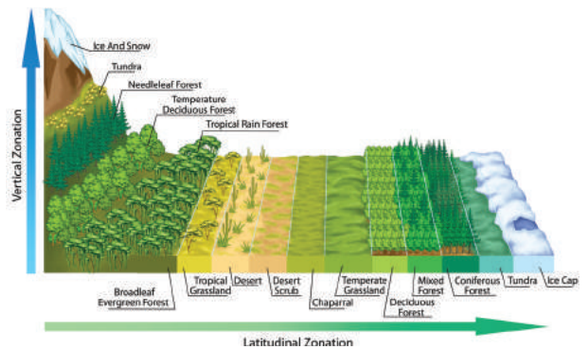


**Figure 6.8:** Latitudinal and Altitudinal Vegetation

Height above the sea level forms the **altitude**. At high altitudes, the velocity of wind remains high, temperature and air pressure decrease while humidity and intensity of light increases. Due to these factors, vegetation at different altitudes varies, showing distinct zonation.

#### b. Direction of Mountain

North and south faces of mountain or hill possess different types of flora and fauna because they differ in their humidity, rainfall, light intensity, light duration and temperature regions.

**Ecotone** - The transition zone between two ecosystems. Example: The border between forest and grassland.

**Edge effect** – Those species are found in the ecotone areas are due to the effect of environment of the two habitats. This is called edge effect. Example: Owl in the ecotone area between forest and grassland.

The two faces of the mountain or hill receive different amount of solar radiation, wind action and rain. Of these two faces, the windward region possesses good vegetation due to heavy rains and the leeward region possesses poor vegetation due to rain shadows (rain deficit).

Similarly in the soil of aquatic bodies like ponds the center and edge possess different depth of water due to soil slope and different wave actions in the water body. Therefore, different parts of the same area may possess different species of organisms.

#### c. Steepness of the mountain

The steepness of the mountain or hill allows the rain to run off. As a result the loss of water causes water deficit and quick erosion of the top soil resulting in **poor vegetation**. On the other hand, the plains and valley are **rich in vegetation** due to the slow drain of surface water and better retention of water in the soil.

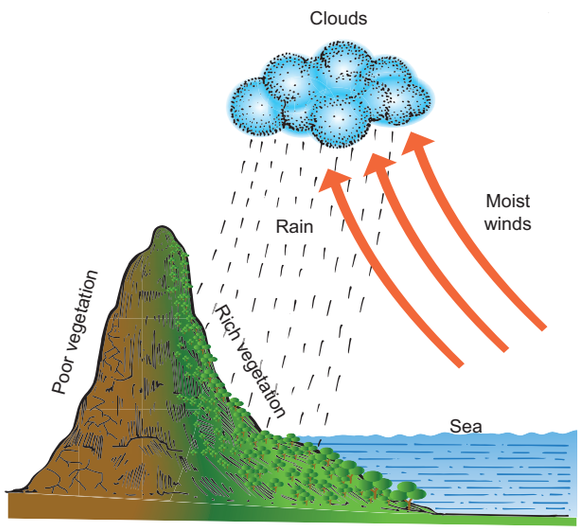


**Figure 6.9:** Steepness of mountain

### 6.2.4 Biotic factors

The interactions among living organisms such as plants and animals are called **biotic factors,** which may cause marked effects upon vegetation. The effects may be direct and indirect and modifies the environment. The plants mostly which lives together in a community and influence one another. Similarly, animals in association with plants also affect the plant life in one or several ways. The different interactions among them can be classified into following two types they are positive interaction and negative interaction

#### Positive interactions

When one or both the participating species are benefited, it is positive interaction. Examples; Mutualism and Commensalism.

**a. Mutualism:** It is an interaction between two species of organisms in which both are benefitted from the obligate association. The following are common examples of mutualism.

**Nitrogen fixation**

**Rhizobium** (Bacterium) forms nodules in the roots of leguminous plants and lives symbiotically. The *Rhizobium* obtains food from leguminous plant and in turn fixes atmospheric nitrogen into nitrate, making it available to host plants.

**Other examples:**

- Water fern (*Azolla*) and Nitrogen fixing Cyanobacterium *(Anabaena* ).
- *Anabaena* present in coralloid roots of *Cycas*. (Gymnosperm)

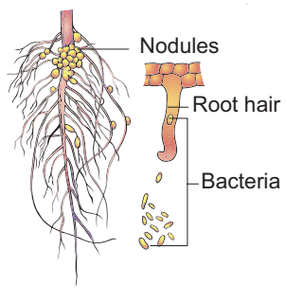


**Figure 6.10:** A nodulated legume plant root with bacteria

- Cyanobacterium (*Nostoc*) found in the thalloid body of *Anthoceros.*(Bryophytes)
- Wasps present in fruits of fig.
- Lichen is a mutual association of an **alga** and **a fungus**.
- Roots of terrestrial plants and fungal hyphae- **Mycorrhiza**

**b. Commensalism:** It is an interaction between two organisms in which one is benefitted and the other is neither benefitted nor harmed. The species that derives benefit is called the **commensal,** while the other species is called the **host**. The common examples of commensalism are listed below:

| | Interaction type | Combination | | Effects | Examples |
|---|---|---|---|---|---|
| **1.Positive interaction** | | | | | |
| **1** | **Mutualism** | (+) | (+) | Both species benefitted | Lichen, *Mycorrhiza* etc. |
| **2** | **Commensalism** | (+) | (0) | One species is benefitted and the other species is neither benefitted nor harmed | orchids, Lianas etc. |
| **2.Negative interaction** | | | | | |
| **4** | **Predation** | (+) | (-) | One species benefitted, the other species are harmed | *Drosera, Nepenthes* etc. |
| **5** | **Parasitism** | (+) | (-) | One species benefitted, the other species are harmed | *Cuscuta, Duranta, Viscum* etc. |
| **6** | **Competition** | (-) | (-) | Harmful for both | Grassland species |
| **7** | **Amensalism** | (-) | (0) | Harmful for one, but the other species are unaffected | *Penicillium* and *Staphylo coccus* |

(+) Benefitted, (-) Harmed (0)Unaffected

**Table 6.4:** Different interactions of plant

**Epiphytes**

The plants which are found growing on other plants without harming them are called epiphytes. They are commonly found in tropical rain forest.

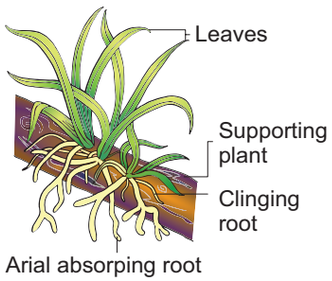


**Figure 6.11:** An epiphytic plant-*Vanda*

The epiphytic higher plant (**Orchids**) gets its nutrients and water from the atmosphere with the help of their hygroscopic roots which contain special type of spongy tissue called **Velamen.** So it prepares its own food and does not depend on the host. They use the host plant only for support and does not harm it in any way.

- Many orchids, ferns, lianas, hanging mosses, *Peperomia*, money plant and *Usnea* (Lichen) are some of the examples of epiphytes.
- Spanish Moss –*Tillandsia* grows on the bark of Oak and Pine trees.


**Proto Cooperation**

An interaction between organisms of different species in which both organisms benefit but neither is dependent on the relationship. Example: Soil bacteria / fungi and plants growing in the soil.

## Negative interactions

When one of the interacting species is benefitted and the other is harmed, it is called **negative interaction** . Examples: predation, parasitism, competition and amensalism.

**a. Predation:** It is an interaction between two species, one of which captures, kills and eats up the other. The species which kills is called a **predator** and the species which is killed is called a **prey**. The predator is benefitted while the prey is harmed.

**Examples:**

- A number of plants like *Drosera* (Sun dew Plant), *Nepenthes* (Pitcher Plant), *Diaonaea* (Venus fly trap), *Utricularia* (Bladder wort) and *Sarracenia* are predators which consume insects and other small animals for their food as a source of nitrogen. They are also called as **insectivorous plants**.

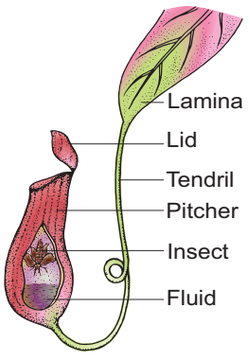


**Figure 6.12:** Pitcher plant – with insect

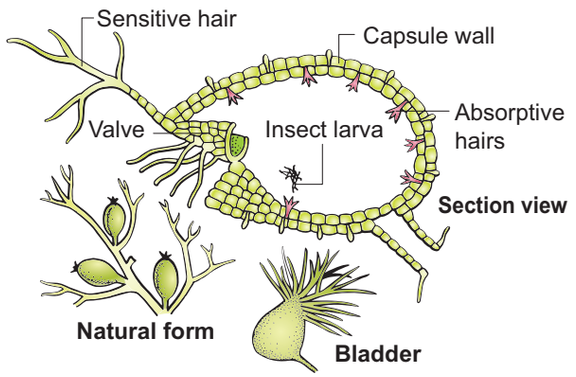


**Figure 6.13:** Insectivorous plant *Utricularia*

- Many herbivores are **predators**. Cattles, Camels, Goats etc., frequently browse on the tender shoots of herbs, shrubs and trees. Generally annuals suffer more than the perennials. Grazing and browsing may cause remarkable changes in vegetation. Nearly 25 percent of all insects are known as phytophagous(feeds on plant sap and other parts of plant)
- Many **defense mechanisms** are evolved to avoid their predations by plants. Examples: *Calotropis* produces highly poisonous cardiac glycosides, Tobacco produces nicotine, coffee plants produce caffeine, *Cinchona* plant produces quinine. Thorns of *Bougainvillea*, spines of *Opuntia*, and latex of cacti also protect them from predators.

**b. Parasitism:** It is an interaction between two different species in which the **smaller partner** (parasite) obtains food from the **larger partner** (host or plant). So the parasitic species is benefited while the host species is harmed. Based on the host-parasite relationship, parasitism is classified into two types they are holoparasite and hemiparasite.

### Holoparasites

The organisms which are dependent upon the host plants for their entire nutrition are called **Holoparasites**. They are also called **total parasites**.

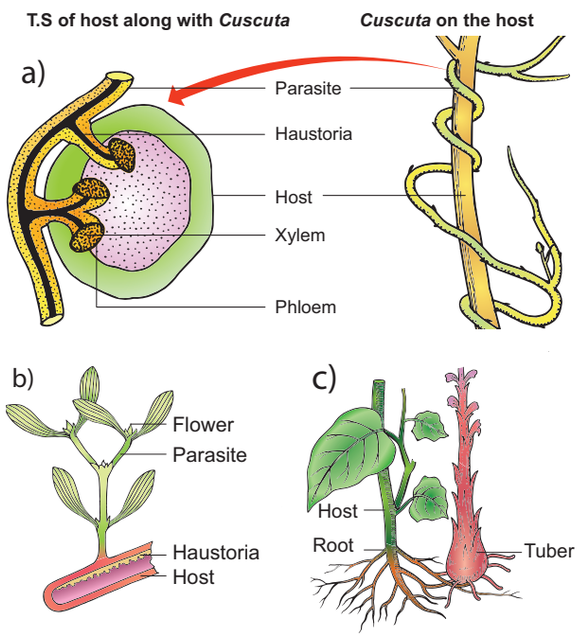


**Figure 6.14:** a) Holoparasite – *Cuscuta*
b) A Partial stem parasite – *Viscum*
c) Root parasite on the brinjal root *Orobanche* spp.

Examples:

- *Cuscuta* is a total stem parasite of the host plant *Acacia*, *Duranta* and many other plants. *Cuscuta* even gets flower inducing hormone from its host plant.
- *Balanophora, orobanche* and *Refflesia* are the total root parasites found on higher plants.

### Hemiparasites

The organisms which derive only water and minerals from their host plant while synthesizing their own food by photosynthesis are called **Hemiparasites**. They are also called **partial parasites**.

Examples:

- *Viscum* and *Loranthus* are **partial stem parasites**.
- *Santalum* (Sandal Wood) is a **partial root parasite**.

The parasitic plants produce the **haustorial roots** inside the host plant to absorb nutrients from the vascular tissues of host plants.

**c. Competition:** It is an interaction between two organisms or species in which both the organisms or species are harmed. Competition is the severest in population that has irregular distribution. Competition is classified into intraspecific and interspecific.

1. **Intraspecific competition:** It is an interaction between individuals of the same species. This competition is very severe because all the members of species have similar requirements of food, habitat, pollination etc. and they also have similar adaptations to fulfill their needs.

2. **Interspecific competition:** It is an interaction between individuals of different species. In grassland, many species of grasses grow well as there is little competition when enough nutrients and water is available. During drought shortage of water occurs . A life and death competition starts among the different species of grass lands. Survival in both these competitions is determined by the quantity of nutrients, availability of water and migration to new areas. Different species of herbivores, larvae and grass hopper competing for fodder or forage plants. Trees, shrubs and herbs in a forest struggle for sunlight, water and nutrients and also for pollination and dispersal of fruits and seeds. The *Utricularia* (Bladderwort) competes with tiny fishes for small crustaceans and insects.

**d. Amensalism:** It is an interspecific interaction in which one species is inhibited while the other species is neither benefitted nor harmed. The inhibition is achieved by the secretion of certain chemicals called **allelopathic** substances. Amensalism is also called **antibiosis.**

- *Penicillium notatum* produces penicillin to inhibit the growth of a variety of bacteria especially *Staphylococcus*.
- *Trichoderma* inhibits the growth of fungus *Aspergillus*.
- Roots and hulls of Black Walnut *Juglans nigra* secretes an alkaloid **Junglone** which inhibits the growth of seedlings of Apple, Tomato and *Alfalfa* around it.

## Interspecific interactions/ Co-evolutionary dynamics

**i. Mimicry:** It is a phenomenon in which living organism modifies its form, appearance, structure or behavior and looks like another living organism as a self defence and increases the chance of their survival. Floral mimicry is for usually inviting pollinators but animal mimicry is often protective. Mimicry is a result of evolutionary significance due to shape and sudden heritable mutation and preservation of natural selection.

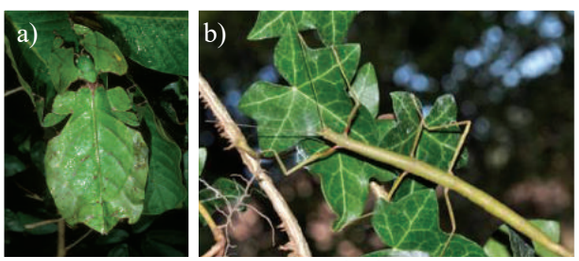


**Figure 6.15:** Mimicry
a) *Phyllium frondosum* b) *Carausium morosus*

Example:

- The plant, *Ophrys* an orchid, the flower looks like a female insect to attract the male insect to get pollinated by the male insect and it is otherwise called 'floral mimicry '.
- *Carausium morosus* – stick insect or walking stick. It is a protective mimicry.
- *Phyllium frondosum* – leaf insect, another example of protective mimicry.

**ii. Myrmecophily:** Sometimes, ants take their shelter on some trees such as Mango, Litchi, Jamun, *Acacia* etc. These ants act as body guards of the plants against any disturbing agent and the plants in turn provide food and shelter to these ants. This phenomenon is known as Myrmecophily. Example: Acacia and acacia ants.


**Figure 6.16:** Myrmecophily

**iii. Co-evolution:** The interaction between organisms, when continues for generations, involves reciprocal changes in genetic and morphological characters of both organisms. This type of evolution is called Co-evolution. It is a kind of co- adaptation and mutual change among interactive species.

**Figure 6.17:** Co-evolution

Examples:

- Corolla length and proboscis length of butterflies and moths ( *Habenaria* and Moth ).
- Bird's beak shape and flower shape and size.
- More examples: Horn bills and birds of Scrub jungles ,Slit size of pollinia of Apocynaceae members and leg size of insects.

DO YOU KNOW?

**Kairomone** released from *Pieris rapae* caterpillar exposed to wild Radish gets the capacity to transmit defence induced by predator to progeny of wild radish. Transmission capacity of defence induced by predator to progeny of wild radish.