TD Nº 01: ECOLOGICAL FACTORS

I. Ecological Factors

An **ecological factor** is any physical, chemical or biological parameter that may directly affect living organisms during at least one phase of their life cycle.

Ecological factors have different effects on living beings:

- **Species distribution**: they influence the distribution of living beings by eliminating certain species from territories whose characteristics are not favorable to them.
- **Influence on population density**: they modify the fertility and mortality rates of species, thereby influencing their development cycle and animal migrations.
- **Adaptation of organisms**: they promote the emergence of adaptive changes in certain living beings.

II. Classification of ecological factors

Generally speaking, we distinguish between abiotic and biotic factors.

1. Abiotic factors

In ecology, abiotic factors represent all the physical and chemical factors in an ecosystem that influence a given biocoenosis. Although it is impossible to list them exhaustively, they can be classified into several categories:

1.1. ***Climatic factors:*** Climatic factors include:

a) Light (solar radiation):

Light is essential for photosynthetic living beings. The photoperiod, the quantity and quality of light reaching living organisms will influence their biology, morphology, behaviour, etc.; we can distinguish **between heliophytes and sciaphytes.**

- **Heliophytes (light-loving plants)**
- **Sciaphyte plants (shade-tolerant)**

b) Temperature:

In practice, most living beings develop at temperatures that vary little, although some tolerate greater variations. Certain animals and microbial species tolerate extreme temperatures. Corals develop in warm seas. Emperor penguins live in the cold of the Antarctic continent.

Photo 01: Coral

Photo 02 : Emperor penguin *(Aptenodytes forsteri)*

c) Water:

Water is both an essential element for the development of living beings and a habitat for aquatic organisms. Depending on living beings' need for water, and consequently their distribution in different environments, we distinguish between: hydrophilic, hygrophilic and mesophilic species.

- **Hydrophilic species (high water requirements)**
- **Hygrophilous species (wet environments)**
- **Mesophilic species (moderate conditions)**

d) Air:

Enables the dispersal of pollen and spores, but also imposes constraints through wind (frequency, intensity and direction).

e) Precipitation:

Refers to water that falls from the atmosphere in the form of rain, snow, hail or fog. It influences biodiversity, the water cycle, soil erosion and agriculture. Its distribution varies according to latitude, altitude, seasons and climate change.

f) Humidity:

Refers to the amount of water vapour in the air. It plays a key role in evapotranspiration, climate, the development of organisms and the spread of disease. It is influenced by temperature, the presence of bodies of water, vegetation and human activity.

g) Atmospheric pressure:

It is a climatic factor that influences the weather by regulating winds and precipitation. Without being an energy or water factor, it modifies temperature and humidity. High pressure brings stable weather, while low pressure promotes rain and storms.

1.2. Edaphic (soil) factors:

a) Soil structure:

This is the spatial arrangement of mineral and organic particles in the soil. This results in structural elements that are arranged differently from one another, depending on the case, and is characterised by:

- The shape of the arrangements and their size.
- The degree of porosity.
- The strength of the bonds between the basic constituents and the structural elements.

b) Particle size: There are four categories of soil:

- **Gravel:** particles larger than 2 mm in diameter.
- **Coarse sand:** particles measuring 0.2 to 2 mm in diameter.
- **Fine sand:** particles measuring 20µm to 0.2mm.
- **Mineral colloids:** clay particles mainly smaller than 20µm.

Particle size affects the distribution of water and animals. The polychaete *Arenicola marina* lives in muddy sand containing approximately 24% water and with a maximum particle size of 247 µm.

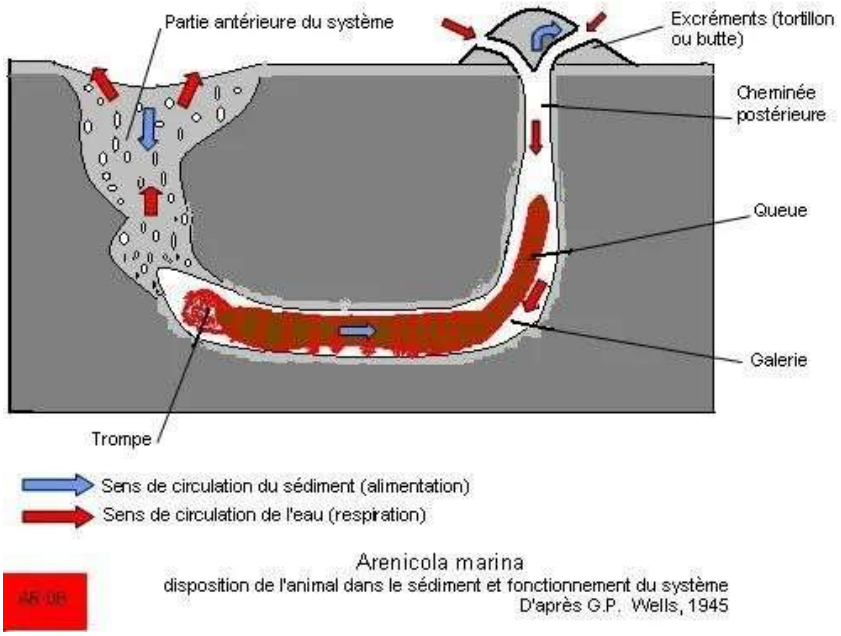

Figure 01: Diagram showing the distribution of the lugworm (*Arenicola marina)* in the sediment and how it functions of the system. The depth is greatly reduced compared to the width.

1.3. Chemical factors:

There is a wide variety of soils depending on their chemical composition:

- Salinity
- Soil and water pH
- Essential nutrients (nitrogen, phosphorus, potassium)
- Minerals and trace elements (calcium, magnesium, sulphates)
- Oxygen dissolved in water
- Humus and organic matter in the soil
- Atmospheric gas composition (O_2, CO_2, N_2)
- Chemical pollutants (heavy metals, pesticides, SO_2, NOx)

Salty soils have a high salt content and are home to vegetation adapted to this type of environment.

Calcium is also a chemical element present in the soil that influences the distribution of living organisms, which can be classified as calcicolous species and calcifuge species.

The development of species varies according to the structure, composition, humus content and microbial richness of the soil. **For example**, halophilic plants grow in salty environments,

while nettles grow on nitrate-rich soils.

1.4. Topographical factors:

Topography **(altitude, slope, aspect, erosion, terrain roughness, landscape fragmentation, etc.)** influences plant growth by modifying both climatic parameters (precipitation, temperature, sunshine) and soil characteristics (water content, erosion, stability). In mountainous environments, vegetation adapts to variations in altitude, while the orientation of slopes determines their exposure to sunlight, thus creating contrasting ecological conditions.

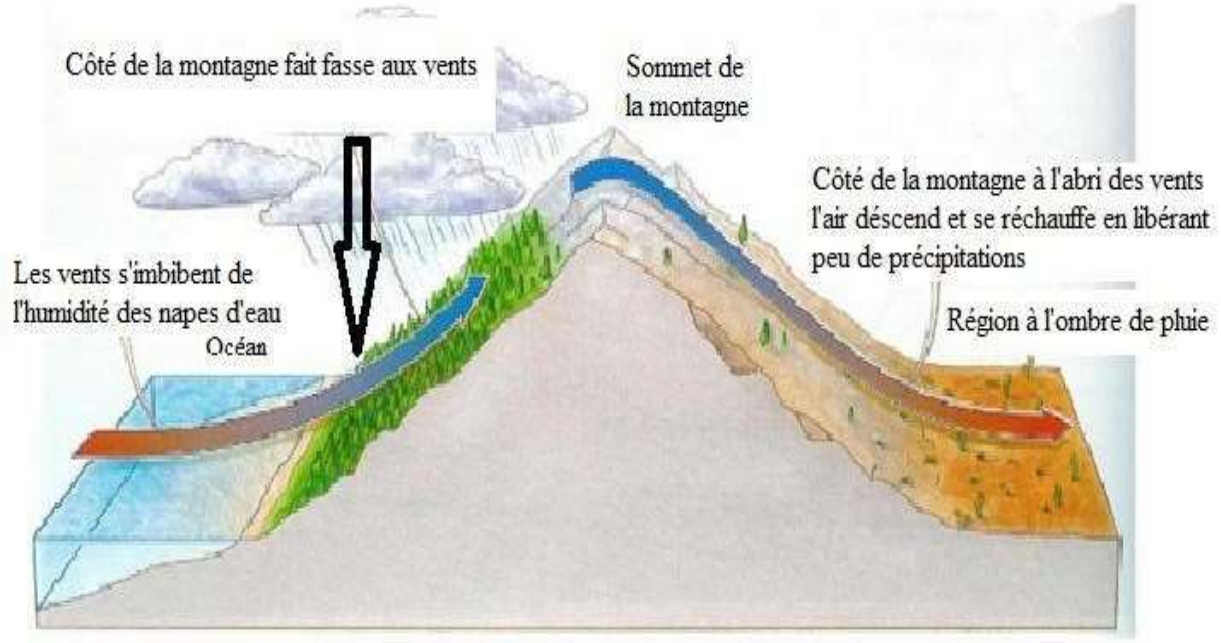

Figure 02: Distribution of living beings according to topography

2. Biotic factors (interactions between living beings)

This term encompasses all the physical, chemical and biological parameters that result from the actions of living organisms. These factors therefore characterise all the influences that living beings exert on each other and on their environments. They can be classified in various ways: physico-chemical factors, trophic factors, factors specific to intraspecific and interspecific interactions.

2.1. Physico-chemical factors of biotic origin:

Living beings exert a mechanical and climatic influence on their biotope, as well as a chemical influence.

- **Mechanical influence:** Action of plant roots or endogeic fauna on the bedrock (e.g. fissuring).

- **Climatic influence:** Role of vegetation on climatic parameters (wind patterns, atmospheric humidity).

- **Chemical influence:** Effect on the chemical composition of the soil:

A- Secretion into the environment of natural, animal and plant substances that are beneficial or toxic to other species.

B- The existence of atmospheric oxygen (autotrophy) is a spectacular example.

Within a biocoenosis, different types of interactions are observed between individuals of different species (interspecific interactions) or of the same species (intraspecific interactions). These interactions can be harmful, neutral or beneficial.

2.2. Interspecific factors (heterotypic reactions):

a) Symbiosis (+; +): a mandatory relationship with mutual benefits

Symbiosis is an essential ecological interaction in which two organisms live in close association, each providing a benefit to the other. This relationship is essential to their survival. **Examples**:

- The association between algae and fungi forms **lichens**, where the algae provide sugars through photosynthesis while the fungi provide water and mineral salts.
- The association between tree roots and fungi, such as **oak bolete**, allows the tree to obtain nutrients and water through fungal filaments, while the fungus receives sugars from the tree.

Photo 03: Lichen , also known as or **(lichenised fungus)**

Photo 04: Oak bolete *(Leccinellum lepidum)*

b) Mutualism (+; +): a beneficial but non-obligatory interaction

Mutualism is an interaction between two species where each benefits, but their association is not essential to their survival.

Example:

- The **remora fish** (*Remora remora*) feeds on parasites and dead skin from the great white shark (*Carcharodon carcharias*), thereby improving its hygiene and reducing the risk of infection.

Photo 05: A remora fish attached to a shark

c) Commensalism (+; 0): a relationship with unilateral benefit

Commensalism refers to an interaction in which one species benefits from the relationship without harming or benefiting the other. contact between the two organisms is often permanent. **Examples**:

- **Climbing plants** (clematis, ivy, Smilax aspera) cling to tree trunks to reach the light without affecting the tree.
- **Jackals** feed on the remains of prey left by lions, without harming them or benefiting them.

Photo 06: Ivy spontaneously climbs trees or obstacles when exposed to light.

d) Amensalism (-; 0): a negative interaction for one species, neutral for the other

Amensalism occurs when one species is negatively affected by another, without the latter deriving any direct benefit.

Examples:

- **Teletoxia**, where certain plants secrete substances that inhibit the growth of other plants.
- **Antibiotic action**, where one microorganism produces substances that prevent the development of another (e.g. production of antibiotics by certain bacteria).

Photo 07: Allelopathic effect of the black walnut tree: sparse undergrowth

e) Parasitism (+; -): a relationship in which one organism lives at the expense of another

Parasitism is an interaction in which one organism (the parasite) benefits from a host by harming it. Some parasites are external, others internal.

Examples:

- **The dog tick** (external parasite).
- **Tapeworm**, an internal parasitic worm that lives in the intestines of certain mammals.

f) Competition (- ; -): rivalry for the same resource

Competition occurs when two species use a common resource (food, light, territory), limiting their their development..

Example:

- **Herbaceous** plants **in forest environments** compete for light.

g) Neutralism (0; 0): no interaction between species

The **neutralism** corresponds to a situation where two species coexist without influencing each other.

Example:

- **Passerines in forests** occupy different strata and exploit varied resources, thus avoiding competition.
- **Chamois, ibex and mouflon in the Mercantour** live in the same environment without interfering with each other.

Photo 08: Harmonious coexistence of species in the natural environment

2.3. Intraspecific factors (homotypic reactions):

These occur between individuals of the same species, forming a population. They involve cooperation or competition, with sharing of territory and sometimes organisation into a hierarchical society.

This of course covers reproductive behaviour, protection and feeding of young (particularly in birds and mammals), competition for the same resources when they become scarce, and social behaviour (examples of social insects: bees, ants, termites).

a) The group effect:

This characterises the physiological, morphological or behavior al changes that occur when several individuals of the same species live together in a reasonable space with sufficient food.

Living in groups confers numerous adaptive advantages. First, it reduces the risk of predation through several mechanisms, including collective defence against predators, enhanced vigilance, predator confusion when confronted with multiple moving targets, and the dilution effect. Since predators, generally capture only one prey at a time, the probability that any given individual will be caught decreases as group size increases.

Group living can also improve foraging success through the exchange of information about food sources and acquisition strategies, cooperative hunting, collective defence of resources against rival groups, and food sharing among group members.

However, living in a herd also has its disadvantages: transmission of diseases and parasites, increased chances of being spotted by predators, and, above all, competition for generally limited resources. Certain compromises are possible.

Example: A herd of elephants must contain at least 25 individuals in order to follow, while a herd of reindeer : 300 to 500 heads.

b) The mass effect:

The mass effect occurs when space is limited and is characterised by adverse effects on the population.

Example:

A study on *Tribolium confusum* demonstrated the existence of an optimal population density at which the number of eggs laid per female reaches a maximum, illustrating a positive group effect. However, beyond this optimal density, female fertility declines, reflecting the so-called mass effect. This decline is associated with high population density, which leads to environmental deterioration due to the accumulation of toxic excreta. These waste products alter environmental conditions and exert a disruptive effect on the reproductive performance of the species.

- **Group effect**: Influence of social interactions and cooperation between individuals within a group.

Example: A group of wolves hunt together to capture prey, thanks to their cooperation and division of roles.

- **Mass effect**: Impact generated by the sheer size of a group, without requiring complex social interactions.

Example: Thousands of fish move together in a shoal, creating a powerful visual effect and protection from predators simply by their numbers.

c) Intraspecific competition:

This manifests itself in a variety of ways:

1. Territorial behaviour:

This behaviour consists of defending a certain area against intrusion by other members of the same species, which allows access to a greater quantity of resources and thus improves the chances of survival (in other words, it prevents the fragmentation of resources among several individuals).

Example: This behaviour is observed in insects such as dragonflies, and also in birds, which protect a territory whose size is determined by the amount of food it provides.

A study by Gill and Wolf in 1975 showed that a hummingbird can defend a territory ranging in size from 1 to 300 square metres, but always containing approximately 1,600 flowers. These findings enabled scientists to develop a theory known as "optimal feeding territory size". In summary, this theory states that the size of the defended territory represents the best compromise between the energy cost of protection and the gain offered by the resources present in that territory.

2. Agonistic behaviour:

This is aggressive behaviour by an individual towards its fellow creatures, which may occur in relation to access to food, shelter or when searching for a sexual partner. It is a kind of duel in which one individual chases another.

Example: It is very common among mammals such as deer.

3. Intraspecific competition for food:

This type of competition increases with population density and its most frequent consequence is a decline in population growth rates. This decline can manifest itself.

For example, with a decrease in the number of pregnant females in deer, or an increase in the age of sexual maturity in elephants, as well as a decrease in the number of offspring per pair of great tits.

4. Interspecific competition:

As a general rule, it occurs most often between neigh bouring species belonging to the same trophic level, but it can also occur between very distant species. It has been reported between birds and fish, between hummingbirds, butterflies, and bees, and between ants and seed-eating rodents.

General summary of the tutorial

Category	Subcategory	Details
Abiotic factors	Climatic factors	Light (solar radiation)
		Temperature
		Water
		Air
		Precipitation
		Humidity
		Atmospheric pressure
	Soil factors	Soil structure
		Grain size
	Chemical factors	Salinity
		Soil and water pH
		Essential nutrients (nitrogen, phosphorus, potassium)
		Minerals and trace elements (calcium, magnesium, sulphates)
		Oxygen dissolved in water
		Humus and organic matter in the soil
		Composition of atmospheric gases (O_2, CO_2, N_2)
		Chemical pollutants (heavy metals, pesticides, SO_2, NOx)
	Topographical factors	Altitude
		Slope
		Slope orientation
		Erosion
		Terrain roughness
		Landscape fragmentation
Biotic factors	Physico-chemical	Mechanical influence
		Climatic influence
		Chemical influence
	Interspecific	Symbiosis (+; +)
		Mutualism (+; +)
		Commensalism (+; 0)
		Amensalism (–; 0)
		Parasitism (+; -)
		Competition (–; –)
		Neutralism (0; 0)
	Intraspecific	Group effect
		Mass effect
		Intraspecific competition
		Territorial behaviour
		Agonistic behaviour
		Intraspecific competition for food
		Interspecific competition