

## **Chapter 6: The Main Continental Biocenoses of the Biosphere**

### **6.1 Introduction**

To understand the shape of the geographical ranges of plant and animal species, it is not sufficient to examine the distribution of water bodies and continents, nor to delineate climatic boundaries; it is also necessary to refer to the geological history of the planet. Geological stratification preserves the history of the appearance and disappearance of major groups of plants and animals and sometimes provides insight into the dominance of one group or another in the landscape. Many reasons justify the study of the distribution of living organisms. Indeed, the current distribution of terrestrial flora and fauna raises questions about their origin and about the common elements shared by territories that are sometimes separated by oceanic expanses or mountain barriers. Each territory possesses species that are unique to it and from which they originate. Some geographical areas host a greater number of species than others (for example, tropical versus polar environments). The distribution of species richness can therefore serve as a criterion for characterizing territories (Bougaham, 2017).

### **6.2 Review and Definitions**

The causes of the current distribution of organisms result from the influence, both past and present, of internal factors inherent to the organisms themselves and external factors related to their environment.

#### **6.2.1 Internal Factors**

The spatial extent of biocenoses initially depends on their intrinsic potential, linked to their genetic makeup, such as their dispersal capacities (ability to produce new individuals), their ecological amplitude (mutation, hybridization), and their evolutionary capacities.

#### **6.2.2 External Factors**

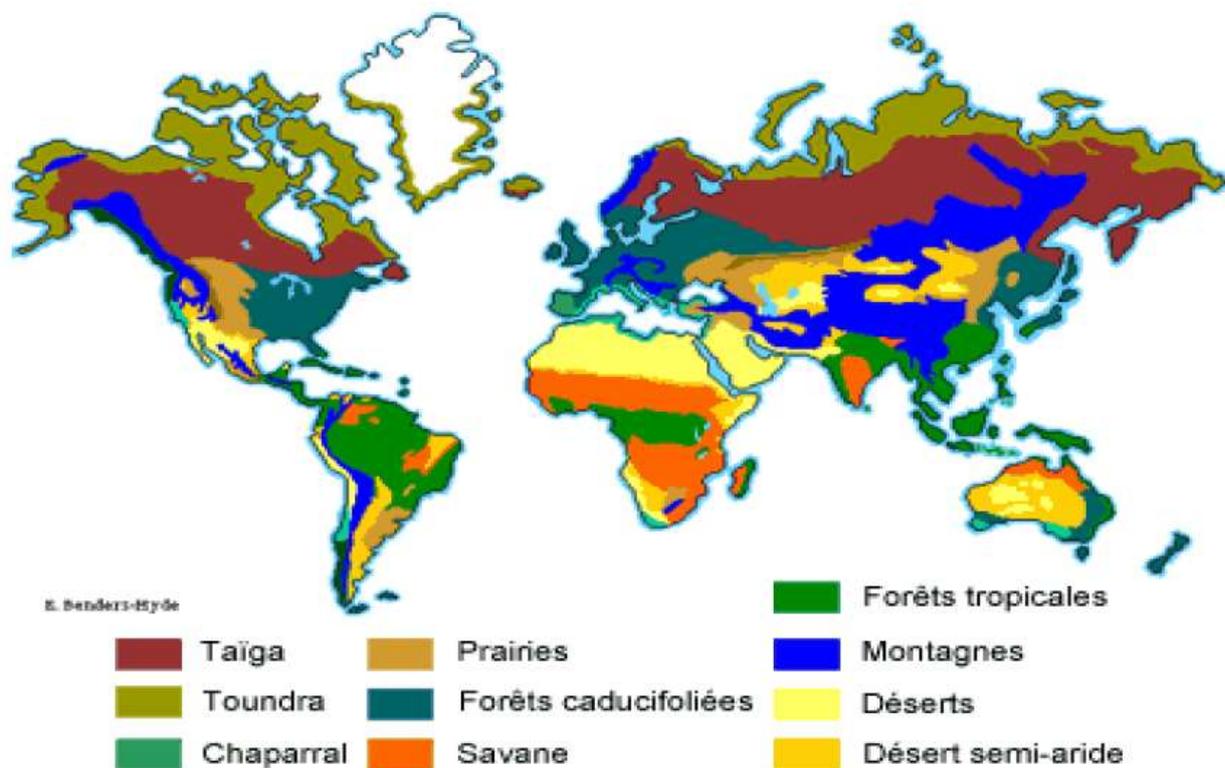
- a. **Abiotic factors** (geographical factors, climatic factors, geological or edaphic factors);
- b. **Biotic factors**, such as the emergence of parasites or predators, competition, as well as human intervention, which may be negative (destruction, fishing, deforestation, etc.) or positive (agriculture, livestock farming, etc.).

### 6.3 Definition of a Biome

A biome is a living community found over vast areas in continental environments. It therefore corresponds to the biocenosis characteristic of macrosystems. The concept of a biome is used mainly in terrestrial ecology. Terrestrial biomes are thus terrestrial ecosystems characteristic of large biogeographical regions that are subject to a particular climate and characterized by a specific biocenosis or climactic community.

The distribution of major vegetation formations, or biomes, is controlled by the macroclimate, as other factors rarely intervene at this scale. Biomes therefore often exhibit a zonal distribution in bands that are more or less parallel to the equator. This zonal distribution is more pronounced in the Northern Hemisphere than in the Southern Hemisphere, where the emerged land area is more limited.

In most cases, vegetation provides the essential features of the physiognomy of biomes, since animals have a much smaller biomass. For this reason, the broad outlines of the division of the globe into biomes are mainly established on the basis of vegetation studies (Fig. 6.1).



**Figure 6.1.** Les principales formations végétales du globe d'après E. Benders-Hyde  
<https://www.notre-planete.info/terre/biomes/>

#### **6.4 Characterization of the major biomes**

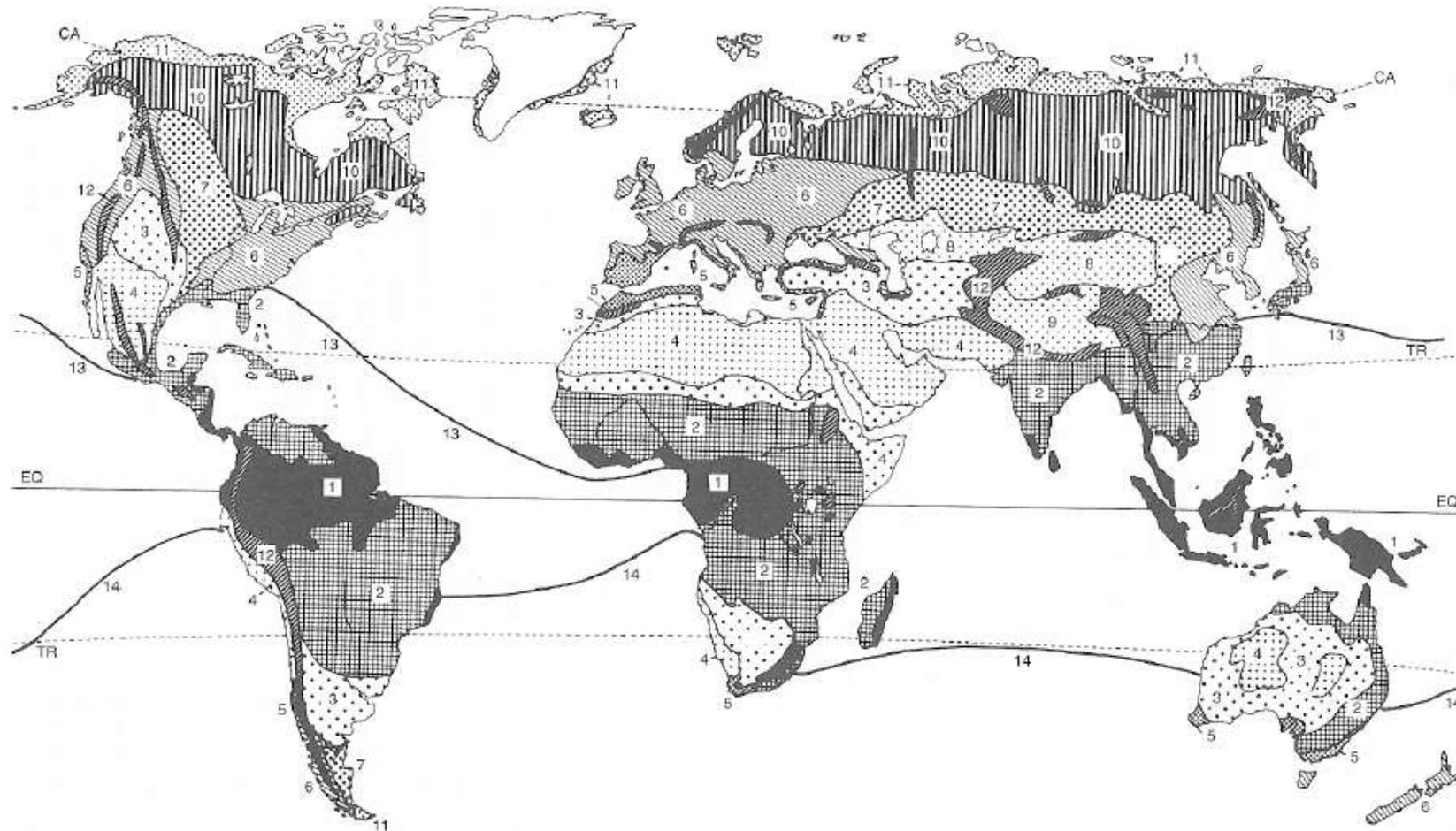
Terrestrial biomes are primarily characterized by their climate, particularly temperature and the amount of precipitation. Climate then determines the plant species that can colonize a given environment, thereby also influencing the animal species that can inhabit the same environment.

On the continents, numerous terrestrial biomes can be distinguished. Their number may vary depending on the criteria considered. However, it is generally recognized that terrestrial biomes can be grouped into seven major categories:

- tundra;
- taiga;
- temperate forest;
- temperate grassland;
- tropical savanna;
- desert;
- tropical rainforest.

There are two main types of continental biomes (Figure 6.2):

- **Forest biomes:** characterized by the dominance of trees and a more or less stable climate;
- **Non-forest biomes:** characterized by the dominance of the herbaceous layer, which may sometimes be almost absent.



**Figure 6.2.** Distribution of the major biomes. **1)** Equatorial rainforest. **2)** Tropophilous forests and humid savannas. **3)** Dry savannas and steppes. **4)** Tropical deserts. **5)** Mediterranean vegetation. **6)** Deciduous forests (nemoral phytocoenoses). **7)** Cold continental steppes. **8)** Central Asian cold deserts. **9)** High-altitude deserts. **10)** Boreal coniferous forest (taiga). **11)** Tundra. **12)** Mountain ecosystems (complex zonation). **13)** Northern limit. **14)** Southern limit of coral reefs (Ozenda, 2000).

## **6.4.1 Influence of Ecological Factors on the Zonation of Biocenoses**

### **6.4.1.1 Zonation of biogeocenoses and climate**

#### **A) Temperature**

**Vegetation zones:** At the global scale, the distribution of major biocenoses into zones more or less parallel to the equator is mainly due to latitudinal variations in the thermal factor (which, of course, correspond to changes in the overall set of climatic factors). Thus, in the Northern Hemisphere, along a meridian passing through Central Europe and Africa, for example, the following major types of formations succeed one another from north to south:

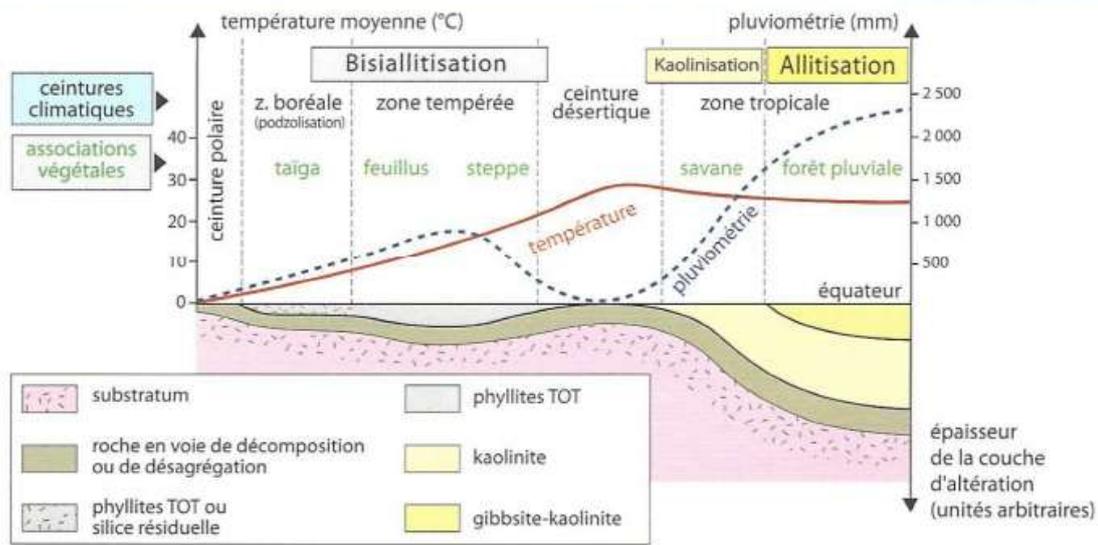
- Arctic tundra ;
- Subarctic taiga;
- Temperate mixed forest (broadleaved and coniferous trees);
- Temperate deciduous forest;
- Mediterranean evergreen forest;
- Steppe;
- Desert;
- Tropical dry forest and savanna;
- Tropical semi-deciduous forest;
- Equatorial evergreen forest.

Indeed, vegetation belts (Ozenda, 1975) clearly express the altitudinal zonation of vegetation in relation to bioclimatic levels. This pattern is modified depending on whether the setting is continental or, conversely, oceanic. Living organisms may respond differently to unfavorable thermal conditions through migration or burrowing, as in the case of invertebrates and reptiles. They may also develop specific adaptations to extreme temperatures.

Thus, to cope with cold conditions, biocenoses adopt a variety of mechanisms:

- development of fur or plumage;
- accumulation of fat layers;
- protection of vegetative buds by scales or hairs;
- reduction of energy requirements through dormancy in certain plants, invertebrates, and vertebrates (poikilotherms), or through hibernation in some mammals;

- acquisition of homeothermy, or the synthesis of electrolytes in the internal environment, leading to a lowering of the freezing point (e.g., Alaska pollock).

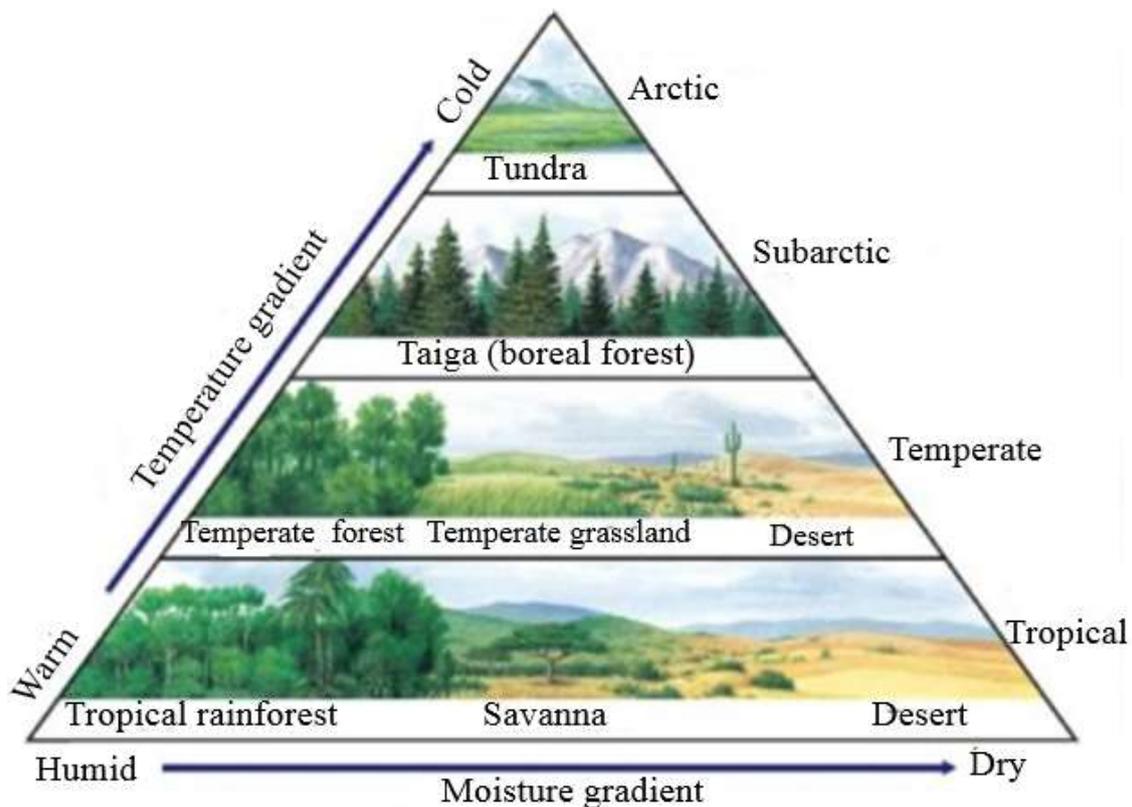


**Zonation des altérations (type et intensité) en fonction de la température et de la pluviométrie**

**Figure 6.3.** Climatic control of soil thickness and mineral composition (after Lagabrielle et al., 2013). Phyllites, kaolinite, gibbsite = clay minerals | Substratum: here refers to the parent rock.

## B) Precipitation

The amount of precipitation largely determines the distribution of biomes. There is a clear correspondence between overall rainfall and the productivity of major biocenoses. At a broad scale, the decreasing precipitation gradient from maritime regions toward the interior of large continental landmasses leads to a progressive transition from forest to savanna, grassland, semi-deserts (steppes), and deserts (Nassiri, 2018). Precipitation and temperature together determine the types of vegetation found in different environments.

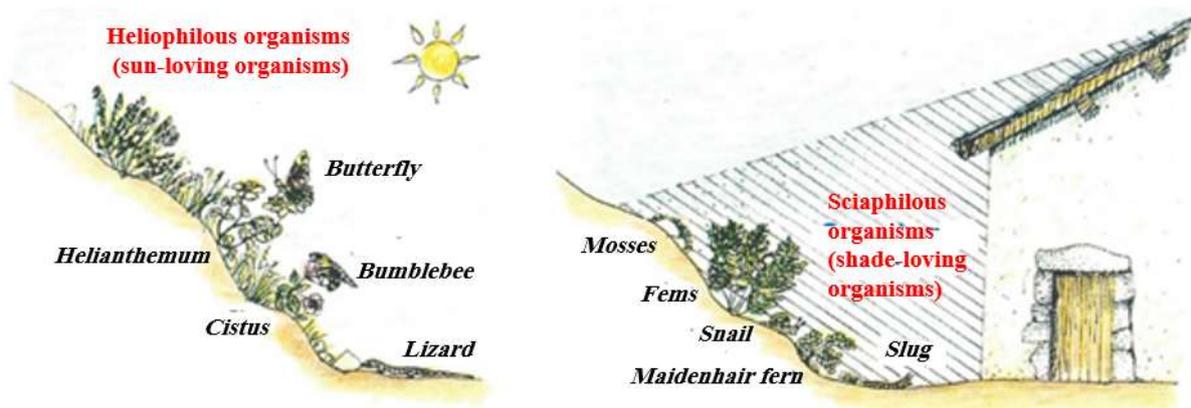


**Figure 6.4.** Whittaker biome diagram / Global distribution of major terrestrial biomes along gradients of temperature and moisture (Whittaker, 1975).

### C) Light

Light affects living organisms through its duration (photoperiod), intensity, and the quality of its radiation. Light availability depends on latitude and altitude, as well as on season, cloud cover, and vegetation canopy cover. Light has physiological effects on both distinguished as light-demanding or heliophilous (such as rosemary and *Helianthemum*), and shade-tolerant or sciaphilous species (*Oxalis acetosella*, many mosses and ferns, etc.). The former reach their optimum in heliophilous communities (single-layered formations such as grasslands, garrigue, and heathlands), as well as in clearings or open forests. The latter occur mainly in the lower strata of various plant communities. However, all intermediate forms between these two extreme types of ecological behavior also exist. animals and plants, and ethological (behavioral) effects on animals. Light cycles, including day–night (nycthemeral or circadian) rhythms and seasonal rhythms, induce periodic behaviors and adaptations to different natural periodicities, under the control of hormonal processes in both plants and animals.

According to the light intensity required for their development, species can be



**Figure 6.5.** A change in a biocenosis on a slope, resulting from the modification of a microclimate caused by a construction (after Fischesser and Dupuis-Tate, 2007).

#### 6.4.1.2 Zonation of biogeocenoses and altitude

Latitude is not the only factor that determines the different climates; altitude also plays an important role in the distribution of biocenoses. Indeed, climatic factors change as one ascends a mountain (atmospheric pressure, UV radiation, temperature, precipitation, etc.), and the seasons are less clearly marked. In contrast, thermal fluctuations between day and night are much more pronounced. Mountain climates give rise to altitudinal belts of vegetation (beech–fir forests, coniferous forests, krummholz/subalpine scrub, alpine grasslands, etc.), depending on the tolerance and robustness of species. Vegetation becomes more stunted, but flowers often display vivid colors.

In the animal kingdom, for example among fish, an altitudinal (longitudinal) zonation also exists, with successive zones such as the bream zone, barbel zone, grayling zone, and trout zone.

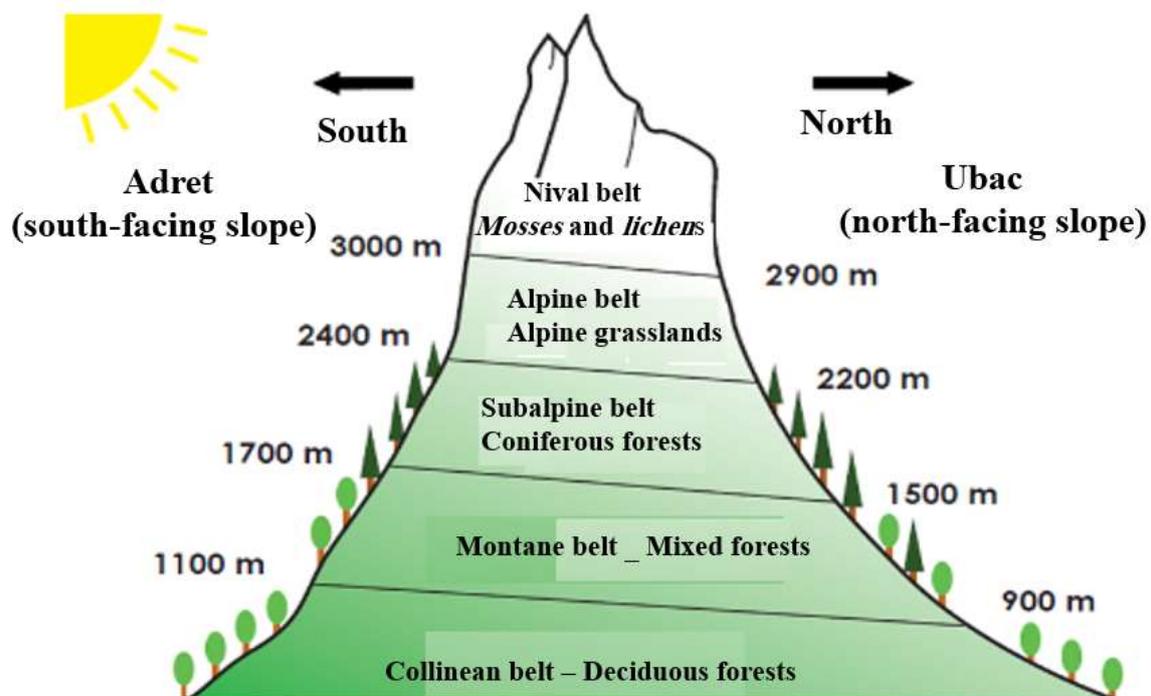
Altitudinal zonation is often even more clearly defined than latitudinal divisions. There is a strong correspondence between the distribution of biomes along altitudinal gradients and their distribution along latitudinal gradients.

The oceanic domain extends from the deepest trenches (approximately 11,000 m) to the surface of the seas. Its average depth is about 3,800 m. Within this domain, a neritic province is distinguished at the level of the continental shelf, which is limited at around 200 m by the

continental slope. Beyond this lies the oceanic province, poorer in nutrients, which occupies about nine-tenths of the total surface area of the oceans.

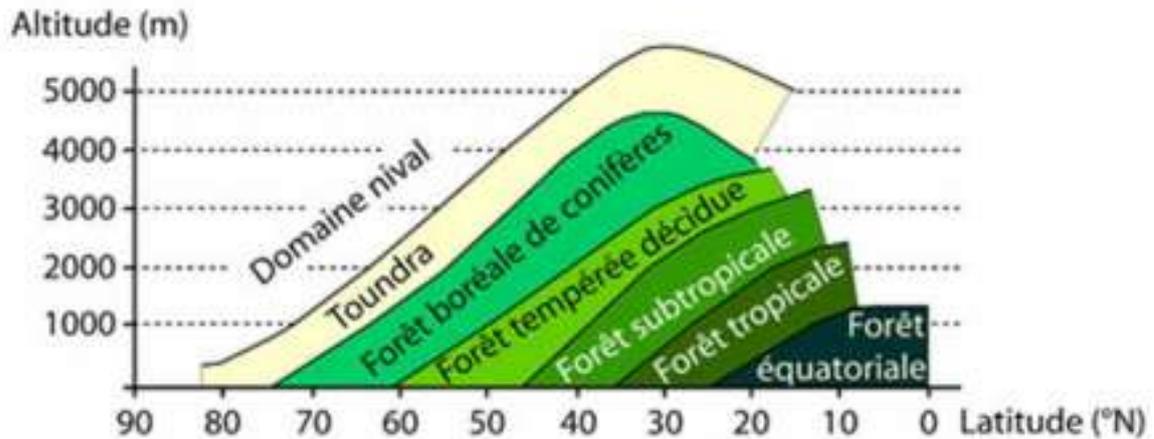
We also distinguish the euphotic zone and the dysphotic zone, the boundary between them being located at approximately 100 m depth in unpolluted open waters. Only this superficial layer allows primary production in aquatic environments. Its thickness is even more limited in lakes.

In terrestrial environments, vertical zonation is very clearly expressed and closely resembles the latitudinal distribution of the major biomes. The vertical extent of the biosphere is greatest in tropical and equatorial regions.



**Figure 6.6.** Altitudinal zonation of vegetation according to slope exposure (adret vs. ubac).

(Troll, 1956).



**Figure 6.7.** Succession of vegetation along a transect in the Northern Hemisphere

(modified after Troll, 1956).

The upper limit of chlorophyll-bearing vegetation is located at around 6,000 m above sea level. Beyond this altitude lies the nival or aeolian zone, which is only occasionally frequented by a few mountaineers and migratory birds (such as geese and cranes).

The upper limit of permanent human habitation is found in the Andes, within alpine grasslands at about 5,200 m in altitude (mountain tundra).

The upper limit of forests is situated around 4,500 m, but in reality; forests rarely exceed 4,000 m, even in equatorial regions.

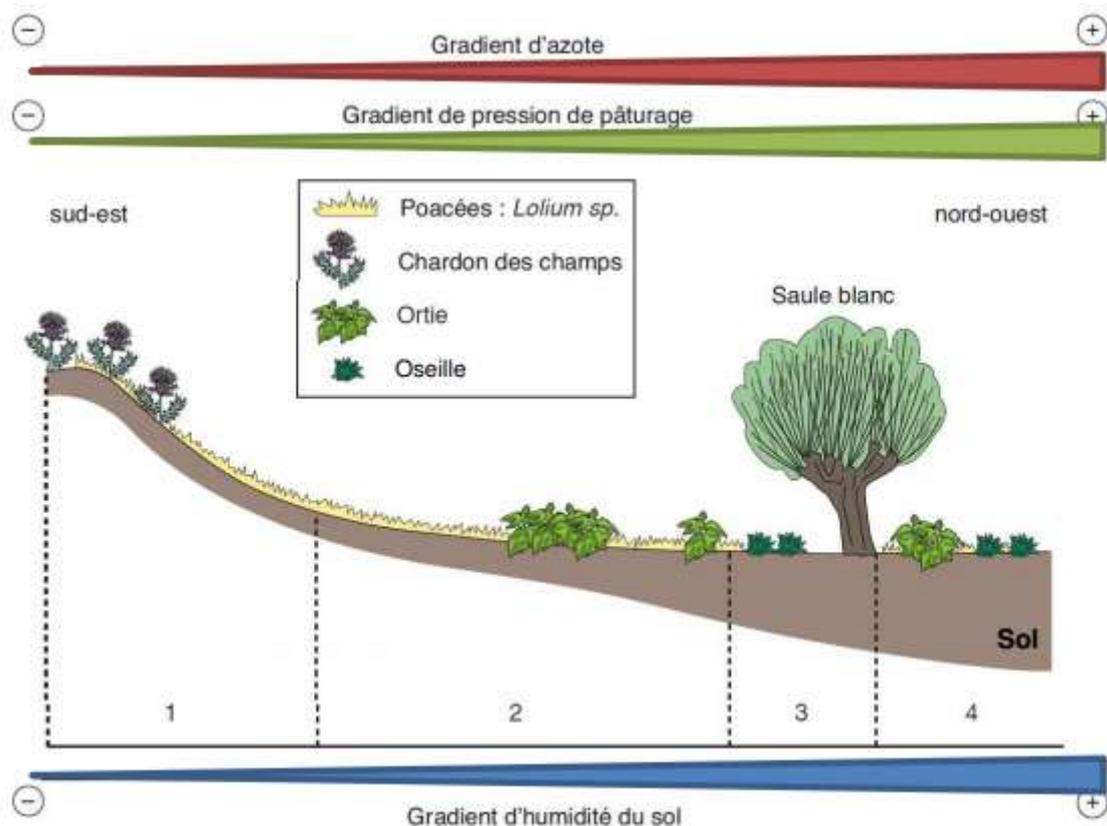
Agricultural activities are scarcely possible above 4,500 m, even under tropical conditions. The average altitude of the continents (875 m) corresponds to the zone of optimal development for forests, grasslands, and cultivated lands.

#### 6.4.1.3 Zonation of biogeocenoses and soil types

Soils are one of the essential components of ecosystems. They play a major role in climate regulation and in the cycling of organic matter and nutrients. The zonation of biocenoses is closely linked to the physical and chemical characteristics of soils. Among edaphic factors, those that play the most important role in determining plant communities include soil moisture content and the concentration of certain ions, such as calcium.

### a) Soil moisture content

Its influence on the distribution of living organisms can be illustrated by the zonation of vegetation around ponds, wetlands, and lakes. Along a decreasing moisture gradient from open water toward inland areas, plant communities are distributed according to their degree of hygrophily, forming more or less concentric belts. Their composition depends on water depth along the shore, the chemical composition of the water (mineral salts, organic matter, acidity), fluctuations in water level (duration of exposure periods), and the nature of the substrate.



**Figure 6.8.** Horizontal zonation of a moderately grazed grassland: relationships with selected abiotic and biotic factors (after Segarra et al., 2015).

### b) Mineral nutrient content

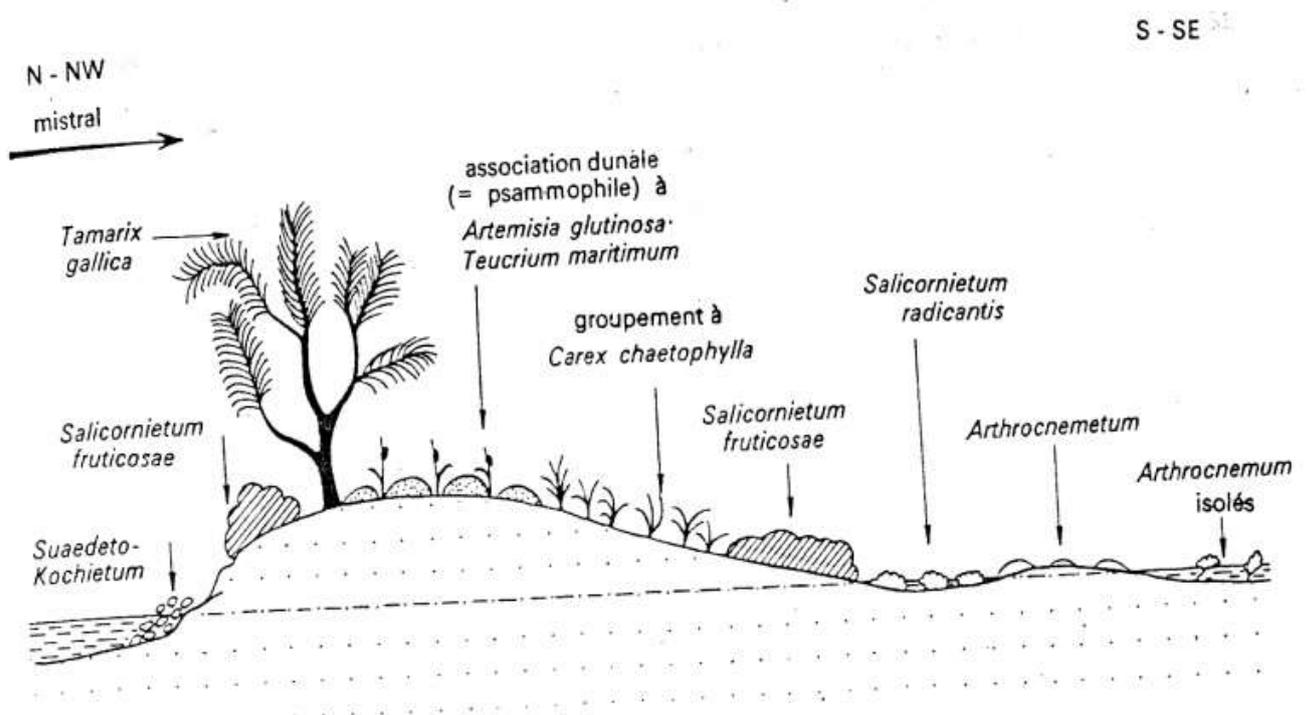
#### o Calcium:

Calcium plays an essential role in the mineral nutrition of plants. It should be noted that the response of plant communities to this element is highly variable. Thus, many species known as **calcicoles** develop on soils where calcium is abundant (e.g. *Lavandula latifolia*), whereas others, known as **calcifuges**, do not tolerate high concentrations of this element, such as

blueberry (*Vaccinium myrtillus*). Other species appear to be indifferent to calcium content. There is a close relationship between the calcium content of a soil and its degree of acidity. In principle, soil acidity increases as the  $\text{Ca}^{2+}$  ion becomes less abundant. Consequently, calcicole plants are generally also **neutrophilous** or **basiphilous** (e.g. dandelion), whereas calcifuge plants are **acidophilous** (e.g. heather, *Calluna*).

○ **Sodium:**

Saline soils are unsuitable for the majority of plant species. These environments are colonized by a very specific flora composed of halophytes, whose most characteristic representatives, generally with fleshy tissues, belong to the family Chenopodiaceae (e.g. *Salicornia*, *Salsola*, *Suaeda*, *Atriplex*). As with water availability, it is possible to observe around coastal lagoons or continental saline depressions a zonation of different halophytic plant communities (e.g. *Salicornia* spp.).



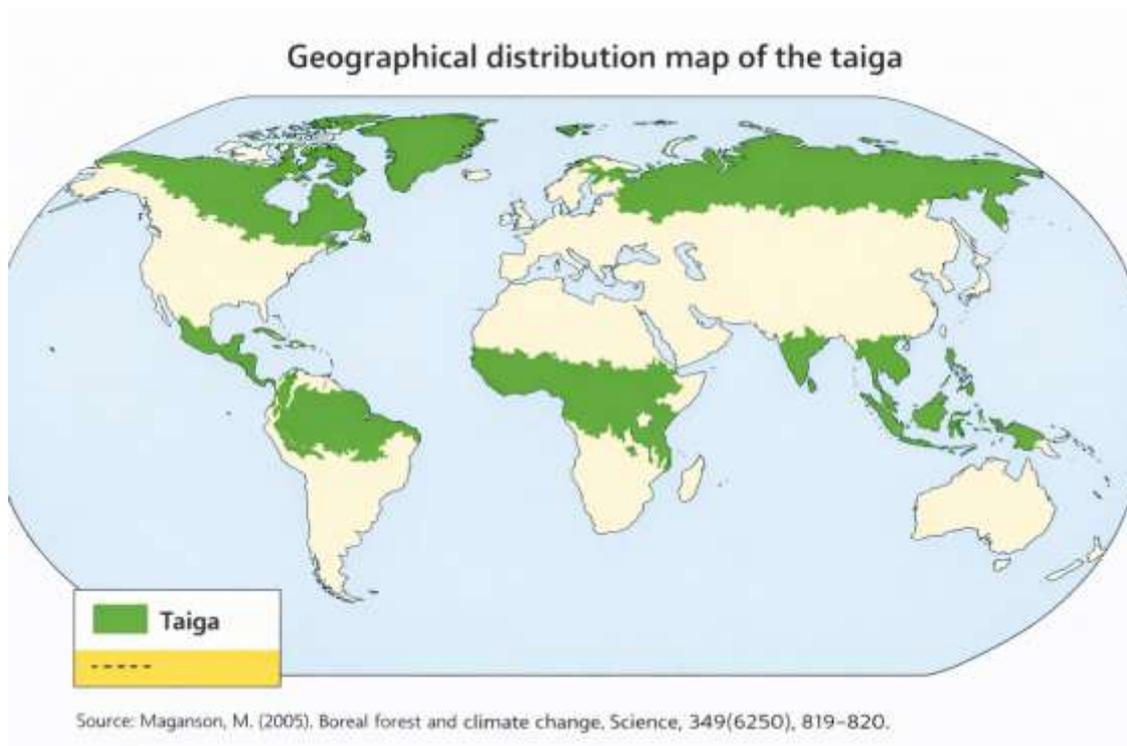
**Figure 6.9.** Example of zonation of plant communities according to soil salinity around a *radeau* (emerged surface in a brackish lagoon) in the Camargue (after Molinier).

## 6.4.2 Ecological characteristics of biomes (Forested and Non-Forested)

### 6.4.2.1 Forest biomes

#### 6.4.2.1.1 Boreal coniferous forest (Taiga)

The taiga occurs in regions with long, very cold winters and moderate to high precipitation. During the long winters, the taiga is covered by a snow mantle. It extends across Eurasia over about 6,000 km from east to west, from eastern Siberia to Scandinavia, passing through northern Russia. In Canada, the equivalent of the taiga is the Hudsonian forest, which extends over approximately 3,500 km, from Alaska to Quebec.



**Figure 6.10.** Geographical distribution of the taiga

The forest cover, whose composition is similar to that of the boreal forest, is continuous but relatively open. The boreal forest is composed mainly of conifers (pines, firs, spruces, larches) associated with deciduous trees (birches, alders). The landscape is interspersed with peat bogs. The taiga borders the tundra, which is found farther north.

The subarctic climate is characterized by short, cool summers with prolonged periods of daylight and very cold winters. Average temperatures in the warmest month range between 10

and 15 °C, while average winter minima may fall below -30 °C. Annual precipitation is generally less than 500 millimeters.

The soil of the taiga is podzol, a leached soil typical of cold and humid climates. It has an ashy consistency (podzol means “ash”).

Animals living in the taiga are adapted to cold conditions, such as the lynx, moose, wolf, reindeer, beaver, and marten. The hare living in the taiga has a coat that changes color in winter (dark in summer, light in winter). Many birds migrate to the taiga to spend the summer there.

**Particular feature:** the largest terrestrial biome.

#### **6.4.2.1.2 Temperate forests proper**

##### **A) Deciduous forests**

These forests characterize the mid-latitude regions of the Northern Hemisphere.

- **European deciduous forests:** They range between 57° and 43° north latitude in Western Europe, then extend through central and eastern Europe. The climate is moderate, with relatively abundant precipitation. The soils are brown soils with active humus, of the mull or mull-moder type. The tree layer is less dense than that of the boreal forest, whereas the flora of the lower strata is generally richer and more diversified. These forests are mainly beech forests and oak forests.
- **Deciduous forests of America and Asia:** They are often considered homologous to European deciduous forests, with a predominance of the same genera, but with a much higher species diversity. They form a vast transcontinental biome made up of large forests of deciduous trees, i.e., trees that shed their leaves during the winter season.

##### **B) Mixed forests**

This is the most widespread biome on Earth. The mixed forest is also called the temperate forest. Temperate forests are found in Europe, Asia, and America. They are composed mainly of deciduous broadleaf trees. Mixed forests are also referred to as temperate deciduous forests. The deciduous forest experiences four distinct seasons: summer, autumn, spring, and winter. It is characterized by:

- the alternation of seasons: spring, summer, autumn, and winter;
- deciduous trees;

- mild and temperate temperatures;
- sufficient and regular precipitation;
- rich and fertile soils due to leaf fall.

The herbaceous richness of the understory is notable. The temperate forest is vertically structured regardless of its geographic location. From the ground upward, the following layers are found:

- mosses;
- herbaceous plants and bulbous species;
- bushes and shrubs;
- shade-tolerant trees;
- tall canopy trees.

- **Coniferous rainforest**

This is a forest belonging to the group of evergreen humid forests. Tropical rainforests depend on warm climates with permanent humidity. The term *rainforest* is also (improperly) used to designate this type of forest. In its overall physiognomy, this formation resembles the boreal coniferous forest, but it is more luxuriant (with the presence of numerous epiphytes) and richer in the herbaceous and shrub layers.

#### 6.4.2.1.3 Tropical forest

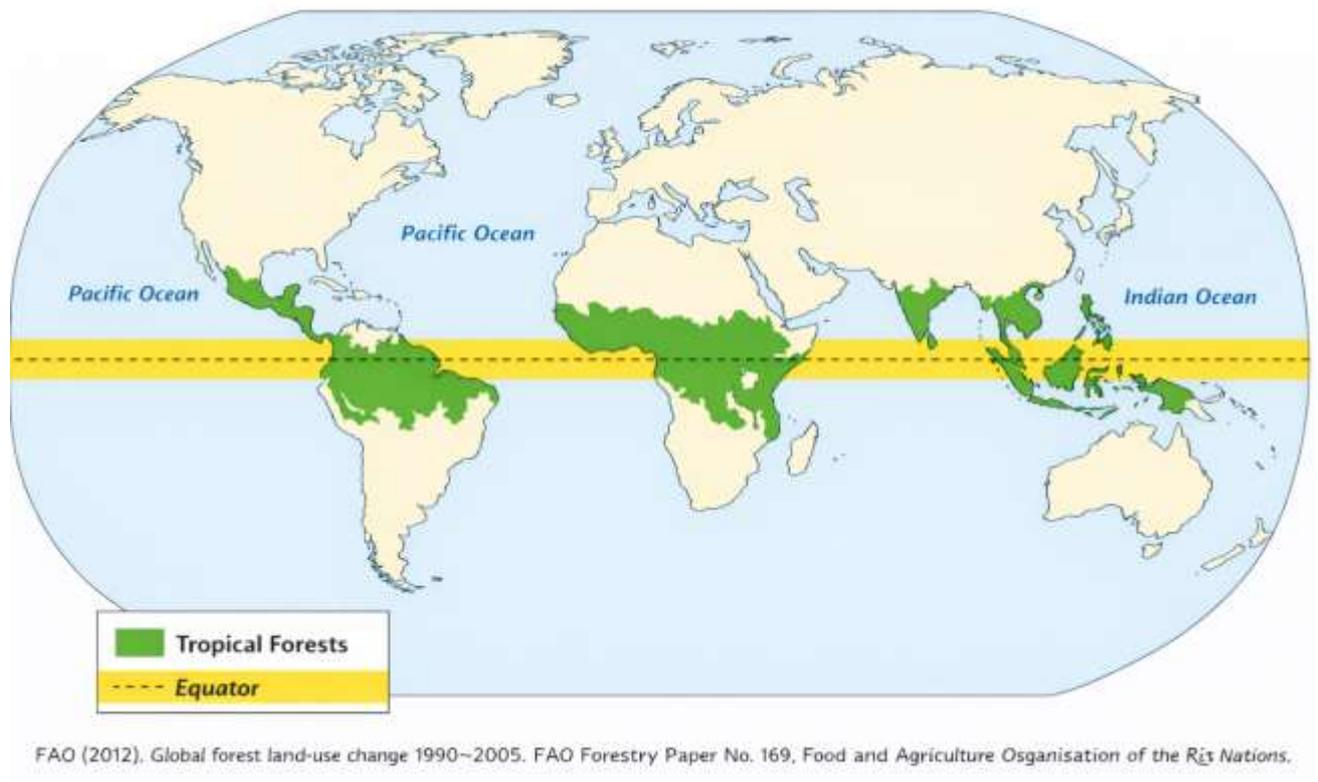
**Geographical distribution:** Extends near the equator, within the intertropical zone; tropical forests of the Amazon and French Guiana in South America, major tropical forests in Southeast Asia and equatorial Africa.

**Climate:** warm and stable temperatures (on average 25-30 °C) throughout the year, with abundant precipitation.

**Vegetation:** very strong competition for light among plants; dense, multilayered vegetation (orchids, epiphytes, lianas, trees, etc.).

**Animals:** numerous insects; reptiles (snakes, lizards); amphibians (frogs); mammals (sloths, tapirs, peccaries, monkeys, pumas, tigers); and a great diversity of birds (hummingbirds, parrots, toucans).

**Distinctive feature:** harbors the greatest diversity of plant and animal species on the planet, accounting for more than half of all known species; biodiversity is so high that up to 150 different tree species can be recorded per square kilometer of forest.



**Figure 6.11.** Geographical distribution of tropical forests

#### 6.4.2.1.4 Forests of the warm temperate region

##### A) Mediterranean Regions

These correspond to warm temperate zones, and these particular climatic conditions affect the biological characteristics of many plant species. Two major types of primitive forest macroecosystems characterized the Mediterranean Basin before human intervention:

- Evergreen oak forests;
- Mixed forests of carob and olive trees.

Under the influence of logging and fire, the primary forest was replaced by a secondary forest of Aleppo pine and maritime pine. Two degraded shrub formations subsequently developed:

**Maquis:**

It is composed of low vegetation and heat-adapted trees such as pine or cork oak.

**Characteristics of Mediterranean maquis:**

The low vegetation of the maquis mainly includes laurels, strawberry trees, shrub heathers, junipers, small shrubs such as thyme and rosemary, lentisks, and myrtles. Trees found in the maquis or Mediterranean forests include olive trees, cork oak, conifers, and eucalyptus. Mediterranean conifers are large and highly varied:

- Maritime pine
- Stone pine
- Aleppo pine
- Laricio pine
- Cedars

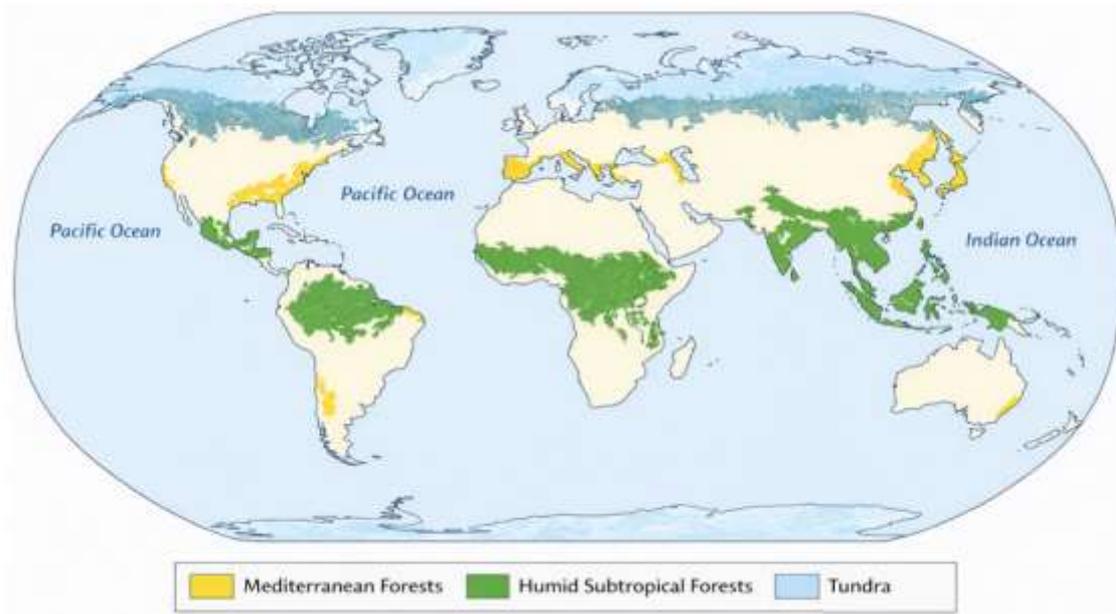
The Mediterranean forest is actually a degraded forest, which is why the term *maquis* is often used rather than forest.

**Garrigue:**

A lower and more open formation on calcareous or marly substrates, rich in nanophanerophytes (rosemary, lavender) and chamaephytes, frequently associated with Kermes oak.

**B) Forests of humid subtropical regions**

These are mainly located on the southeastern coasts of Asia and North America. These regions are more favorable for vegetation due to the absence of a dry season and high rainfall. They are rich in evergreen species with leathery and waxy leaves, which are usually large and oval.



**Figure 6.12.** Geographical distribution of Mediterranean forests, humid subtropical forests, and tundra (Maganson, 2005).

Source: Maganson, M. (2005). Boreal forest and climate change, *Science*, 349(6250), 819–820.

## 6.4.2.2 Non-forest biomes

### 6.4.2.2.1 Tundras

**Geographical distribution:** a broad belt around the Arctic circle covering more than eight million square kilometers (approximately 6% of Earth's land area).

**Climate:** very cold temperatures slow down plant growth and the decomposition of organic matter.

**Animals:** cold-adapted species (musk oxen, Arctic foxes, polar bears, etc.), as well as numerous migratory animals that visit for breeding (caribou, snowy owls, snow geese, etc.).

**Vegetation:** grows on permafrost and is covered by snow for nearly 11 months of the year, including mosses, lichens, grasses, and dwarf shrubs.



**Figure 6.13.** Situation géographique de la toundra (Katpatuka, 2006)

### **Arctic Tundra**

The Arctic tundra corresponds to the biome of the highest latitudes, with a short growing season during which temperatures remain low, resulting in a very cold climate and short winter days. Despite its limited flora, tundra vegetation is relatively diverse, and two main types can be distinguished:

- **Herbaceous Tundra:** Representative of the northernmost regions, it consists of more or less sparse grasslands dominated by grasses, sedges, and rushes, and is particularly rich in mosses and especially lichens.
- **Shrubby Tundra:** Its development gradually increases toward lower latitudes and is characterized by bands of dwarf shrubs (*chamaephytes*). The animal population is also limited due to harsh winter conditions, with the exception of insects. Among mammals, adaptation to the cold is ensured by fat deposits, fur, and other protective features.

#### 6.4.2.2 Steppes

Steppes are characterized by harsh winters, hot summers, and generally a dry period with low precipitation (300–500 mm). Vegetation is primarily herbaceous, dominated by perennial grasses, with a minor contribution of woody plants. Species diversity is relatively high, including many dicotyledons and various monocotyledons, which join the more xerophilous grass taxa.

##### A) In Eurasia (from north to south according to latitude):

- **Arboreal steppe:** Rich in legumes, particularly clovers, dominated by rather mesophilic grasses.
- **Herbaceous steppe:** Tall and dense, often with shrubs; among the grasses, various *Stipa* species are added to forage grasses. Vernal-flowering dicotyledons are abundant (sage, astragalus).
- **Dry southern steppe:** More sparse when precipitation drops below approximately 300 mm. The xeric grass component (very rich in *Stipa*) is associated with chamaephytes, such as various *Artemisia* species.

##### B) In North America:

These formations are broadly analogous to the Eurasian steppes but are more commonly called **prairies**. Due to gradual climatic variations, the following can be distinguished:

- **Tallgrass prairie:** In the wetter eastern sector, formed by tall grasses; cereal cultivation has profoundly altered this area.
- **Mixed prairie:** In the central band, a transitional formation with medium-height grasses (*Stipa*, *Koeleria*) or already shorter species.

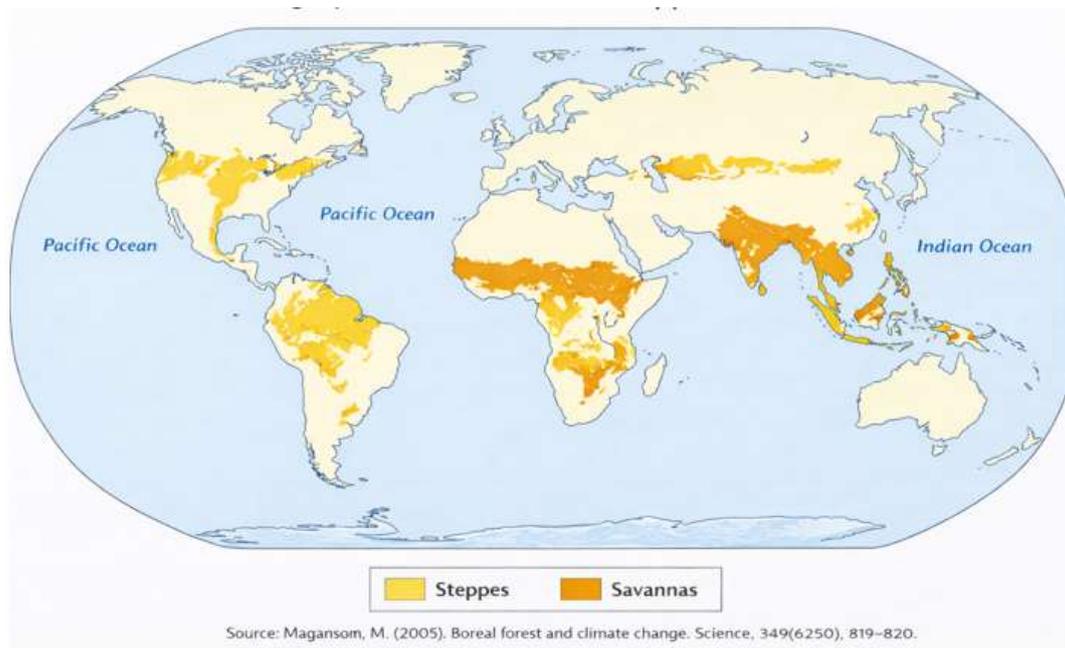
##### C) Steppes of the warm temperate zone

Very similar to North American prairies. Depending on precipitation, two types exist:

- **Tallgrass prairie:** Very rich and diverse grass flora.
- **Shortgrass prairie:** Dominated by *Stipa*.

### 6.4.2.2.3 Savannas

Savannas extend between the two tropics (South America, Africa, India, and northern Australia), wherever rainfall is insufficient to support forest ecosystems. A pronounced dry season occurs (at least 4 months). They are characterized by a generally dense herbaceous layer, predominantly tall perennial grasses, though there are also shrub and tree savannas. These latter types differ in their layer of mesophanerophytes, which is lower but denser in shrub savannas and more open in tree savannas.



**Figure 6.13.** Geographical distribution of steppes and savannas (Maganson, 2005).

- **Geographical distribution:** Vast semi-arid plains located in the intertropical zone, in Africa, Central America, and Australia.
- **Climate:** Highly variable rainfall throughout the year, with a rainy season and a dry season.
- **Vegetation:** Scattered trees and shrubs (acacias, baobabs, eucalyptus, etc.).
- **Animals:** Diverse fauna (ostriches, antelopes, giraffes, lions, hyenas, etc.); some species migrate to other areas during dry periods.

#### 6.4.2.2.4 Deserts

Deserts are the driest terrestrial biomes. They cover very large areas, representing nearly one third of the Earth's land surface, and occur at all latitudes.

Precipitation is low and irregular; rainfall events may occur abruptly, causing sudden flooding of wadis. Deserts receive a large amount of heat during the day but lose it rapidly at night. Seasonal temperature variations make it possible to distinguish **hot deserts**, characterized by extremely hot summers and mild winters, from **cold deserts**, which experience hot summers and cold winters.

Aridity, strong thermal contrasts, and wind, which increases dryness, make these environments particularly harsh for the emergence and development of living organisms. Consequently, vegetation cover is very sparse and discontinuous, often occurring only in isolated patches, when it is not completely absent. Over vast areas, bedrock is exposed, regardless of its nature.



**Figure 6.14.** On the right: **Sand dune desert** (Death Valley, USA) (Wikimedia Commons, 2005); On the left: **Rock desert** (Mauritania) (Ji-Elle, 2010).

- **Geographical distribution**

Large **hot deserts** are mainly located in the tropical belt (e.g. the Sahara in Africa and the Great Sandy Desert in Australia). **Cold desert regions** are found north and south of the intertropical zone (e.g. the Gobi Desert in Asia and the Mojave Desert in the United States).

- **Climate**

Very strong daily temperature contrasts, with extremely hot days and very cold nights; precipitation is very scarce.

- **Vegetation**

Vegetation is adapted to drought and is scattered according to water availability, wind intensity, and soil type. It is generally low-growing, with very deep and well-developed root systems, reduced leaves or leaves transformed into spines, and fleshy stems used for water storage (cacti, yuccas, etc.).

- **Animals**

Fauna is adapted to desert conditions through light-colored skin or fur and nocturnal or burrowing lifestyles (scorpions, insects, lizards, snakes, running birds, rodents, camels, antelopes, etc.).

- **Particularity**

An arid environment where the presence of living organisms is limited due to poor soils and the lack of precipitation.

### Examples from the Sahara Desert

- **Sand dunes (ergs):** colonized by vigorous grasses with long rhizomes (*Stipa tenacissima*, *Aristida pungens*), sometimes accompanied by shrubs (*Ephedra alata*);
- **Stony plateaus (regs):** dominated by *Haloxylon scoparium* (shrubby Chenopodiaceae) and small annual grasses (*Aristida pungens*);
- **Clay–sandy depressions (dayas):** retaining some moisture and able to support large tree specimens (*Pistacia atlantica*) as well as jujube trees (*Ziziphus lotus*);
- **Wadi beds:** characterized by tall tufts of perennial grasses (*Panicum turgidum*) and numerous woody species (*Acacia*, *Tamarix*);
- **Salt depressions (sebkhas):** dominated by various Chenopodiaceae (*Atriplex halimus*, *Salsola*, etc.).

**Conclusion**

Vegetation is generally organized in a zonal pattern, although some plant formations are linked to specific natural conditions and are therefore azonal. However, classifying biomes remains a difficult exercise, and the map proposed by Pech and Regnauld only partially addresses this complexity. By grouping the entire globe into a limited number of biomes, it provides a general overview of global organization. Nevertheless, it remains imprecise, as it brings together very different realities under the same label, such as savanna and prairie grouped into a single “dry biome.” Some terms are also vague, such as “forests with hibernating animals.” Moreover, several so-called “biomes” are not biomes in the strict sense: by definition, a biome corresponds to “a vast bioclimatic area,” which is not the case for mountains (scattered across the globe and highly heterogeneous internally and among themselves) nor for deserts (also heterogeneous and discontinuous, although some, such as the Sahara, are extensive and relatively homogeneous). While this typology is synthetic and easy to understand, it should not be considered sufficient on its own (Carlesso & Galland, 2010).