

# **BIO 308**



Biogeography Module 1

# BIO 308 (Biogeography) Module I

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# Unit I Fundamentals of Biogeography and Ecosystem

#### 1.0 Introduction

In this unit, the concept of biogeography will be explained. This will include the definition and the aims and objectives of the study of biogeography. Some historical developments in the study of biogeography will also be explained.

# 2.0 Objectives

At the end of this unit, you should be able to:

- explain the concept of biogeography
- outline the aim and the objectives of the study of biogeography.

#### 3.0 Main Content

#### 3. I Definition of Biogeography

Biogeography is the study of the distribution of plants and animals throughout the world. From this, it is known that each of the continents has its own distinctive fauna and flora. In Africa, for example, we find rhinoceroses, hippopotamuses, lions, hyenas, giraffes, zebras, chimpanzees and gorillas. South America has none of these. Instead, it is home to pumas, jaguars, raccoons, opossums and armadillos. Marsupials are found in Australia and South America, but not in Europe. Such observations have led biogeographers to divide the world into six main faunal regions.

Similarly, six main floral regions have been identified. Evolutionists claim that the most reasonable explanation for these biogeographic distributions is that the different animals and plants evolved separately, from ancestors that colonized different areas of the world thousands or millions of years ago. Further evidence for this is argued from the study of island biogeography. For example, of the 1,500 known species of fruit flies (*Drosophila*); nearly one third of them live on the Hawaiian Islands. These islands are also home to more than 1,000 species of snails and other land molluscs that are not found anywhere else.

In fact, some biogeographic observations are extremely difficult to explain within an evolutionary framework.

Biogeography is a branch of geography that studies the past and present distribution of the world's many species. It is usually considered to be a part of physical geography as it often relates to the examination of the physical environment and how it affects species and shaped their distribution across space. As such it studies the world's biomes and taxonomy - the naming of species.

In addition, biogeography has strong ties to biology, ecology, evolution studies, climatology, and soil science.

Biogeography is the study of the distribution of species (biology) spatially (geography) and temporally (history). Biogeography aims to reveal where organisms live, at what abundance, and why they are (or are not) found in a certain geographical area. It is important as a branch of geography that sheds light on the natural habitats around the world. It is also essential in understanding why species are in their present locations and in developing protecting the world's natural habitats. Biogeography is a synthetic science, related to geography, biology, soil science, geology, climatology, ecology and evolution.

#### 3.2 Historical Development of Biogeography

Edward O. Wilson, a prominent biologist and conservationist, co-authored "The Theory of Island Biogeography" and helped to start much of the research that has been done on this topic since the work of Watson and Wallace almost a century before.

The scientific theory of biogeography grows out of the work of Alexander von Humboldt (1769–1859), Hewett Cottrell Watson (1804–1881), Alfred Russel Wallace (1823–1913), and Philip LutleySclater (1829–1913) and other biologists and explorers.

Wallace studied the distribution of flora and fauna in the Amazon Basin and the Malay Archipelago in the mid-19th century. Wallace and Sclater saw biogeography as a source of support for the theory of evolution. Key findings, such as the sharp difference in fauna either side of the Wallace Line, can only be understood in this light. Otherwise, the field of biogeography would be seen as a purely descriptive one.

The publication of The Theory of Island Biogeography by Robert MacArthur and E.O. Wilson in 1967 showed that the species richness of an area could be predicted in terms of such factors as habitat area, immigration rate and extinction rate. This added to the long-standing interest in island biogeography. The application of island biogeography theory to habitat fragments spurred the development of the fields of conservation biology and landscape ecology.

Classic biogeography has been expanded by the development of molecular systematics, creating a new discipline known as phylogeography. This development allowed scientists to test theories about the origin and dispersal of populations, such as island endemics. For example, while classic biogeographers were able to speculate about the origins of species in the Hawaiian Islands, phylogeography allows them to test theories of relatedness between these populations and putative source populations in Asia and North America.

# 3.3 Types of Biogeography

Today, biogeography is broken into three main fields of study. The three fields are historical biogeography, ecological biogeography, and conservation biogeography. Each field, however, looks at phytogeography (the past and present distribution of plants) and zoogeography (the past and present distribution of animals).

Historical biogeography is called paleobiogeography and studies the past distributions of species. It looks at their evolutionary history and things like past climate change to determine why a certain species may have developed in a particular area. For example, the historical approach would say there are more species in the tropics than at high latitudes because the tropics experienced less severe climate change during glacial periods. This led to fewer extinctions and more stable populations over time.

The branch of historical biogeography is called paleobiogeography because it often includes paleogeographic ideas- most notably plate tectonics. This type of research uses fossils to show the movement of species across space via moving continental plates. Paleobiogeography also takes varying climate as a result of the physical land being in different places into account for the presence of different plants and animals.

Ecological biogeography looks at the current factors responsible for the distribution of plants and animals. The most common fields of research within ecological biogeography are climatic equability, primary productivity, and habitat heterogeneity.

#### 4.0 Conclusion

Biogeography studies the distribution or the geographical location of organisms. It can be divided into phytogeography and zoogeography. Other branches/types include paleobiogeography and ecological biogeography

# 5.0 Summary

In this unit, you have learnt the:

- meaning of biogeography
- historical developments in biogeography
- branches and aim of the study of biogeography.

#### **6.0 Self-Assessment Exercise**

- 1. Describe the different types of biogeography.
- 2. Explain the importance of the study of biogeography.

# 7.0 Reference/Further Reading

Taggart, S. (2004). Biology: The Unity and Diversity of Life. (10thed). Belmont, CA: Thomson Brooks/Cole.

# Unit 2 Tropical and Temperate Flora

#### 1.0 Introduction

The nature of a region affects the type of plants and animals to be found in such region. The flora and the fauna in the tropic and temperate regions are considered in this unit. The unit begins with an overview of the tropical and temperate regions

# 2.0 Objectives

At the end of this unit, you should be able to:

- tell the parts of the world that make up the tropic and the temperate regions
- classify the types of plants and animals found in the tropical and temperate regions.

#### 3.0 Main Content

#### 3.1 Tropical and Temperate Regions

The tropic is a region of the earth surrounding the equator. It is limited in latitude by the Tropic of Cancer in the northern hemisphere at approximately 23° 26′ 16″ (or 23.4378°) N and the Tropic of Capricorn in the southern hemisphere at 23° 26′ 16″ (or 23.4378°) S. The tropics are also referred to as the tropical zone and the Torrid Zone. The tropics include all the areas on the Earth where the sun reaches a point directly overhead at least once during the solar year. About 40 percent of the world's human population lives within the tropical zone (by 2008 statistics), and by 2060, 60% of the human population will be in the tropics, owing to high birth rates and migration.

Some regions within the tropics may well not have a tropical climate. There are alpine tundra and snow-capped peaks, including Mauna Kea, Mount Kilimanjaro, and the Andes as far south as the northernmost parts of Chile and Argentina. In biogeography, the tropics are divided into Paleotropics (Africa, Asia and Australia) and Neotropics (Caribbean, Central America, and South America). Together, they are sometimes referred to as the Pantropics.

Temperate or tepid regions of the globe lie between the tropics and the polar circles. The changes in these regions between summer and winter are generally relatively moderate, rather than extreme hot or cold. However, in certain areas, such as Asia and central North America, the variations between summer and winter can be extreme because these areas are far away from the sea, causing them to have a Continental climate. In regions traditionally considered tropical, localities at high altitudes (e.g. parts of the Andes) may have a temperate climate.

The North Temperate Zone extends from the Tropic of Cancer (at about 23.5 degrees north latitude) to the Arctic Circle (at approximately 66.5 degrees north latitude). The South Temperate Zone extends from the Tropic of Capricorn (at approximately 23.5 degrees south latitude) to the Antarctic Circle (at approximately 66.5 degrees south latitude). Within these borders there are many climate types, which are generally grouped

into six categories: oceanic (maritime), Mediterranean, humid subtropical, continental, arid and semi-arid.

#### 3.2 Tropical and Temperate Flora

**Common characteristics of tropical trees:** Tropical plant species frequently possess one or more of the following attributes not seen in trees of higher latitudes.

**Buttresses:** many species have broad, woody flanges at the base of the trunk. Originally believed to help support the tree, now it is believed that the buttresses channel stem flow and it's dissolved nutrients to the roots.

**Large leaves** are common among trees of the C layer. Young individuals of trees destined for the B and A layers may also have large trees. When the reach the canopy new leaves will be smaller. The large leaf surface helps intercept light in the sun-dappled lower strata of the forest.

**Drip tips** facilitate drainage of precipitation off the leaf to promote transpiration. They occur in the lower layers and among the saplings of species of the emergent layer (A layer).

#### **Examples of Temperate Plants**

Dominant plants include trees like Maple (Acer spp.), Beech (Fagus spp.), Oak (Quercus spp.), Hickory (Carya spp.), Basswood (Tilia spp.), Cottonwood (Populus spp.), Elm (Ulmus spp.), and Willow (Salix spp.).

#### 3.3Differences between Tropical and Temperate Flora

The characteristics that distinguish tropical species of trees from those of temperate forests include:

- Exceptionally thin bark, often only 1-2 mm thick. Usually very smooth, although sometimes armed with spines or thorns.
- Cauliflory, the development of flowers (and hence fruits) directly from the trunk, rather than at the tips of branches.
- Large fleshy fruits attract birds, mammals, and even fish as dispersal agents.
- Often palms and tree seedlings poke up from a sparsely covered ground while convoluted vines weave their way from one tree trunk to another.
- Branches may be heavily weighed by birds nest ferns and orchids growing on them.

# 3.4 Tropical and Temperate Fauna

#### **Tropical Animals**

S/N	Animals	Features
I	Toucans	Their large, colourful beaks are almost half the size of their short bodies. They have small wings because they don't need to fly long distances. Toucans mostly eat fruits and their long beaks help them grab fruit in far to reach places. They build

		their nests inside hollow trees and the tropical climates give
		them the perfect tree house.
2	Red-Eyed Tree Frogs	Most frogs hop, but these frogs like walking or climbing in trees! These tree frogs live in areas near ponds, streams and rivers. They like to eat the insects mostly found in tropical climates
3	Orangutans:	These monkeys have taught themselves how to make hats and roofs out of leaves to protect themselves from the rain! They spend most of their time in the trees, they have feet like hands and very long arms that make it easy for them to travel through the trees by swinging from one to the other. Orangutans eat things like tropical fruit and insects
4	Gorillas:	They move around by walking on their knuckles. Like chimps, gorillas are very smart. When raised by humans, gorillas can learn sign language
5	Bengal Tigers:	These tigers are good swimmers and climb trees. There are lots of trees in the rainforest making it a great place for them to live. The beautiful orange and brown colours of their fur help them blend into the rainforest, allowing them to sneak up on their prey (food). Bengal Tigers eat so much during one meal that they can go a few days without having to eat again
6	Boa Constrictors	These huge snakes can grow longer than 10 feet! They are usually pinkish or tan in colour with dark bands. Boa constrictors are not poisonous, and they eat small animals like bats and lizards
7	Chimpanzees	They are the closest living relatives to people! Chimpanzees are very smart, and sometimes make hunting tools out of twigs or sticks. Chimps eat plants and small animals. They spend a lot of time on the ground, but usually sleep in nests they build up in the trees.
8	Monarch butterflies	These are a species of poisonous butterfliesthat feed on the milkweed plant. They are mainly found in North America. They appear beautiful and have bright-coloured scaly wings. Their predators fall sick if they eat them due to the poison and hence, avoid preying on them.
9	Poison Dart Frogs	Poison dart frogs are brightly coloured frogs found in the tropical rainforests of South and Central America. They have a poisonous skin and the poison is used on the tips of darts and arrows for hunting. The poison also works on their predators. They feed on small insects like spiders, ants and flies
10	Anaconda	These also known as the water boa, is the largest snake in the world and is mostly found in marshes and swamps. It is not venomous and it swallows its prey. It is a good climber and can

		go without food for almost a year after feeding on a big prey. It mostly hunts at night and kills its prey by constricting. It feeds on rodents, pigs, deer, birds, fish, etc
II	Golden Lion Tamarin	Golden lion tamarins are primates of the size of a squirrel, with a golden silky mane like that of a lion. They are arboreal; they live in families and are mainly found in the tropical rainforests of Brazil in South America. Golden lion tamarins mainly feed on insects, fruits and small birds. They have very strong legs with long, sharp claws that enable them to dig out insects from tree barks. They have been declared endangered due to the vast destruction of their habitats and also because they are poached for their golden silky mane.
12	Jaguar	Jaguars are species of wild cats found in the tropical rainforests of Central and South America. They prefer living in habitats that have water sources and they are good swimmers. They prey on capybaras, turtles, birds and reptiles. Jaguars are nocturnal animals with strong physical features like short limbs and an extremely strong jaw with long and sharp canine teeth. Jaguars are declared as endangered owing to their hunting and considerable loss of habitat.
13	Capybara	Capybaras are the largest rodents and are found in swamps, marshes and near rivers and lakes in Central and South America. They are found in large groups and are excellent swimmers. They mainly feed on aquatic plants, tree barks and fruits. They have barrel-shaped bodies with brownish fur and webbed feet to help them swim. They are preyed upon by jaguars, anacondas, harpy eagles, etc
14	Toco Toucan	Toco Toucans are the largest among their species and are mainly found in the Amazon river basin. Their striking feature is their long, curved bill and their bright colour. They cannot fly very well and are found hopping most of the time. They feed on bird eggs, frogs and fruits. They are social birds and live in cavities built in tree barks.

Some of the temperate animals are shown in the table below:

S/N	Zone	Animals
Ι	Australia	koalas, possums, wallabies, wombats, kookaburras, and many small marsupials
2	Europe	boars, badgers, squirrels, and songbirds
3	Canada and the United States	deer, bears, mountain lions, bobcats, rabbits,

	woodpeckers, and many smaller bir	
4	China	Giant pandas, red pandas

Others include Slugs, banana slug, *Nucifragacolumbiana*, *Dendeagapus obscurus*, *Ixoreusnaevis*, American bald eagle, American black bear, coyote, duckbill platypus, eastern chipmunk, fat dormouse, least weasel, and white -tailed bear.

#### 4.0 Conclusion

The prevailing condition in the tropical and temperate regions influence the flora and fauna found in these regions. The flora and fauna found in the regions have distinguishing features.

# 5.0 Summary

In this unit, you have learnt about the:

- tropical and the temperate regions
- flora and fauna in these regions
- differences between the organisms in the regions.

#### **6.0 Self-Assessment Exercise**

- 1. State the differences between tropical flora and temperate flora
- 2. State the features of five name tropical animals.

# 7.0 Reference/Further Reading

Fact Sheet: bald eagle, http://www.seaworld.org/animalbytes/ eaglefc. html

# Unit 3 Dispersal and Colonization of Plants and Animals

#### 1.0 Introduction

This unit explains the mechanisms of plants and animals dispersal. Dispersal helps in distribution of organisms, reduces competition and enhances occupation of new areas.

# 2.0 Objectives

At the end of this unit, you should be able to:

- relate the patterns of seed and animal dispersals
- describe the agents of plants and animals dispersal
- discuss factors affecting dispersal.

#### 3.0 Main Content

Species of animals and plants show some well-known patterns of distribution. Three laws that govern distribution and postulate that every species should be found everywhere unless:

- 1. It was unable to reach the place where it is absent due to barriers.
- 2. It was unable to stay and adapt there because of unfavourable conditions.
- 3. It became modifies into another species due to directional selection.

#### 3.1 Dispersal of Plants

Agents of plant dispersal: These include animals, wind, water, and force due to gravity.

Animals can act as dispersers of seeds by:

- eating fruit and seed and passing the seeds undamaged in faeces
- eating the fruit but discarding the seed
- transporting seeds which get caught or stick to the body of the animal.

One of the most important groups for seed dispersal is the pigeons. The rainforest species tend to be nomadic, moving around to take advantage of locally available fruit. Fruit bats are also important long-distance dispersal agents. Cassowaries are considered the main animal dispersal agent for many large-fruited trees. If an animal dispersal agent should ever become rare, the plant species dependent upon it would also be affected.

Rainforest trees with seeds adapted to dispersal by fruit eaters have traits which encourage certain dispersal agents and discourage others. Fruits with bird-dispersal traits are generally vibrantly coloured black, blue, red, orange or white. Bat-dispersed fruits are usually duller colours such as browns, greens or yellows.

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Plants have also evolved character traits which protect immature fruits from being eaten, including camouflage (e.g. unripe fruits are often green), spines and chemicals which make the unripe fruits unpalatable or poisonous to potential consumers.

**Wind dispersal**: Seeds which glide in a still environment are well represented amongst trees and lianes of tropical rainforests. Although wind dispersed seeds are common among canopy and emergent trees where both wind and height enhance the potential dispersal distance, it is also found in some tree species of the sub-canopy. Wind dispersed seeds are usually grey or brown, mimicking the colour of dead plant tissue.

**Water dispersal**: Dispersal of seed by water is basically confined to rainforest trees fringing watercourses. The woody material enclosing the seed of some tree species can float while the actual seed remains viable for considerable periods. This is a necessary requirement for species often found in riparian rainforests and species near salt water such as mangroves.

**Gravity dispersal**: While rolling down slopes may seem trivial, it is possibly the only means of dispersal for some species with large seeds. Generally, only a select few animals with a large gape can disperse large seeded species which highlights the importance of the cassowary as a dispersal agent (and as a keystone species) in Wet Tropics rainforests.

Seed dispersal must take place quickly. Seeds of many species of the primary forest have no dormancy period and lose viability quickly, remaining fertile for only a few weeks. Even seeds of the wider ranging secondary forests remain viable for only a few months and seeds which are enclosed by a fleshy fruit generally cannot tolerate prolonged desiccation.

#### 3.2 Means of Dispersal of Animals

All animals do not spread across the sea or other barriers with the same speed, some spread faster and others slowly and some do not cross the barriers at all. Therefore, distribution also depends on the animal's body size, psychology, reproductive rate, locomotory organs, physiological endurance and some means to carry them to long distances across barriers. Some means of dispersal are discussed below:

#### Land bridges

They are land connections between two large land masses which are separated by sea that may have existed in the past and facilitated movement of animals across them. The theory of land bridges was formulated to explain away discontinuous distribution of animals in continents that are presently separated by thousands of kilometres of oceans.

For instance, ostriches and lungfishes occur in South America, Africa and Australia and few species of marsupials are found in South America apart from their home in Australia and alligators exist in America and China. They are of two types, namely, Corridor bridges and Filter bridges.

#### Corridor bridges

They are land connections of continent size stretching across oceans and connecting two continents. When a single continental mass called Gondwanaland existed in Mesozoic, all southern continents, namely, South America, Africa, Australia and Antarctica were connected by huge corridors across which animals could freely migrate. The continuity of

southern land masses can account for the distribution of marsupials, lungfishes, flightless birds, side-neck turtles and crocodiles if we presume that the bridges existed after the origin of these groups and that Antarctica was a habitable continent at that time.

**South Atlantic Corridor**: This bridge is supposed to have connected South America with Africa and also included islands of St. Helena, Tristan da Cunha and Ascension and facilitated spread of lungfish, characin fish, pipid toads, ostriches, porcupines and monkeys which are common in both the continents today.

**Lemuria Corridor**: The continent of Lemuria is believed to have existed till early Coenozoic and connected Africa, Madagascar and India across which lemurs and their relative lorises spread.

Antarctica Corridor: This would have been the largest land bridge that connected South America with Australia through Antarctica during Mesozoic and its position was more northerly and habitable.

**PanamaCorridor**:During end Cretaceous and early Palaeocene North America and South America were connected by a narrow corridor, through which migrated to the south marsupials and early placentals such as Condylartha which were ancestors of modern ungulates. After Palaeocene this corridor submerged, disconnecting the two continents and isolating the South American fauna which then got a chance to diversify. The two continents again joined together sometime in Pliocene facilitating advent of New World Monkeys, rodents and placental carnivores.

**Arctic Corridor**:During Mesozoic Nearctic and Palaearctic Regions were connected by a broad corridor that later narrowed but continued until late Eocene, allowing free exchange of marsupials and insectivores and also freshwater fishes and amphibian.

Land bridge theory does not explain with certainty the distribution of late Mesozoic and Coenozoic animals and can perhaps be used to explain invertebrates, fish, amphibians and primitive reptiles as these animals existed when the super continents, Laurasia and Gondwanaland existed and animals were uniformly distributed over all continents.

#### Filter bridges

Filter bridges are series of islands between two land masses that allow some animals to spread across but stop others. The animals could spread by "island hopping", crossing small stretches of sea by swimming, flying, rafting or through wind. Such a filter bridge now exists between the Oriental and Australian Regions through Wallacea. The two regions are separated by a chain of islands called Malaya Archipelago and it is difficult to determine which island belongs to which region.

Two lines, namely, Wallace's line and Weber's line were suggested as boundaries and they enclose an area called Wallacea that contains large number of islands that serves as Filter Bridge between the Oriental and Australian regions.

Bering Strait contains a chain of islands that served as Filter Bridge during Oligocene and Miocene and then after Pleistocene between eastern Asia and Alaskan side of North America.

During late Cretaceous Africa got disconnected from Eurasia, was surrounding by sea on all sides and perhaps had a filter bridge in the north which lasted until late Oligocene. Arboreal

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primates such as lemurs and other prosimians and insectivores arrived in Africa from the Palaearctic through this route and later evolved into old world monkeys and apes.

#### **Sweepstakes**

Rafts, driftwood, icebergs and other floating objects in the sea can carry small animals, their eggs and other stages to long distances. But this is a one-way transport, uncertain and enormously dangerous. Natural rafts are made when trees are uprooted by storms, cyclones or hurricanes to make small floating islands on which insects, snails, reptiles of all kinds, rats, insectivores and other small animals can make a journey to islands thousands of miles away. Rats are known to be accomplished rafters and hence can boast of worldwide distribution.

Winds and storms: Wind is used by many plants for dispersal of their seeds for which they possess specialised aerodynamic structures to keep them airborne and drift to long distances. Flying insects can also be carried by air current to long distances across oceans. Insect nets tied to airplanes have collected insects at altitudes of 15,000 to 20,000 above sea level. Birds and bats can make use of favourable air currents to cross long stretches of sea.

**Through birds:** Birds being gifted with the power to fly can cross long stretches of sea to travel from one continent to another and to remote islands in the sea. Water birds can carry eggs of snails and seeds of plants on their legs and transport them across the sea. Parasites such as lice and mites can travel on their bodies hidden under the feathers and helminths in the intestine only to be released in remote uninhabited areas elsewhere.

**Human agency:** Rats, cockroaches, houseflies and grain feeding insects have been constant companions of man in habitation as well as in travel. They are quite common in cargo ships and have spread to all places visited by man. Pets such as dogs, cats, rabbits, sheep and goats have travelled with man to all parts of the world and have sometimes become wild as in Australia where otherwise placental mammals were unknown

# 3.3 Factors Affecting Dispersal of Animals and Plants

There are four main factors due to which animals and plants are prevented from spreading to every possible area:

#### Climate

Animals are adapted to a combination of temperature and humidity that is affected by rainfall. Lower temperature prevents majority of reptiles from migrating northwards into the temperate areas. Polar bear, penguins and a large number of mountain inhabiting species are adapted to cold climate and cannot come down to tropics and subtropics. Amphibians need high humidity not only for their survival but also for reproduction and hence cannot venture into areas of low rainfall.

Majority of animals cannot cross or survive in deserts due to extremely low moisture and high temperature. That makes deserts effective physical barriers. Fishes, although adapted to live in aquatic environment, are clearly restricted to either marine or freshwater habitats apparently due to osmotic problems.

Very few migratory fishes can make use of both environments such as species of salmons and eels that migrate thousands of kilometres for reproduction. Low temperature of mountains prevents certain animals such as parrots from spreading to these areas.

#### **Vegetation**

Like animals plants are also sensitive to temperature and rainfall and they affect dispersal of animals because the latter depend on vegetation for food. Tropical areas support broadleaved dense forests whereas in temperate areas only cold tolerant conifers can survive, each type harbours its distinctive fauna.

Desert climate can support few plants and thereby few animals. Some animals can feed on many types of vegetation and hence can spread to larger areas but others are choosy and would not accept anything except for their specialised diet. For instance, giant panda feeds on bamboo shoots in China and Koala can live only on eucalyptus leaves in Australia. Such animals cannot survive outside their habitats.

#### Other animals

Different animals at different tropic levels make food chains which are interwoven in a complex food web. Such interactions among animals often restrict a particular species to migrate alone to other areas. Interaction between predator and prey, parasite and host and among commensals and competitors pose complex problems in an ecosystem and any immigrating exotic species can upset the balance in the native population. Dingo dogs, placental cats and foxes are in a danger of exterminating native carnivores in Australia.

When two species have similar ecological requirements, they become competitors and one of the species is generally exterminated and restricted to a very small area. British red squirrel has reduced its range after the introduction of American grey squirrel. Similarly extinction of Tasmanian wolf is attributed to the arrival of dingo dogs in Australia. Parasites generally have specific hosts and hence must migrate together to new areas. Predators and prey also show similar interactions.

#### **Physical barriers**

Barriers such as mountains, deserts, rivers and oceans physically stop animals from invading new areas even when environment is conducive to their survival. For land animals water is a barrier and for aquatic animals land. Fresh water fishes and amphibians cannot cross seas but amphibious reptiles such as tortoises, lizards and snakes, owing to their thick and impervious skin have crossed seas to reach distant islands far away from the mainland.

Climate and scarcity of vegetation makes deserts and mountains effective barriers rather than inability of animals to walk over them. Generally, rivers and lakes do not form effective barriers for most of the vertebrate species if they are good swimmers and usually they are, and rivers form a network of highways for migrating freshwater fishes.

# 3.4 Principles of Animal Distribution

1. Animal species are distributed in areas where they are most adapted.

- 2. Different barriers act differently for different species depending on their modes of locomotion and dispersal.
- 3. Poikilotherms generally spread slowly as compared to homeotherms (birds and mammals).
- 4. Food, temperature, water etc. restrict animals to an area even without barriers. For example, penguins are restricted to Antarctica, giant panda to bamboo forests in China and Koala to eucalyptus forests of Australia.
- 5. Parasites generally disperse with their hosts and predators along with prey.
- 6. Majority of birds do not face any physical barriers due to their ability to fly over them.
- 7. Low temperature prevents tropical animals to migrate northwards and polar and temperate animals to migrate southwards.
- 8. For aquatic animals land is the barrier while for terrestrial animals sea, rivers and lakes are physical barriers.
- 9. Oceans act as barriers for freshwater fishes and amphibians due to osmotic problems.

#### 4.0 Conclusion

The dispersal of plants and animals is affected by certain factors and can be facilitated by certain agents. The availability and distribution of the organisms also depend on the climatic conditions and resources available.

# 5.0 Summary

In this unit, you have learnt the:

- agents of plant dispersal
- means and factors that affect animal dispersal
- distribution of animals.

#### **6.0 Self-Assessment Exercise**

- I. State the mechanisms of animal dispersal
- 2. What are the agents that facilitate plant dispersal.

# 7.0 Reference/Further Reading

Taggart, S. (2004). Biology: The Unity and Diversity of Life. (10th ed). Belmont, CA: Thomson Brooks/Cole.

# Unit 4 Floristic Regions of the World

#### L.0Introduction

In this unit, the different floristic kingdoms will be highlighted. A map showing the different kingdoms will be also provided.

# 2.0 Objective

At the end of this unit, you should be able to:

• state the six floristic regions of the world and their sub-kingdoms and regions.

#### 3.0 Main Content

Floristic regions of the world are grouped into six kingdoms. Each kingdom has regions and each region is subdivided into provinces. A floristic kingdom is the botanical analogue to an ecozone, which takes into account the distribution of animal as well as plant species.

#### 3.1 Holarctic Kingdom

Circumboreal, Eastern Asiatic, North American Atlantic, Rocky Mountain, Macaronesian Mediterranean, Saharo-Arabian, Irano-Turanian, and Madrean

# 3.2 Paleotropical Kingdom

Guineo-Congolian, Usambara-Zululand, Sudano-Zambezian, Karoo-Namib, St. Helena and Ascension, Madagascan, Indian, Indochinese, Malesian, Fijian, Polynesian, Hawaiian and Neocaledonian.

# 3.3 Neotropical Kingdom

Caribbean, Guayana Highlands, Amazonian, Brazilian, and Andean

# 3.4 South African Kingdom

Cape

# 3.5Australian Kingdom

Northeast Australian-Southwest Australian, Central Australian

# 3.6Antarctic Kingdom

Fernandezian · Chile-Patagonian · South Subantarctic Islands · Neozeylandic

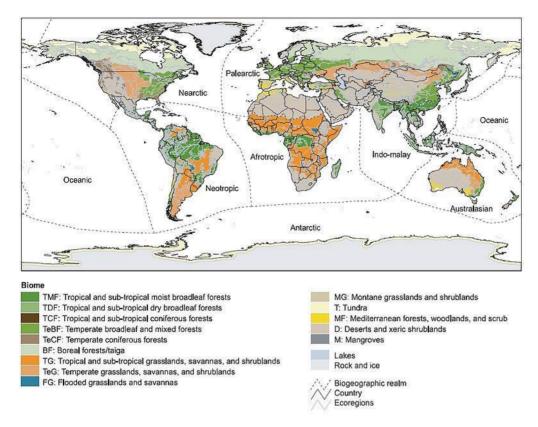


Fig.4.1: World Map Showing the different Floristic Kingdoms and Regions

#### 4.0 Conclusion

There are six floristic kingdoms with each kingdom subdivided into subkingdoms, provinces and regions.

# 5.0 Summary

In this unit, you have learnt the different floristic kingdoms and their global locations with the aid of the world floristic map attached.

#### **6.0 Self-Assessment Exercise**

State the different floristic kingdoms and the regions in each kingdom

# 7.0 Reference/Further Reading

Taggart, S. (2004). Biology: The Unity and Diversity of Life. (10thed). Belmont, CA: Thomson Brooks/Cole.

# Unit 5 Holarctic Kingdom

#### 1.0 Introduction

In this unit, the nature and location of the Holarctic kingdom will be explained. The different kingdoms, regions, and provinces of the Holarctic kingdom will also be explained. Some endemic plants in the kingdom will be highlighted.

# 2.0 Objectives

At the end of this unit, you should be able to:

- evaluate general nature of the Holarctic kingdom
- mention sub-divisions and the regions of the Holarctic kingdom
- analyse the organisms endemic in the Holarctic kingdom.

#### 3.0 Main Content

#### 3.1 General Description of the Holarctic Kingdom

The Boreal Kingdom or Holarctic Kingdom (Holarctic) is a floristic kingdom identified by botanist Ronald Good (and later by Armen Takhtajan), which includes the temperate to Arctic portions of North America and Eurasia. Its flora is inherited from the ancient supercontinent of Laurasia. However, much of the floristic kingdom (and most of its Circumboreal Region) was glaciated during the Pleistocene and has a very young flora. Tertiary relicts found refuge in the southern and mountainous parts of the kingdom, especially in the Eastern Asiatic Region and North American Atlantic Region.

Good noted that the plant species of temperate North America and Eurasia were very closely related, despite their separation by the Atlantic Ocean and the Bering Strait.

Millions of years ago, before the opening of the Atlantic Ocean, North America and Eurasia were joined as a single continent, Laurasia. After the opening of the Atlantic, the continents were connected to one another periodically via land bridges linking Alaska and Siberia.

Until a few million years ago, the global climate was warmer than at present, especially at higher latitudes, and many temperate climate species were distributed across North America and Eurasia via Alaska and Siberia. The sharply cooler climate of the past few million years eliminated a temperate-zone connection between North America and Eurasia, but common Laurasian origins and a long history of temperate-climate land bridges account for the botanical similarities between the temperate floras on the two continents.

Many biogeographers distinguish the Boreal Kingdom as comprising two ecozones, the Nearctic (North America) and Palearctic (Eurasia). Others, based on the distribution of related plant and animal families, include the Palearctic and Nearctic in a single Holarctic ecozone, which corresponds to Good's Boreal Kingdom.

The kingdom is subdivided into three floristic subkingdoms and nine floristic regions. These include: Boreal Subkingdom, Tethyan Subkingdom and Madrean Subkingdom.

#### 3.2 Subdivisions of the Holarctic Kingdom

**Boreal Sub-kingdom:** Circumboreal Region, Eastern Asiatic Region, North American Atlantic Region, Rocky Mountain Region.

**Tethyan Sub-kingdom:** Macaronesian Region, Mediterranean Region, Saharo-Arabian Region, Irano-Turanian Region.

Madrean Sub-kingdom: Madrean Region.

#### 3.3 The Circumboreal Region

The Circumboreal Region is a floristic region within the Holarctic Kingdom in Eurasia and North America, as delineated by such geobotanists as Josias Braun-Blanquet and Armen Takhtajan. It is the largest floristic region in the world by area, comprising most of Canada, Alaska, Europe, Caucasus and Russia, as well as North Anatolia (as the southernmost part of the region) and parts of northern New England, Michigan, and Minnesota. Many geobotanists divide the Eurasian and North American areas into two distinct regions.

The continents, however, share much of their boreal flora (e.g. Betula nana, Alnusviridis, Vacciniumvitis-idaea, Arctostaphylosuva-ursi). The flora was severely impoverished during glaciations in the Pleistocene. The region is bordered by Eastern Asiatic, North American Atlantic, Rocky Mountain, Mediterranean and Irano-Turanian Regions.

There are no biological families endemic to this region, but it has endemic genera (e.g. Lunaria, Borodinia, Gorodkovia, Redowskia, Soldanella, Physospermum, Astrantia, Thorella, Pulmonaria, Erinus, Ramonda, Haberlea, Jankaea, Stratiotes, Telekia) and a lot of endemic species, especially in the mountains.

Floristic Provinces: It is subdivided into a number of floristic provinces. Their delineation is debatable. According to a version of Takhtajan's classification, these are the Arctic, Atlantic European, Central European, Illyrian, Euxinian, Caucasian, Eastern European, Northern European, West Siberian, Altai-Sayan, Central Siberian, Transbaikalian, Northeastern Siberian, Okhotsk-Kamtchatkan and Canadian Provinces.

**Arctic Province:** (Greenland, Iceland, northern treeless parts of Norway, Finland, Russia, Alaska and Canada, all the Arctic Islands), with one endemic genus (Diapensia) and more than a hundred endemic species (e.g. Ranunculussabinei, Papaver polare, Salix arctica, Colpodiumvahlianum, Colpodiumwrightii, Puccinelliaangustata).

**Atlantic European Province:** (Ireland, United Kingdom, Andorra, parts of Portugal, Spain, France, Belgium, Netherlands, Germany, Denmark and Norway), with two endemic genera (Petrocoptis and Thorella), few dozens of endemic species (e.g. *Corydalis claviculata*, *Ulexeuropaeus, Genistaanglica*, *Deschampsiasetacea*).

**Central European Province:** (Austria, Switzerland, Luxembourg, Poland, Czech Republic, Slovakia, Hungary, parts of Croatia, Slovenia, Italy, France, Belgium, Netherlands, Germany, Denmark, Norway, Sweden, Finland, Russia, Estonia, Latvia, Lithuania, Belarus, Ukraine,

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Moldova, Romania), with several endemic genera (e.g. Rhizobotrya, Hacquetia, Hladnikia, Berardia) and 10-15% endemic species (e.g. Aconitum paniculatum, Dianthus alpinus, Rhododendron hirsutum, Soldanellacarpatica, Rosa abietina, Saxifragamuscoides, Trifoliumsaxatile, Chaerophyllumvillarsii, Heracleumcarpaticum, Syringajosikaea, Valerianatripteris, Campanula zoysii, Campanulacarpatica, Pulmonariafilarzkyana, Leontopodiumalpinum, Narcissus poeticus, Narcissus angustifolius, Gymnadeniaalbida, Carexcarvula, Calamagrostisvillosa).

Illyrian Province: (Bosnia and Herzegovina, Serbia, Kosovo, Republic of Macedonia, parts of Slovenia, Croatia, Montenegro, Albania, Bulgaria, Greece and Turkey) with several endemic genera (e.g. Haberlea and Jankaea) and many endemic species (e.g. Ramondanathaliae, Ramondaserbica, Piceaomorika, Pinusheldreichii, Pinuspeuce, Rheum rhaponticum, Aesculushippocastanum, Forsythia europaea, Lathraearhodopea, Wulfeniabaldacci, Solenanthusscardicus, Amphoricarpusneumayeri, Nartheciumscardicum, Dioscoreabalcanica).

**Euxinian Province:** (parts of Bulgaria, Turkey, Georgia and Russia around the Black Sea), with two endemic genera (Chymsidia and Megacaryon) and many endemic species (e.g. Abiesnordmanniana, Epimediumpubigerum, Quercuspontica, Quercushartwissiana, Betulamedwedewii, Betulamegrelica, Coryluscolchica, Coryluspontica, Paeoniawittmanniana, Hypericumbupleuroides, Hypericumxylosteifolium, Rhododendron ungernii, Rhododendron smirnovii.

Others areEpigaeagaultherioides, Primula megaseifolia, Cyclamen adsharicum, Andrachnecolchica, Trapacolchica, Staphyleacolchica, Hederacolchica, Astrantiapontica, Heracleummantegazzianum, Seselirupicola, Rhamnusimeretinus, Osmanthusdecorus, Trachystemonorientalis, Rhamphicarpamedwedewii, Gentianaparadoxa, Scabiosaolgae, Campanula mirabilis, Campanulalactiflora, Inulamagnifica, Liliumponticum, Ruscuscolchicus, Dioscoreacaucasica, Campanula mirabilis), some endemic species and genera shared with the Caucasian Province.

Caucasian Province: (parts of Russia, Georgia, Armenia and Azerbaijan), with five endemic genera (Pseudovesicaria, Symphyoloma, Pseudobetckea, Trigonocaryum and Cladochaeta) and many endemic species (e.g. Betularaddeana, Papaver oreophilum, Corydalis pallidiflora, Corydalisemanuelii, Cerastiumkasbek, Cerastiumargenteum, Cerastiummultiflorum, Minuartiainamoena, Silenalacera, Gypsophila acutifolia.

Others are Dianthus fragrans, Sobolevskiacaucasica, Drababryoides, Drabaelisabethae, Drabasupranivalis, Drabamolissima, Drabaossetica, Primula bayernii, Saxifragasubverticillata, Sedum stevenianum, Geranium renardii, Oxytropisowerinii, Genlianagrossheimii, Gentinanaseptemfida var. lagodechiana, Gentianamarcowiczii, Veronica caucasica, Campanula andina, Centaureaamblyolepis, Liliummonadelphum, Galanthuslatifolius, Ornithogalum magnum, Colchicum laetum, Asphodolinetenuior, Gageahelenae, Calamagrostiscaucasica), many endemic species and genera shared with the Euxinian Province (e.g. Agasyllis, Sredinskya, Rhododendron caucasicum, Vacciniumarctostaphylos, Daphne pontica, Paris incompleta).

**Eastern European Province:** (parts of Estonia, Latvia, Lithuania, Russia, Belarus, Ukraine, Moldova and Romania) without endemic genera, with some endemic species (e.g. Anemone uralensis, Papaver maeoticum, Dianthus eugeniae, Dianthus krylovianus, Dianthus volgicus, Diplotaxiscretacea, Sisymbriumwolgense, Syreniatalievii, Pyrusrossica, Hedysarumcretaceum, Hedysarumucrainicum, Erodiumbeketowii, Linariacretacea, Linariamacroura, Scrophulariacretacea).

Northern European Province (parts of Finland, Sweden, Norway and Russia); without endemic genera, but with few endemic species (e.g. Corispermumalgidum, Castillejaschrenkii).

West Siberian Province: (parts of Russia and Kazakhstan), without endemic genera, with few endemic species.

Altai-Sayan Province: (Parts of Russia and Mongolia), with one endemic genus (Microstigma) and many endemic species (e.g. Callianthemumsajanense, Eranthissibirica, Aquilegia borodinii, Delphinium mirabile, Delphinium inconspicuum, Aconitum krylovii, Aconitum altaicum, Anemone baicalensis, Ranunculussajanensis, Gymnospermiumaltaicum, Betulakelleriana, Stellariamartjanovii, Stellariaimbricata, Stellariairrigua, Sileneturgida, Aphragmusinvolucratus, Erysimuminense, Euphorbia alpine.

Others are Euphorbia altaica, Euphorbia tshuiensis, Rhodiolaalgida, Sedum populifolium, Chrysospleniumfilipes, Caraganaaltaica, Vicialilacina, Lathyrusfrolovii, Lathyruskrylovii, Linumviolascens, Scrophulariaaltaica, Schizonepetaannua, Valerianapetrophila, Brachanthemumbaranovii, Echinopshumilis, Saussureaserratuloides, Saussureasajanensis, Allium pumilum, Carextatjanae, species of Astragalus and Oxytropis).

**Central Siberian Province:** (parts of Russia) without endemic genera, with but few endemic species.

**Transbaikalian Province:** (Parts of Russia and Mongolia) without endemic genera, with some endemic species (e.g. Aconitum montibaicalensis, Drababaicalensis, Saxifragaalgisii, Potentillaadenotricha, Astragalustrigonocarpus, Oxytropisheterotricha, Mertensiaserrulata).

Northeastern Siberian Province: (parts of Russia), with one endemic genus (Gorodkovia) and many endemic species (e.g. Corydalis gorodkovii, Androsacegorodkovii, Saxifragaanadyrensis, Potentillaanadyrensis, Potentillatollii, Helictotrichonkrylovii, Poalanatiflora).

**Okhotsk-KamchatkanProvince:** (parts of Russia), with one endemic genus (Redowskia) and many endemic species (e.g. Abiesgracilis, Piceakamtschatkensis, Delphinium ochotense, Aconitum ajanense, Aconitum ochotense, Corydalis redowskii, Stellariapeduncularis, Arenariaredowskii, Lychnisajanensis, Sorbuskamtschatcensis, Oxytropisajanensis, Oxytropistilingii, Sambucuskamtschatica).

# 3.3 Tethyan Sub-kingdom

This is divided into the macronesia region, the Mediterranean region

# 3.4 Macaronesia Region

Macaronesia is a modern collective name for several groups of islands in the North Atlantic Ocean near Europe and North Africa belonging to three countries: Portugal, Spain, and Cape Verde. The name (which is often misspelt 'Macronesia') comes from the Greek for "islands of the fortunate" μακάρωννῆσοιmakárōnnêsoi, a term used by Ancient Greek geographers for islands to the west of the Straits of Gibraltar.

Macaronesia consists of five archipelagos:

- Azores (Portugal)
- Canary Islands (Spain)
- Cape Verde (Cape Verde)
- Madeira, including Porto Santo Island and the Desertas Islands (Portugal)
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Savage Islands (Portugal), administratively part of the Madeira Autonomous Region.

The islands of Macaronesia are volcanic in origin, and are thought to be the product of several geologic hotspots. The climate of the Macaronesian islands ranges from subtropical to tropical. The Portuguese archipelagos of the Azores and Madeira have a generally cooler climate and higher rainfall than the Canaries and Cape Verde.

The islands have a unique biogeography, and are home to several distinct plant and animal communities. None of the Macaronesian islands were part of a continent, so the native plants and animals reached the islands via long-distance dispersal. Laurel-leaved forests, called laurisilva, once covered most of the Azores, Madeira, and parts of the Canaries between 400–1200 m altitude (the eastern Canaries and Cape Verde being too dry).

These forests resemble the ancient forests that covered the Mediterranean basin and northwestern Africa before cooling and drying of the ice ages. Trees of the genera Apollonias (Lauraceae), Clethra (Clethraceae), Dracaena (Ruscaceae), Ocotea (Lauraceae), Persea (Lauraceae), and Picconia (Oleaceae), which are found in the Macaronesian laurel forests, are also known from fossils to have lived around the Mediterranean before the ice ages.

Felling of the forests for timber and firewood, clearing vegetation for grazing and agriculture, and the introduction of exotic plants and animals by humans has displaced much of the native vegetation. The laurisilva has been reduced to small pockets. As a result, many of the endemic biota of the islands are seriously endangered or extinct.

#### **Mediterranean Basin**

The Mediterranean Basin comprises the lands around and surrounded by the Mediterranean Sea. In biogeography, the Mediterranean Basin refers to the lands around the Mediterranean Sea that have a Mediterranean climate, with mild, rainy winters and hot, dry summers, which supports characteristic Mediterranean forests, woodlands, and scrub vegetation. As a rule of thumb, the Mediterranean Basin is the Old World region where olive trees grow.

#### Geography

The Mediterranean basin covers portions of three continents, Europe, Asia, and Africa. Europe lies to the north, and three large Southern European peninsulas, the Iberian Peninsula, Italian Peninsula, and the Balkan Peninsula, extend into the Mediterranean-climate zone.

A system of folded mountains, including the Pyrenees dividing Spain from France, the Alps dividing Italy from Central Europe, the Dinaric Alps along the eastern Adriatic, and the Balkan and Rhodope mountains of the Balkan Peninsula divide the Mediterranean from the temperate climate regions of Western and Central Europe.

The Mediterranean Basin extends into Western Asia, covering the western and southern portions of the peninsula of Turkey, excluding the temperate-climate Mountains of central Turkey. It includes the Mediterranean climate Levant at the eastern end of the Mediterranean, bounded on the east and south by the Syrian and Negev deserts.

The northern portion of the Maghreb region of north-western Africa has a Mediterranean climate, separated from the Sahara Desert, which extends across North Africa, by the Atlas Mountains.

In the eastern Mediterranean the Sahara extends to the southern shore of the Mediterranean, with the exception of the northern fringe of the peninsula of Cyrenaica in Libya, which has a dry Mediterranean climate.

#### Flora and fauna

**Aphyllantes** 

Phytogeographically, the Mediterranean basin together with the nearby Atlantic coast, the Mediterranean woodlands and forests and Mediterranean dry woodlands and steppe of North Africa, the Black Sea coast of northeasten Anatolia, the southern coast of Crimea between Sevastopol and Feodosia and the Black Sea coast between Anapa and Tuapse in Russia forms the Mediterranean Floristic Region, which belongs to the Tethyan Subkingdom of the Boreal Kingdom and is enclosed between the Circumboreal, Irano-Turanian, Saharo-Arabian and Macaronesian floristic regions.

The Mediterranean Region was first proposed by German botanist August Grisebach in the late 19th century. Drosophyllaceae, recently segregated from Droseraceae, is the only plant family endemic to the region. Among the endemic plant genera are:

Tetraclinis	Rupicapnos	Ceratocapnos
Soleirolia	Ortegia	Bolanthus
Lycocarpus	lonopsidium	Bivonaea
Euzomodendron	Hutera	Vella
Boleum	Didesmus	Morisia
Guiraoa	Malope Droso	phyllum
Ceratonia	Chronanthus	Anagyris
Callicotome	Spartium	Hymenocarpus
Biserrula	Argania	Petagnia
Lagoecia	Putoria	Fedia
Tremastelma	Bellardia	Lafuentea
Rosmarinus	Argantoniella	Preslia
Gyrocarion	Dorystoechas	Coridothymus
Trachelium	Santolina	Cladanthus
Staehelina	Leuzea	Andryala
Rothmaleria	Chionodoxa	Hermodactylus
Triplachne	Helicodiceros	Chamaerops

The genera Aubrieta, Sesamoides, Cynara, Dracunculus, Arisarum and Biarum are nearly endemic. Among the endemic species prominent in the Mediterranean vegetation are the

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Aleppo Pine, Stone Pine, Mediterranean Cypress, Bay Laurel, Oriental Sweetgum, Holm Oak, Kermes Oak, Strawberry Tree, Greek Strawberry Tree, Mastic, Terebinth, Common Myrtle, Oleander, *Acanthus mollis, Vitexagnus-castus*. Moreover, many plant taxa are shared with one of the four neighboring floristic regions only.

According to different vesions of Armen Takhtajan's delineation, the Mediterranean Region is further subdivided into seven to nine floristic provinces: Southwestern Mediterranean (or Southern Moroccan and Southwestern Mediterranean), Ibero-Balearian (or Iberian and Balearian), Liguro-Tyrrhenian, Adriatic, East Mediterranean, South Mediterranean and Crimeo-Novorossiysk.

The Mediterranean Basin is the largest of the world's five Mediterranean forests, woodlands, and scrub regions. It is home to a number of plant communities, which vary with rainfall, elevation, latitude, and soils.

Scrublands occur in the driest areas, especially areas near the seacoast where wind and salt spray are frequent. Low, soft-leaved scrublands around the Mediterranean are known as garrigue in France, phrygana in Greece, tomillares in Spain, and batha in Israel.

Shrublands are dense thickets of evergreen sclerophyll shrubs and small trees, and are the commonest plant community around the Mediterranean. Mediterranean shrublands are known as matorral in Spain, macchia in Italy, and maquis in France, Malta and elsewhere around the Mediterranean. In some places shrub lands are the mature vegetation type, and in other places the result of degradation of former forest or woodland by logging or overgrazing, or disturbance by major fires.

Savannas and grasslands occur around the Mediterranean, usually dominated by annual grasses.

Woodlands are usually dominated by oak and pine, mixed with other sclerophyll and coniferous trees.

Forests are distinct from woodlands in having a closed canopy, and occur in the areas of highest rainfall and in riparian zones along rivers and streams where they receive summer water. Mediterranean forests are generally composed of evergreen trees, predominantly oak and pine. At higher elevations Mediterranean forests transition to mixed broadleaf and tall conifer forests similar to temperate zone forests.

The Mediterranean Basin is home to considerable biodiversity, including 22,500 endemic vascular plant species. Conservation International designates the region as a biodiversity hotspot, because of its rich biodiversity and its threatened status. The Mediterranean Basin has an area of 2,085,292 km², of which only 98,009 km² remains undisturbed.

Endangered mammals of the Mediterranean Basin include the Mediterranean Monk Seal, the Barbary Macague, and the Iberian Lynx.

Table 1.3: Ecoregions

Ecoregions	Vegetation	Locations
Aegean and Western Turkey	sclerophyllous and mixed forests	Greece, Turkey

Anatolian	conifer and deciduous mixed forests	Turkey
Canary Islands	dry woodlands and forests	Spain
•	,	•
Corsican	montane broadleaf and mixed forests	France
Crete	Mediterranean forests	Greece
Cyprus	Mediterranean forests	Cyprus
Eastern Mediterranean	conifer-sclerophyllous-	Lebanon, Israel, the West
	broadleaf forests	Bank, the Gaza Strip, Jordan, Syria, Turkey
Iberian	conifer forest	Portugal, Spain
	sclerophyllous and semi- deciduous forests	
Illyrian	deciduous forests	Albania, Bosnia and
,		Herzegovina, Croatia,
		Greece, Italy, Slovenia
Italian	sclerophyllous and semi- deciduous forests	France, Italy
Mediterranean	acacia-argania dry woodlands and succulent thickets	Morocco, Canary Islands (Spain
Mediterranean	dry woodlands and steppe	Algeria, Egypt, Libya, Morocco, Tunisia
Mediterranean	woodlands and forests	Algeria, Morocco, Tunisia
Northeastern Spain and Southern France	Mediterranean forests	France, Spain
Northwest Iberian	montane forests	Portugal, Spain
Pindus Mountains	mixed forests	Albania, Greece, Macedonia
South Apennine	mixed montane forests	Italy
Southeastern Iberian	shrubs and woodlands	Spain
Southern Anatolian	montane conifer and deciduous forests	Lebanon, Israel, Jordan, Syria, Turkey
Southwest Iberian	Mediterranean sclerophyllous and mixed forests	France, Italy, Morocco, Portugal, Spain
Tyrrhenian-Adriatic	sclerophyllous and mixed	Croatia, France, Italy, Malta

forests	

#### 3.5 Saharo-Arabian Region

The Saharo-Arabian Region is a floristic region of the Holarctic Kingdom proposed by Armen Takhtajan. The region is covered by hot deserts, semideserts and savannas.

#### Distribution

The Saharo-Arabian Region occupies the temperate parts of the Sahara desert, Sinai Peninsula, Arabian Peninsula (geographically defined), Southern Palestine and Lower Mesopotamia.

#### Flora

Much of its flora is shared with the neighboring Mediterranean and Irano-Turanian Regions of the Holarctic Kingdom and Sudano-Zambezian Region of the Paleotropical Kingdom. However, about a quarter of the species, especially in the families Asteraceae, Brassicaceae and Chenopodiaceae, are endemic.

#### **Endemism**

Some of the endemic genera are Nucularia, Fredolia, Agathophora, Muricaria, Nasturtiopsis, Zilla, Oudneya, Foleyola, Lonchophora, Gymnarrhena, Lifago.

#### 3.6 Madrean Region

The Madrean Region (named after the Sierra Madre Occidental) is a floristic region within the Holarctic Kingdom in North America, as delineated by Armen Takhtajan and Robert F. Thorne. It occupies arid or semiarid areas in the southwestern United States and northwestern Mexico and is bordered by the Rocky Mountain Region and North American Atlantic Region of the Holarctic Kingdom in the north and in the east, as well as by the Caribbean Region of the Neotropical Kingdom in the south.

The Madrean Region is characterised a very distinct flora with at least three endemic families (Fouquieriaceae, Simmondsiaceae, and Setchellanthaceae). Crossosomataceae, Garryaceae, Lennoaceae, Limnanthaceae and Stegnospermataceae have their principal development here; for Onagraceae, Polemoniaceae and Hydrophyllaceae, it is the major centre of diversity. More than 250 genera and probably more than half of the species of the region are endemic to it according to Takhtajan.

#### Floristic provinces

The Madrean region is subdivided into four floristic provinces: They are

Great Basin Province, Californian Province, Sonoran Province and Mexican Highlands Province.

**Great Basin Province:** The Great Basin Province includes most of the Great Basin. It shares much of its flora with the neighboring provinces and has but few endemic genera. Species endemism is also moderate (about 25%), but is much more considerable in such genera as Astragalus, Eriogonum, Penstemon, Cymopterus, Lomatium, Cryptantha,

Chrysothamnus, Erigeron, Phacelia, Castilleja, and Gilia. The vegetation is dominated by Artemisia species and Chenopodiaceae in the central part of the province.

Californian Province: The Californian Province occupies Central and Southern California from the seashore to the foothills of the Cascade Range, the Sierra Nevada range, and northern parts of Baja California in Mexico. It possesses the most diverse flora within the floristic region. About half of the species are endemic. More than 50 genera (e.g. Adenostoma, Bergerocactus, Carpenteria, Cneoridium, Dendromecon, Fremontodendron, Jepsonia, Lyonothamnus, Neostapfia, Odontostomum, Ornithostaphylos, Pickeringia, Romneya) are endemic or near-endemic as well.

Arctostaphylos, Brodiaeinae, Calochortus, Caulanthus, Streptanthus, Ceanothus, Cryptantha, Downingia, Dudleya, Eritrichieae, Eriogonoideae, Gileae, Hydrophyllaceae, Limnanthaceae, Lotus, Madiinae, Mimulus, Onagreae, Epilobieae, Orcuttieae, Eschscholzioideae, Platystemonoideae, Astragalus and Cupressus have a principal centre of diversity within the province. The flora of the Californian Province is partially shared with the spatially distant Chile-Patagonian Region of the Antarctic Kingdom and to a lesser extent Mediterranean Region of the Holarctic Kingdom.

The vegetation of the Californian Province is varied. Wetter northern parts of the Californian Province (Northern California and Oregon) as defined by Peter Raven and D.I. Axelrod, as well as by Conservation International, fall under the Rocky Mountain Region in Takhtajan and Thorne's system and don't make parts of the Madrean Region.

**Sonoran Province:** The Sonoran Province comprises arid areas in the southwestern U.S. and northwestern Mexico from California and Baja California to Texas and Tamaulipas, including the Mojave (characterised by Yucca brevifolia, Joshua Tree), Sonora and Chihuahua Deserts. The vegetation is dominated by Yucca, Cactaceae species (Opuntia spp. and other), as well as by Larreatridentata (Creosote bush).

**Mexican Highlands Province:** The Mexican Highlands Province comprises areas in the Mexican Plateau region, including Madrean pine-oak woodlands.

#### 4.0 Conclusion

The Holarctic Kingdom is made up of three sub-kingdoms. Each sub-kingdom has floristic provinces and regions. Several plants are endemic in this kingdom.

# 5.0 Summary

In this unit, you have learnt the:

- general nature of the Holarctic kingdom
- Sub-kingdom, provinces and regions of the Holarctic Kingdom
- plants that are endemic in this kingdom.

#### **6.0 Self-Assessment Exercise**

- 1. State the regions of each of the sub-kingdoms of the Holarctic kingdom.
- 2. State the eco-zones of the holarctic region.
- 29 downloaded for free as an Open Educational Resource at oer.nou.edu.ng

3. Give seven eco-regions of the Holarctic kingdom stating the type of plants found each eco-region and the countries where such eco-region is found.

# 7.0 Reference/Further Reading

Dallman, P. F. (1998). *Plant Life in the World's Mediterranean Climates*. California Native Plant Society, California: University of California Press, Berkeley.